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Canadian Intellectual Property Office
An agency of Industry Canada

CA 2788100 A1 2014/02/28

(21) 2 788 100

(12) DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION

(13) A1

(22) Date de dépôt/Filing Date: 2012/08/28

(41) Mise à la disp. pub./Open to Public Insp.: 2014/02/28

(51) Cl.Int./Int.Cl. *G06F 17/00* (2006.01),
H04L 12/26 (2006.01)

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(54) Titre : BALAYAGE INCREMENTIEL DE CONTENU COTE SERVEUR GENERE
(54) Title: CRAWLING OF GENERATED SERVER-SIDE CONTENT

(57) Abrégé/Abstract:
An illustrative embodiment of a computer-implemented process for selective processing of items having embedded delay actions, receives an item to process containing a delay action, processes the item using a delay action process, wherein the delay action process comprises exploring dynamically generated server-side content of the item received, by recognizing when a wait occurs for a server process, and performing one of a wait for a predetermined period of time, or circumventing an actual wait, to generate a result and returns the result to a requester.

ABSTRACT OF THE DISCLOSURE

An illustrative embodiment of a computer-implemented process for selective processing of items having embedded delay actions, receives an item to process containing a delay action, processes the item using a delay action process, wherein the delay action process comprises exploring dynamically generated server-side content of the item received, by recognizing when a wait occurs for a server process, and performing one of a wait for a predetermined period of time, or circumventing an actual wait, to generate a result and returns the result to a requester.

CRAWLING OF GENERATED SERVER-SIDE CONTENT

BACKGROUND

1. Technical Field:

[0001] This disclosure relates generally to rich Internet applications in a data processing system and more specifically to Web applications using scripting in the data processing system.

2. Description of the Related Art:

[0002] Intrinsic nature of a webpage requires code executed at a client side, in the web browser, to wait for a web server response. Typically the client side does not need to wait for a long period of time for the content to arrive from the server. However, there are situations requiring a longer waiting time, including for example, generation of a report, processing of the data entered by the user, and locating information required for the response.

[0003] In cases where a longer waiting time are evident, web designers typically use a visual representation of the waiting time in a text or graphical form, such as a waiting bar, a message displayed to the user, or simply an image of a clock, or other visual cue. The visual representation enables the user too understand content is currently being processed and generated by the website, and the user needs to wait for processing to finish.

[0004] In contrast, a web crawler is not able to detect an operation is in progress unless the web crawler examines at the code for the page and use a strategy to understand the code is waiting for the user response. In these situations, to automatically explore the dynamically generated server-side web content, a web crawler would need to understand when the client waits for the server, and do the same.

[0005] There are however, alternative methods enabling the user to *record* user actions. Throughout such recording, the crawler could monitor generated hypertext transport protocol (HTTP) traffic and extract content from the traffic. A disadvantage of this method is a need for user input. In addition, depending on implementation, an additional disadvantage may arise due to not analyzing the content returned by the web server in the context of the current page.

SUMMARY

[0006] According to one embodiment, a computer-implemented process for selective processing of items having embedded delay actions, receives an item to process containing a delay action, processes the item using a delay action process, wherein the delay action process comprises exploring dynamically generated server-side content of the item received, by recognizing when a wait occurs for a server process, and performing one of a wait for a predetermined period of time, or circumventing an actual wait, to generate a result and returns the result to a requester..

[0007] According to another embodiment, a computer program product for selective processing of items having embedded delay actions, comprises a computer recordable-type media containing computer executable program code stored thereon. The computer executable program code comprises computer executable program code for receiving an item to process containing a delay action, computer executable program code for processing the item using a delay action process, wherein the delay action process comprises exploring dynamically generated server-side content of the item received, by recognizing when a wait occurs for a server process, and performing one of a wait for a predetermined period of time, or circumventing an actual wait, to generate a result and computer executable program code for returning the result to a requester.

[0008] According to another embodiment, an apparatus for selective processing of items having embedded delay actions comprises a communications fabric, a memory connected to the communications fabric, wherein the memory contains computer executable program code, a communications unit connected to the communications fabric, an input/output unit connected to the communications fabric, a display connected to the communications fabric and a processor unit connected to the communications fabric. The processor unit executes the computer executable program code to direct the apparatus to receive an item to process containing a delay action, process the item using a delay action process, wherein the delay action process comprises exploring dynamically generated server-side content of the item received, by recognizing when a wait occurs for a server process, and performing one of a wait for a predetermined period of time, or circumventing an actual wait, to generate a result and return the result to a requester.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0009] For a more complete understanding of this disclosure, reference is now made to the following brief description, taken in conjunction with the accompanying drawings and detailed description, wherein like reference numerals represent like parts.

[0010] **Figure 1** is a block diagram of an exemplary network data processing system operable for various embodiments of the disclosure;

[0011] **Figure 2** is a block diagram of an exemplary data processing system operable for various embodiments of the disclosure;

[0012] **Figure 3** is a block diagram of a system operable for various embodiments of the disclosure;

[0013] **Figure 4** is a block diagram of screenshots in accordance with one embodiment of the disclosure;

[0014] **Figure 5** is a flowchart of delay action processing using the system of **Figure 3** operable for various embodiments of the disclosure;

[0015] **Figure 6** is a flowchart of a hybrid process using the delay action processing of **Figure 5** operable for various embodiments of the disclosure; and

[0016] **Figure 7** is a flowchart of an alternative embodiment of the hybrid process of **Figure 6** operable for various embodiments of the disclosure.

DETAILED DESCRIPTION

[0017] Although an illustrative implementation of one or more embodiments is provided below, the disclosed systems and/or methods may be implemented using any number of techniques. This disclosure should in no way be limited to the illustrative implementations, drawings, and techniques illustrated below, including the exemplary designs and implementations illustrated and described herein, but may be modified within the scope of the appended claims along with their full scope of equivalents.

[0018] As will be appreciated by one skilled in the art, aspects of the present disclosure may be embodied as a system, method or computer program product. Accordingly, aspects of the present disclosure may take the form of an entirely hardware embodiment, an entirely software embodiment (including firmware, resident software, micro-code, etc.) or an embodiment combining software and hardware aspects that may all generally be referred to herein as a "circuit," "module," or "system." Furthermore, aspects of the present invention may take the form of a computer program product embodied in one or more computer readable medium(s) having computer readable program code, instructions, embodied thereon.

[0019] Any combination of one or more computer-readable data storage medium(s) may be utilized. A computer-readable data storage medium may be, for example, but not limited to, an electronic, magnetic, optical, or semiconductor system, apparatus, or device, or any suitable combination of the foregoing. More specific examples (a non-exhaustive list) of the computer-readable data storage medium would include the following: a portable computer diskette, a hard disk, a random access memory (RAM), a read-only memory (ROM), an erasable programmable read-only memory (EPROM or Flash memory), a portable compact disc read-only memory (CDROM), an optical storage device, or a magnetic storage device or any suitable combination of the foregoing. In the context of this document, a computer-readable data storage medium may be any tangible medium that can contain, or store a program for use by or in connection with an instruction execution system, apparatus, or device.

[0020] A computer-readable signal medium may include a propagated data signal with the computer-readable program code embodied therein, for example, either in baseband or as part of a carrier wave. Such a propagated signal may take a variety of forms, including but not limited to electro-magnetic, optical or any suitable combination thereof. A computer readable signal

medium may be any computer readable medium that is not a computer readable storage medium and that can communicate, propagate, or transport a program for use by or in connection with an instruction execution system, apparatus, or device.

[0021] Program code embodied on a computer-readable medium may be transmitted using any appropriate medium, including but not limited to wireless, wire line, optical fiber cable, RF, etc. or any suitable combination of the foregoing.

[0022] Computer program code for carrying out operations for aspects of the present disclosure may be written in any combination of one or more programming languages, including an object oriented programming language such as Java®, Smalltalk, C++, or the like and conventional procedural programming languages, such as the "C" programming language or similar programming languages. Java and all Java-based trademarks and logos are trademarks of Oracle, and/or its affiliates, in the United States, other countries or both. The program code may execute entirely on the user's computer, partly on the user's computer, as a stand-alone software package, partly on the user's computer and partly on a remote computer or entirely on the remote computer or server. In the latter scenario, the remote computer may be connected to the user's computer through any type of network, including a local area network (LAN) or a wide area network (WAN), or the connection may be made to an external computer (for example, through the Internet using an Internet Service Provider).

[0023] Aspects of the present disclosure are described below with reference to flowchart illustrations and/or block diagrams of methods, apparatus, (systems), and computer program products according to embodiments of the invention. It will be understood that each block of the flowchart illustrations and/or block diagrams, and combinations of blocks in the flowchart illustrations and/or block diagrams, can be implemented by computer program instructions.

[0024] These computer program instructions may be provided to a processor of a general purpose computer, special purpose computer, or other programmable data processing apparatus to produce a machine, such that the instructions, which execute via the processor of the computer or other programmable data processing apparatus, create means for implementing the functions/acts specified in the flowchart and/or block diagram block or blocks.

[0025] These computer program instructions may also be stored in a computer readable medium that can direct a computer or other programmable data processing apparatus to function in a particular manner, such that the instructions stored in the computer readable medium

produce an article of manufacture including instructions which implement the function/act specified in the flowchart and/or block diagram block or blocks.

[0026] The computer program instructions may also be loaded onto a computer or other programmable data processing apparatus to cause a series of operational steps to be performed on the computer or other programmable apparatus to produce a computer-implemented process such that the instructions which execute on the computer or other programmable apparatus provide processes for implementing the functions/acts specified in the flowchart and/or block diagram block or blocks.

[0027] With reference now to the figures and in particular with reference to **Figures 1-2**, exemplary diagrams of data processing environments are provided in which illustrative embodiments may be implemented. It should be appreciated that **Figures 1-2** are only exemplary and are not intended to assert or imply any limitation with regard to the environments in which different embodiments may be implemented. Many modifications to the depicted environments may be made.

[0028] **Figure 1** depicts a pictorial representation of a network of data processing systems in which illustrative embodiments may be implemented. Network data processing system **100** is a network of computers in which the illustrative embodiments may be implemented. Network data processing system **100** contains network **102**, which is the medium used to provide communications links between various devices and computers connected together within network data processing system **100**. Network **102** may include connections, such as wire, wireless communication links, or fiber optic cables.

[0029] In the depicted example, server **104** and server **106** connect to network **102** along with storage unit **108**. In addition, clients **110**, **112**, and **114** connect to network **102**. Clients **110**, **112**, and **114** may be, for example, personal computers or network computers. In the depicted example, server **104** provides data, such as boot files, operating system images, and applications to clients **110**, **112**, and **114**. Clients **110**, **112**, and **114** are clients to server **104** in this example. Network data processing system **100** may include additional servers, clients, and other devices not shown.

[0030] In the depicted example, network data processing system **100** is the Internet with network **102** representing a worldwide collection of networks and gateways that use the Transmission Control Protocol/Internet Protocol (TCP/IP) suite of protocols to communicate with one another.

At the heart of the Internet is a backbone of high-speed data communication lines between major nodes or host computers, consisting of thousands of commercial, governmental, educational and other computer systems that route data and messages. Of course, network data processing system **100** also may be implemented as a number of different types of networks, such as for example, an intranet, a local area network (LAN), or a wide area network (WAN). **Figure 1** is intended as an example, and not as an architectural limitation for the different illustrative embodiments.

[0031] With reference to **Figure 2** a block diagram of an exemplary data processing system operable for various embodiments of the disclosure is presented. In this illustrative example, data processing system **200** includes communications fabric **202**, which provides communications between processor unit **204**, memory **206**, persistent storage **208**, communications unit **210**, input/output (I/O) unit **212**, and display **214**.

[0032] Processor unit **204** serves to execute instructions for software that may be loaded into memory **206**. Processor unit **204** may be a set of one or more processors or may be a multi-processor core, depending on the particular implementation. Further, processor unit **204** may be implemented using one or more heterogeneous processor systems in which a main processor is present with secondary processors on a single chip. As another illustrative example, processor unit **204** may be a symmetric multi-processor system containing multiple processors of the same type.

[0033] Memory **206** and persistent storage **208** are examples of storage devices **216**. A storage device is any piece of hardware that is capable of storing information, such as, for example without limitation, data, program code in functional form, and/or other suitable information either on a temporary basis and/or a permanent basis. Memory **206**, in these examples, may be, for example, a random access memory or any other suitable volatile or non-volatile storage device. Persistent storage **208** may take various forms depending on the particular implementation. For example, persistent storage **208** may contain one or more components or devices. For example, persistent storage **208** may be a hard drive, a flash memory, a rewritable optical disk, a rewritable magnetic tape, or some combination of the above. The media used by persistent storage **208** also may be removable. For example, a removable hard drive may be used for persistent storage **208**.

[0034] Communications unit **210,** in these examples, provides for communications with other data processing systems or devices. In these examples, communications unit **210** is a network

interface card. Communications unit **210** may provide communications through the use of either or both physical and wireless communications links.

[0035] Input/output unit **212** allows for input and output of data with other devices that may be connected to data processing system **200**. For example, input/output unit **212** may provide a connection for user input through a keyboard, a mouse, and/or some other suitable input device. Further, input/output unit **212** may send output to a printer. Display **214** provides a mechanism to display information to a user.

[0036] Instructions for the operating system, applications and/or programs may be located in storage devices **216,** which are in communication with processor unit **204** through communications fabric **202.** In these illustrative examples the instructions are in a functional form on persistent storage **208**. These instructions may be loaded into memory **206** for execution by processor unit **204**. The processes of the different embodiments may be performed by processor unit **204** using computer-implemented instructions, which may be located in a memory, such as memory **206**.

[0037] These instructions are referred to as program code, computer usable program code, or computer readable program code that may be read and executed by a processor in processor unit **204**. The program code in the different embodiments may be embodied on different physical or tangible computer readable storage media, such as memory **206** or persistent storage **208**.

[0038] Program code **218** is located in a functional form on computer readable storage media **220** that is selectively removable and may be loaded onto or transferred to data processing system **200** for execution by processor unit **204**. Program code **218** and computer readable storage media **220** form computer program product **222** in these examples. In one example, computer readable storage media **220** may be in a tangible form, such as, for example, an optical or magnetic disc that is inserted or placed into a drive or other device that is part of persistent storage **208** for transfer onto a storage device, such as a hard drive that is part of persistent storage **208**. In a tangible form, computer readable storage media **220** also may take the form of a persistent storage, such as a hard drive, a thumb drive, or a flash memory that is connected to data processing system **200**. The tangible form of computer readable storage media **220** is also referred to as computer recordable storage media. In some instances, computer readable storage media **220** may not be removable.

[0039] Alternatively, program code **218** may be transferred to data processing system **200** from

computer readable storage media **220** through a communications link to communications unit **210** and/or through a connection to input/output unit **212**. The communications link and/or the connection may be physical or wireless in the illustrative examples. The computer readable media also may take the form of non-tangible media, such as communications links or wireless transmissions containing the program code.

[0040] In some illustrative embodiments, program code **218** may be downloaded over a network to persistent storage **208** from another device or data processing system for use within data processing system **200**. For instance, program code stored in a computer readable storage medium in a server data processing system may be downloaded over a network from the server to data processing system **200**. The data processing system providing program code **218** may be a server computer, a client computer, or some other device capable of storing and transmitting program code **218.**

[0041] Using data processing system **200** of **Figure 2** as an example, a computer-implemented process for selective processing of items having embedded delay actions is presented. Processor unit **204** receives an item to process containing a delay action. Processor unit **204** processes the item using a delay action process, wherein the delay action process comprises exploring dynamically generated server-side content of the item received, by recognizing when a wait occurs for a server process. Processor unit **204** performs one of a wait for a predetermined period of time, or circumventing an actual wait, to generate a result. Processor unit **204** returns the result to a requester.

[0042] With reference to **Figure 3** a block diagram of a system operable for various embodiments of the disclosure is presented. System **300** is an example of a processing system providing a capability of programmatically processing progress pages enabling automated crawling of server side generated content.

[0043] System **300** comprises a number of components leveraging support of an underlying data processing system for example, network data processing system **100** of **Figure 1** and/or data processing **200** of **Figure 2**. System **300** may be implemented in various manners including a set of discrete components functioning as a logical unit or a single unit without comprising functionality provided. For example, system **300** may be implemented as a replacement for an existing web crawler or as extensions to an existing web crawler processing environment. In alternative implementations, the example using system **300** is not meant to be a limitation as the

disclosed process may also be implemented in other environments such as a search process augmentation.

[0044] System **300** includes functional units comprising enhanced crawler **302**, delay indicators **304**, detector **306**, predefined callback methods **308**, preselected pages **310** and monitor **312**.

[0045] Enhanced crawler **302** is an example of a processor providing a capability of analyzing an item, in the current example, a web page, to determine and manage progress pages to enable programmatic processing of server-side content. For example, using an embodiment of system **300**, enhanced crawler **302**, is able to programmatically explore dynamically generated server-side web content, by recognizing when a client waits for the server, and do the same, or circumvent the actual wait and continue to process.

[0046] Delay indicators **304** are predefined identifiers associated with a function or operation, which results in a delay in receiving a server-side response. For example, when using a scripting language such as JavaScript™ (JavaScript is a trademark of Oracle Corporation), an example of a delay indicator is a *setTimeout* call. Delay indicators are identified in respective items to be processed to enable proper scanning and processing of the items.

[0047] Detector **306** provides a capability to identify a particular server-side technology is used in association with an item to be processed. For example, detector **306** may be used to identify the server side technology of *asp.net*, for example via http header, and assuming common server callback methods used by the framework. Once detected and identified the server side technology typically is used to identify associated delay indicators.

[0048] Predefined callback methods **308** provides a capability to a user to pre-identify server callback methods, enabling the system to not rely on absolute timeout, and accordingly to typically improve scanning speed as a result. For example, provision of the predefined callbacks would enable the system to avoid using detector 306 to identify a server side technology and associated delay indicators, thereby reducing process resources and time to provide a result.

[0049] Preselected pages **310** are maintained in a data structure containing items, in the current web crawler example web pages, which contain delaying indicators. Items previously identified by a user of the system enable the system to avoid processing all items to identify a subset of items having the delay indicators. When not provided the system must process all items to determine whether delay indicators exist and accordingly incur extra processing overhead.

[0050] Monitor **312** provides a capability to monitor or track calls made to a specific routine for example, when a function is called using a scripting language, monitor calls to XMLHttpRequest.open() and/or frame navigation is being called. When the calls do not occur, the system assumes a delay indicator such as a *setTimeout* call is not used for server-side content processing.

[0051] With reference to **Figure 4** a block diagram of screenshots operable for various embodiments of the disclosure is presented. Screenshots **400** is an example of visual cues provided indicating a delay in processing while an operation is in progress.

[0052] Page **402** provides an example of a screen prompting a user to select an operation. The server is awaiting a user response at this time. Page **404** provides an example of when the server is busy responding to the user request from page **402**. The response indicates a user is to await a response. Page **406** is an example of a screen prompting a user to select an operation in response to completing processing associated with the previous user request.

[0053] In each case a delay is encountered, either due to a wait for user input or to a server operation in progress. Different causes of delay may be detected and processed programmatically by an enhanced crawler of the disclosure.

[0054] With reference to **Figure 5** a flowchart of delay action processing operable for various embodiments of the disclosure is presented. Process **500** is an example of a process using system **300** of **Figure 3**.

[0055] In the example, process **500** proposes additional sub-processes as compared with conventional processing of a crawler. In a first sub-process programmatic identification of those web pages that require the client side to wait for the server side processing to be finished is performed to identify pages requiring additional processing. In a second sub-process an enhanced crawling technique for those types of identified pages is used.

[0056] Process **500** receives an item to process containing a delay action and processes the item using a delay action process, wherein the delay action process comprises exploring dynamically generated server-side content of the item received, by recognizing when a wait occurs for a server process, and performing one of a wait for a predetermined period of time, or circumventing an actual wait, to generate a result. Process **500** returns the result to a requester. In the current example the item is a web page and the process is a web crawler. The delay action may be a specified timeout function as used in the programming language of the page or may be

representative of another known cause of delay including, for example, a frame navigation call.

[0057] Process **500** begins (step **502**) and determines whether a crawl is completed (step **504**). Responsive to a determination the crawl is completed, process **500** terminates (step **514**). Responsive to a determination the crawl is not completed, process **500** receives a page to crawl (step **506**).

[0058] Process **500** determines whether the page contains a delay action (step **508**). For example, the crawler must search for specific delayed actions (for example, JavaScript has a *setTimeout(function, timeout)* method call) in the body of the received page to crawl. All the pages identified as containing these types of calls need to be handled using delay action processing.

[0059] Responsive to a determination the page does not contain delay actions, process **500** processes the page in a conventional manner (step **512**) and returns to step **504** for continued processing as before. Responsive to a determination the page does not contain delay actions; process **500** processes the page using delay action processing for the page including attempting to not wait for the timeout, but to compare the document object models (DOMs) representative of the page before and after executing a function associated with the timeout. When the DOMs are the same, process **500** waits the same amount of time as specified in the timeout. The wait enables the web server to finish a task in progress. After the timeout expires, process **500** executes the associated function, compares the DOMs again and crawls the differences.

[0060] Process **500** does not require user input. Process **500** when attempting to bypass the defined timeout, if not successful, process **500** simulates a real waiting time, to enable a process on a web server (in the example) to catch up. Embodiments in the current example refer to web applications using JavaScript on the client side. However, the embodiments can be potentially generalized to other types of processing including rich Internet applications and search applications.

[0061] With reference to **Figure 6** a flowchart of hybrid processing using delay action processing operable for various embodiments of the disclosure is presented. Process **600** is a detailed example of an embodiment using the process of system **300** of **Figure 3** and the delay process of **Figure 5**.

[0062] Generally speaking, there are two sections in the flowchart of process **600**. An outer section depicts processing in an example applicable to a regular crawler comprising steps **602**-

606 and **622-630**. In the conventional processing, process **600** performs loading of the DOM of the page, executing the *onLoad* event (an event handler triggered after a item has been loaded, such as a web page in this example) and also execute all the other JavaScript events on the page in process. The enhancement to the conventional process therefore includes processing comprising steps **608-620** to produce a hybrid process or simply an enhanced process.

[0063] Process **600** begins (step **602**) and loads a DOM of a current page (step **604**). Process **600** executes JavaScript onLoad actions (step **606**). The enhanced portion is executed after *onLoad* of the page and also after the execution of any JavaScript action on the page. The execution of the portion of process **600** in this manner accommodates dynamic pages for example those created for the asynchronous JavaScript and extensible markup language (XML) (AJAX) environment, where content of a page can change as a consequence of a JavaScript action.

[0064] Process **600** determines whether a delay action is specified in the DOM (step **608**). The delay actions may be referred to as delayed events. For example, in an embodiment using JavaScript process **600** seeks to find *setTimeout* functions, as a delay action. Responsive to a determination that a delay action is specified in the DOM process **600**, executes a function associated with the delay action to capture a new DOM (step **610**). Process **600** determines whether the DOM before execution is equivalent to the DOM after the execution of the associated function (step **612**).

[0065] Responsive to a determination that the DOM before execution is not equivalent to the DOM after the execution of the associated function (the DOM changes, with new content added or content is removed) process **600** processes the DOM (step **618**). Process **600** determines whether more delay actions exist in the DOM (step **620**). Responsive to a determination that more delay actions exist in the DOM, process **600** loops back to perform step **610** as before.

[0066] Responsive to a determination that the DOM before execution is equivalent to the DOM after the execution of the associated function, process **600** determines whether the process waited for a timeout (delay event) (step **614**). Responsive to a determination that process **600** did not wait for the timeout, process **600** waits for a time specified in the timeout (step **616**) and continues to process step **610** as before.

[0067] When process **600** determines the DOMs are still identical, process **600** can move on. When process **600** determines there are some differences, process **600** processes the differences as new information.

[0068] Process **600** determines whether there are more JavaScript actions to process (step **622**). Responsive to a determination that there are more JavaScript actions to process **600** executes a next JavaScript action (step **624**). Process **600** process the DOM (step **626**) and loops back to perform step **608** as before. Responsive to a determination that there are no more JavaScript actions to process, process **600** performs any other actions (step **628**) and terminates thereafter (step **630**).

[0069] Processing the DOM is about extracting information required by the crawler, for the purpose of gathering data, or finding additional resources to crawl. A new DOM is a result of the delay action modifying the DOM with additional or removed content (for example, a new hyperlink is added: 'get report', and another hyperlink is removed: 'cancel report generation').

[0070] Comparing the old DOM and the new DOM is possible by keeping track of the original DOM in a form including an entirety, a compressed format, an abridged format, or by using other memory efficient algorithms. An abridged DOM format means reducing the DOM to only the elements of the DOM desired by an implementer of the crawler using either heuristics or other algorithms, to compare the DOMs as part of a crawling process. For example, comparing the old DOM and new DOM using an abridged format may lead to ignoring elements including a progress indicator, or advertisements.

[0071] Typically the new DOM created would be a slight variation of the original DOM, but nothing prevents the delay action from re-writing a brand new DOM. The implementer of the process may decide to treat the original DOM and resulting modified new DOM as two different pages and process each individually, but optimizations would typically not do so and process only the modified content, which is currently shown.

[0072] In a case where creating the new DOM removes most of the original DOM content, processing the original DOM and the modified DOM as two different pages is recommended, to not prevent the crawler from gathering data from the original DOM or finding additional resources (for example, a 'cancel report generation' hyperlink leads to additional content including a list of cancelled report generation requests).

[0073] With reference to **Figure 7** a flowchart of an alternative embodiment of hybrid

processing using delay action processing operable for various embodiments of the disclosure is presented. Process **700** is an alternative embodiment of process **600** of **Figure 6** using the process of system **300** of **Figure 3**, in which a page or set of pages known to have one or more delay actions thereon is provided.

[0074] In this example process **700** performs loading of the DOM of the page, executing the *onLoad* event and also executes all the other JavaScript events on the page in process as before, however the determination of whether a delay action is specified in the DOM (previous step **608** of process **600** of **Figure 6**) is avoided, thereby typically reducing processing.

[0075] Process **700** begins (step **702**) and determines whether a crawl is completed (step **704**). Responsive to a determination that a crawl is completed, process **700** terminates (step **728**). Responsive to a determination that the crawl is not completed, process **700** receives a next page with delay action to crawl (step **706**).

[0076] Process **700**, executes a function associated with the delay action to capture a new DOM (step **708**). Process **700** determines whether the DOM before execution is equivalent to the DOM after the execution of the associated function (step **710**).

[0077] Responsive to a determination that the DOM before execution is not equivalent to the DOM after the execution of the associated function (the DOM changes, with new content added or content is removed) process **700** processes the DOM (step **716**). Process **700** determines whether more delay actions exist in the DOM (step **718**). Responsive to a determination that more delay actions exist in the DOM, process **700** loops back to perform step **708** as before.

[0078] Responsive to a determination that the DOM before execution is equivalent to the DOM after the execution of the associated function, process **700** determines whether the process waited for a timeout (delay event) (step **712**). Responsive to a determination that process **700** did not wait for the timeout, process **700** waits for a time specified in the timeout (step **714**) and continues to process step **708** as before.

[0079] When process **700** determines the DOMs are still identical, process **700** can move on. When process **700** determines there are some differences, process **700** processes the differences as new information.

[0080] Process **700** determines whether there are more JavaScript actions to process (step **720**). Responsive to a determination that there are more JavaScript actions to process **700** executes a next JavaScript action (step **722**). Process **700** process the DOM (step **724**) and loops back to

perform step **704** as before. Responsive to a determination that there are no more JavaScript actions to process, process **700** performs any other actions (step **726**) and terminates thereafter (step **728**).

[0081] In a similar manner, an embodiment of process **600** or process **700** may be altered to include processing in which detector **306** of system **300** of **Figure 3** is used to identify a server side technology being used and according select a predefined callback method **308** also of **Figure 3** to not rely on an absolute timeout (delay action). In another embodiment, monitor **312** of **Figure 3** can be used to monitor function calls, such as when a JavaScript call to *XMLHttpRequest.open()* and/or frame navigation is made. When no such call is indicated, the disclosed process assumes a delay action such as *setTimeout* is not used for server side content processing.

[0082] Thus is presented in an illustrative embodiment a computer-implemented process for selective processing of items having embedded delay actions. The computer-implemented process receives an item to process containing a delay action, processes the item using a delay action process, wherein the delay action process comprises exploring dynamically generated server-side content of the item received, by recognizing when a wait occurs for a server process, and performing one of a wait for a predetermined period of time, or circumventing an actual wait, to generate a result and returns the result to a requester.

[0083] The flowchart and block diagrams in the figures illustrate the architecture, functionality, and operation of possible implementations of systems, methods, and computer program products according to various embodiments of the present invention. In this regard, each block in the flowchart or block diagrams may represent a module, segment, or portion of code, which comprises one or more executable instructions for implementing a specified logical function. It should also be noted that, in some alternative implementations, the functions noted in the block might occur out of the order noted in the figures. For example, two blocks shown in succession may, in fact, be executed substantially concurrently, or the blocks may sometimes be executed in the reverse order, depending upon the functionality involved. It will also be noted that each block of the block diagrams and/or flowchart illustration, and combinations of blocks in the block diagrams and/or flowchart illustration, can be implemented by special purpose hardware-based systems that perform the specified functions or acts, or combinations of special purpose hardware and computer instructions.

[0084] The corresponding structures, materials, acts, and equivalents of all means or step plus function elements in the claims below are intended to include any structure, material, or act for performing the function in combination with other claimed elements as specifically claimed. The description of the present invention has been presented for purposes of illustration and description, but is not intended to be exhaustive or limited to the invention in the form disclosed. Many modifications and variations will be apparent to those of ordinary skill in the art without departing from the scope and spirit of the invention. The embodiment was chosen and described in order to best explain the principles of the invention and the practical application, and to enable others of ordinary skill in the art to understand the invention for various embodiments with various modifications as are suited to the particular use contemplated.

[0085] The invention can take the form of an entirely hardware embodiment, an entirely software embodiment or an embodiment containing both hardware and software elements. In a preferred embodiment, the invention is implemented in software, which includes but is not limited to firmware, resident software, microcode, and other software media that may be recognized by one skilled in the art.

[0086] It is important to note that while the present invention has been described in the context of a fully functioning data processing system, those of ordinary skill in the art will appreciate that the processes of the present invention are capable of being distributed in the form of a computer readable data storage medium having computer executable instructions stored thereon in a variety of forms. Examples of computer readable data storage media include recordable-type media, such as a floppy disk, a hard disk drive, a RAM, CD-ROMs, DVD-ROMs. The computer executable instructions may take the form of coded formats that are decoded for actual use in a particular data processing system.

[0087] A data processing system suitable for storing and/or executing computer executable instructions comprising program code will include at least one processor coupled directly or indirectly to memory elements through a system bus. The memory elements can include local memory employed during actual execution of the program code, bulk storage, and cache memories which provide temporary storage of at least some program code in order to reduce the number of times code must be retrieved from bulk storage during execution.

[0088] Input/output or I/O devices (including but not limited to keyboards, displays, pointing devices, etc.) can be coupled to the system either directly or through intervening I/O controllers.

[0089] Network adapters may also be coupled to the system to enable the data processing system to become coupled to other data processing systems or remote printers or storage devices through intervening private or public networks. Modems, cable modems, and Ethernet cards are just a few of the currently available types of network adapters.

CLAIMS:

What is claimed is:

1. A computer-implemented process for selective processing of items having embedded delay actions, the computer-implemented process comprising:

receiving an item to process containing a delay action;

processing the item using a delay action process, wherein the delay action process comprises exploring dynamically generated server-side content of the item received, by recognizing when a wait occurs for a server process, and performing one of a wait for a predetermined period of time, or circumventing an actual wait, to generate a result; and

returning the result to a requester.

2. The computer-implemented process of claim 1 wherein receiving an item to process containing a delay action further comprises:

loading a document object model (DOM) of a current item;

executing an event handler action; and

determining whether a delay action is specified in the DOM.

3. The computer-implemented process of claim 1 wherein processing the item using a delay action process further comprises:

responsive to a determination that a delay action is specified in DOM, executing a function associated with the delay action to capture a new DOM;

responsive to a determination that the DOM before execution of the function is equivalent to the new DOM after execution of the function, determining whether a process waited for a timeout;

responsive to a determination that the process did not wait for the timeout, waiting a time specified in the timeout;

executing the function associated with the delay action to capture the new DOM;

determining whether the DOM before execution of the function is equivalent to the new DOM after execution of the function;

responsive to a determination that the DOM before execution of the function is not equivalent to the new DOM after execution of the function, processing the DOM.

4. The computer-implemented process of claim 1 wherein receiving an item to process containing a delay action further comprises:

receiving a preselected set of items, wherein each item contains one or more delay actions embedded therein.

5. The computer-implemented process of claim 3 further comprising:

determining whether there are more delay actions to process in the DOM;

responsive to a determination that there are no more delay actions to process in the DOM, determining whether there are more JavaScript actions to process;

responsive to a determination that there are more JavaScript actions to process, executing a next JavaScript; and

processing the DOM.

6. The computer-implemented process of claim 1 wherein receiving an item to process containing a delay action further comprises:

detecting in the item to identify a server side technology being used; and

selecting a predefined callback method according to the identified server side technology, wherein reliance on an absolute timeout (delay action) is obviated.

7. The computer-implemented process of claim 1 wherein receiving an item to process containing a delay action further comprises:

monitoring predetermined function calls to identify an item to process containing a delay action; and

assuming a delay action is not used for server side content processing when no such call is indicated.

8. A computer program product for selective processing of items having embedded delay actions, the computer program product comprising:

a computer recordable-type media containing computer executable program code stored thereon, the computer executable program code comprising:

computer executable program code for receiving an item to process containing a delay action;

computer executable program code for processing the item using a delay action process, wherein the delay action process comprises exploring dynamically generated server-side content of the item received, by recognizing when a wait occurs for a server process, and performing one of a wait for a predetermined period of time, or circumventing an actual wait, to generate a result; and

computer executable program code for returning the result to a requester.

9. The computer program product of claim 8 wherein computer executable program code for receiving an item to process containing a delay action further comprises:

computer executable program code for loading a document object model (DOM) of a current item;

computer executable program code for executing an event handler action; and

computer executable program code for determining whether a delay action is specified in the DOM.

10. The computer program product of claim 8 wherein computer executable program code for processing the item using a delay action process further comprises:

computer executable program code responsive to a determination that a delay action is specified in DOM, for executing a function associated with the delay action to capture a new DOM;

computer executable program code responsive to a determination that the DOM before execution of the function is equivalent to the new DOM after execution of the function, for determining whether a process waited for a timeout;

computer executable program code responsive to a determination that the process did not wait for the timeout, for waiting a time specified in the timeout;

computer executable program code for executing the function associated with the delay action to capture the new DOM;

computer executable program code for determining whether the DOM before execution of the function is equivalent to the new DOM after execution of the function;

computer executable program code responsive to a determination that the DOM before execution of the function is not equivalent to the new DOM after execution of the function, for processing the DOM.

11. The computer program product of claim 8 wherein computer executable program code for receiving an item to process containing a delay action further comprises:

computer executable program code for receiving a preselected set of items, wherein each item contains one or more delay actions embedded therein.

12. The computer program product of claim 10 further comprising:

computer executable program code for determining whether there are more delay actions to process in the DOM;

computer executable program code responsive to a determination that there are no more delay actions to process in the DOM, for determining whether there are more JavaScript actions to process;

computer executable program code for responsive to a determination that there are more JavaScript actions to process, for executing a next JavaScript; and

computer executable program code for processing the DOM.

13. The computer program product of claim 8 wherein computer executable program code for receiving an item to process containing a delay action further comprises:

computer executable program code for detecting in the item to identify a server side technology being used; and

computer executable program code for selecting a predefined callback method according to the identified server side technology, wherein reliance on an absolute timeout (delay action) is obviated.

14. The computer-implemented process of claim 1 wherein computer executable program code for receiving an item to process containing a delay action further comprises:

computer executable program code for monitoring predetermined function calls to identify an item to process containing a delay action; and

computer executable program code for assuming a delay action is not used for server side content processing when no such call is indicated.

15. An apparatus for selective processing of items having embedded delay actions, the apparatus comprising:

a communications fabric;

a memory connected to the communications fabric, wherein the memory contains computer executable program code;

a communications unit connected to the communications fabric;

an input/output unit connected to the communications fabric;

a display connected to the communications fabric; and

a processor unit connected to the communications fabric, wherein the processor unit executes the computer executable program code to direct the apparatus to:

receive an item to process containing a delay action;

process the item using a delay action process, wherein the delay action process comprises exploring dynamically generated server-side content of the item received, by recognizing when a wait occurs for a server process, and performing one of a wait for a predetermined period of time, or circumventing an actual wait, to generate a result; and

return the result to a requester.

16. The apparatus of claim 15 wherein the processor unit executes the computer executable program code to receive an item to process containing a delay action further directs the apparatus to::

load a document object model (DOM) of a current item;

execute an event handler action; and

determine whether a delay action is specified in the DOM.

17. The apparatus of claim 15 wherein the processor unit executes the computer executable program code to receive an item to process the item using a delay action process further directs

the apparatus to:

responsive to a determination that a delay action is specified in DOM, execute a function associated with the delay action to capture a new DOM;

responsive to a determination that the DOM before execution of the function is equivalent to the new DOM after execution of the function, determine whether a process waited for a timeout;

responsive to a determination that the process did not wait for the timeout, wait a time specified in the timeout;

execute the function associated with the delay action to capture the new DOM;

determine whether the DOM before execution of the function is equivalent to the new DOM after execution of the function;

responsive to a determination that the DOM before execution of the function is not equivalent to the new DOM after execution of the function, process the DOM.

18. The apparatus of claim 15 wherein the processor unit executes the computer executable program code to receive an item to process containing a delay action further directs the apparatus to:

receive a preselected set of items, wherein each item contains one or more delay actions embedded therein.

19. The apparatus of claim 17 wherein the processor unit executes the computer executable program code to receive an item to further direct the apparatus to:

determine whether there are more delay actions to process in the DOM;

responsive to a determination that there are no more delay actions to process in the DOM, determine whether there are more JavaScript actions to process;

responsive to a determination that there are more JavaScript actions to process, execute a next JavaScript; and

process the DOM.

20. The apparatus of claim 1 wherein the processor unit executes the computer executable program code to receive an item to process containing a delay action further directs the apparatus

to:

detect in the item to identify a server side technology being used; and

select a predefined callback method according to the identified server side technology, wherein reliance on an absolute timeout (delay action) is obviated.

FIG. 1

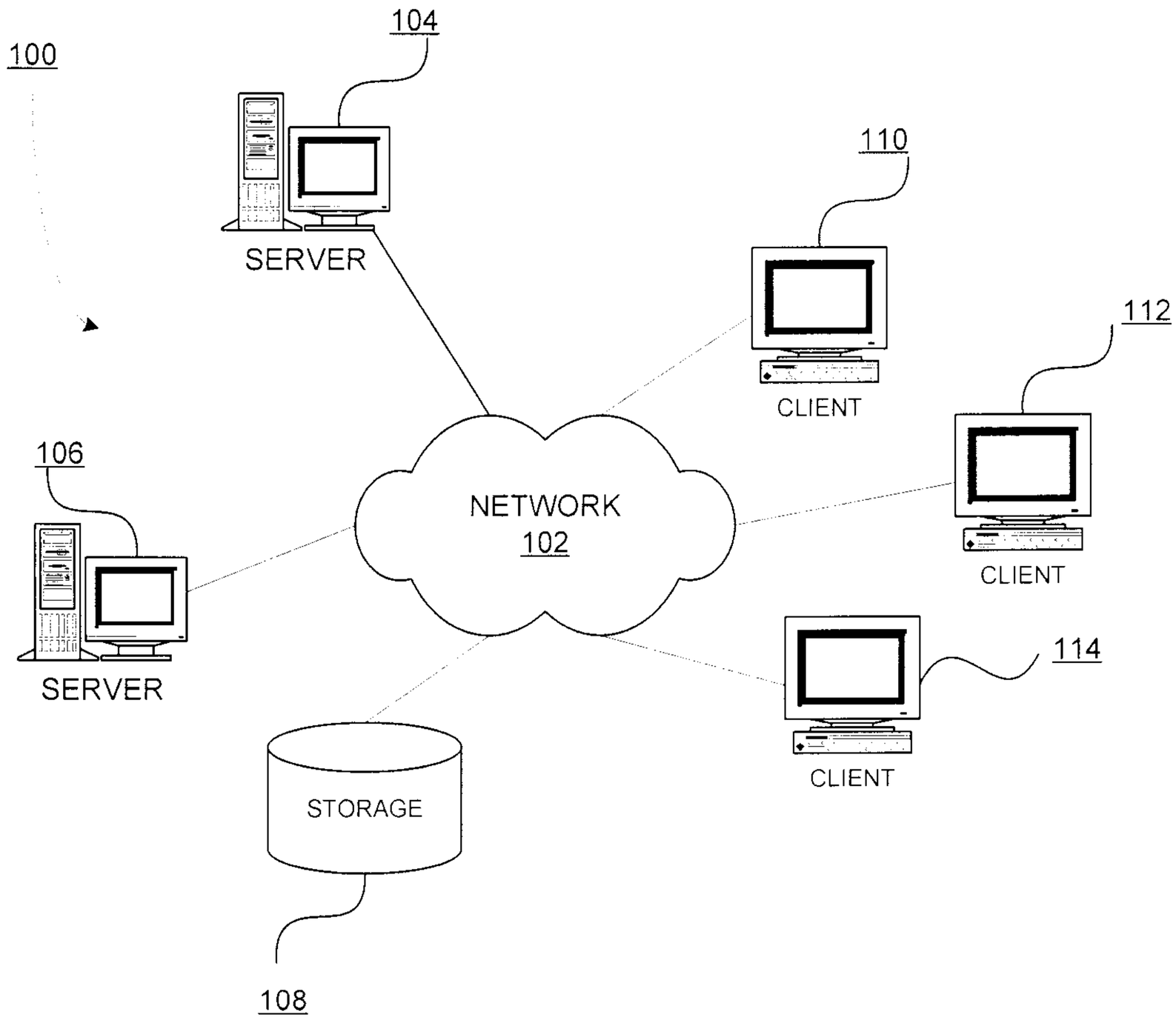

100
104
SERVER
110
CLIENT
112
CLIENT
106
SERVER
NETWORK
102
114
CLIENT
STORAGE
108

FIG. 2

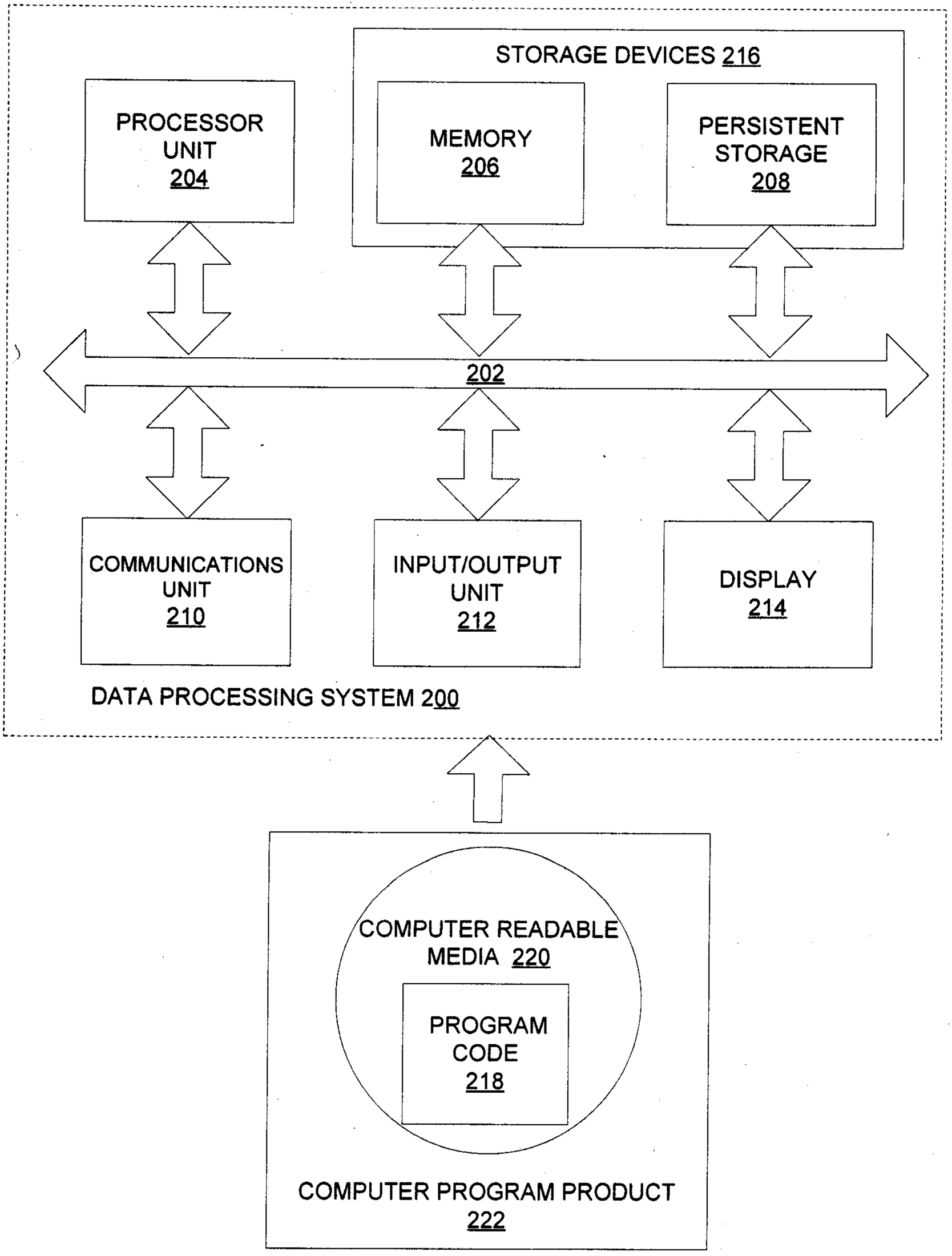

STORAGE DEVICES 216
PROCESSOR UNIT 204
MEMORY 206
PERSISTENT STORAGE 208
202
COMMUNICATIONS UNIT 210
INPUT/OUTPUT UNIT 212
DISPLAY 214
DATA PROCESSING SYSTEM 200
COMPUTER READABLE MEDIA 220
PROGRAM CODE 218
COMPUTER PROGRAM PRODUCT 222

FIG. 3

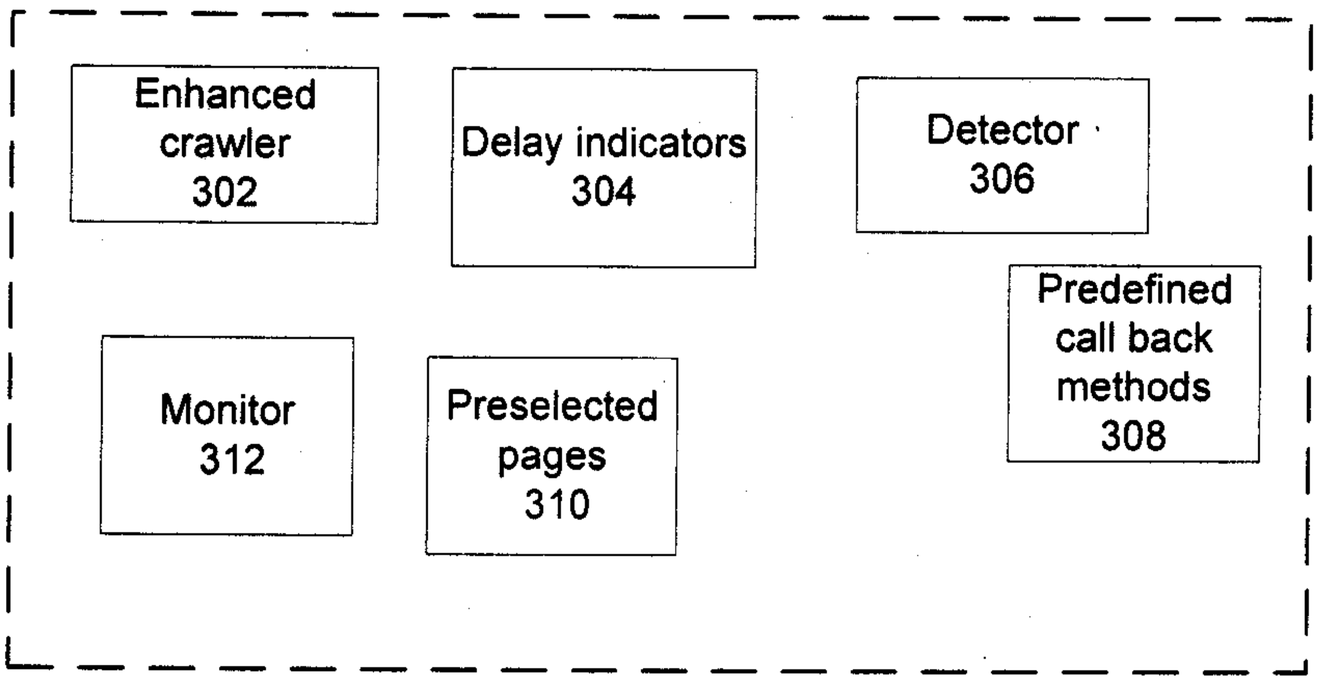

Enhanced crawler 302
Delay indicators 304
Detector 306
Predefined call back methods 308
Monitor 312
Preselected pages 310
System 300

FIG. 4

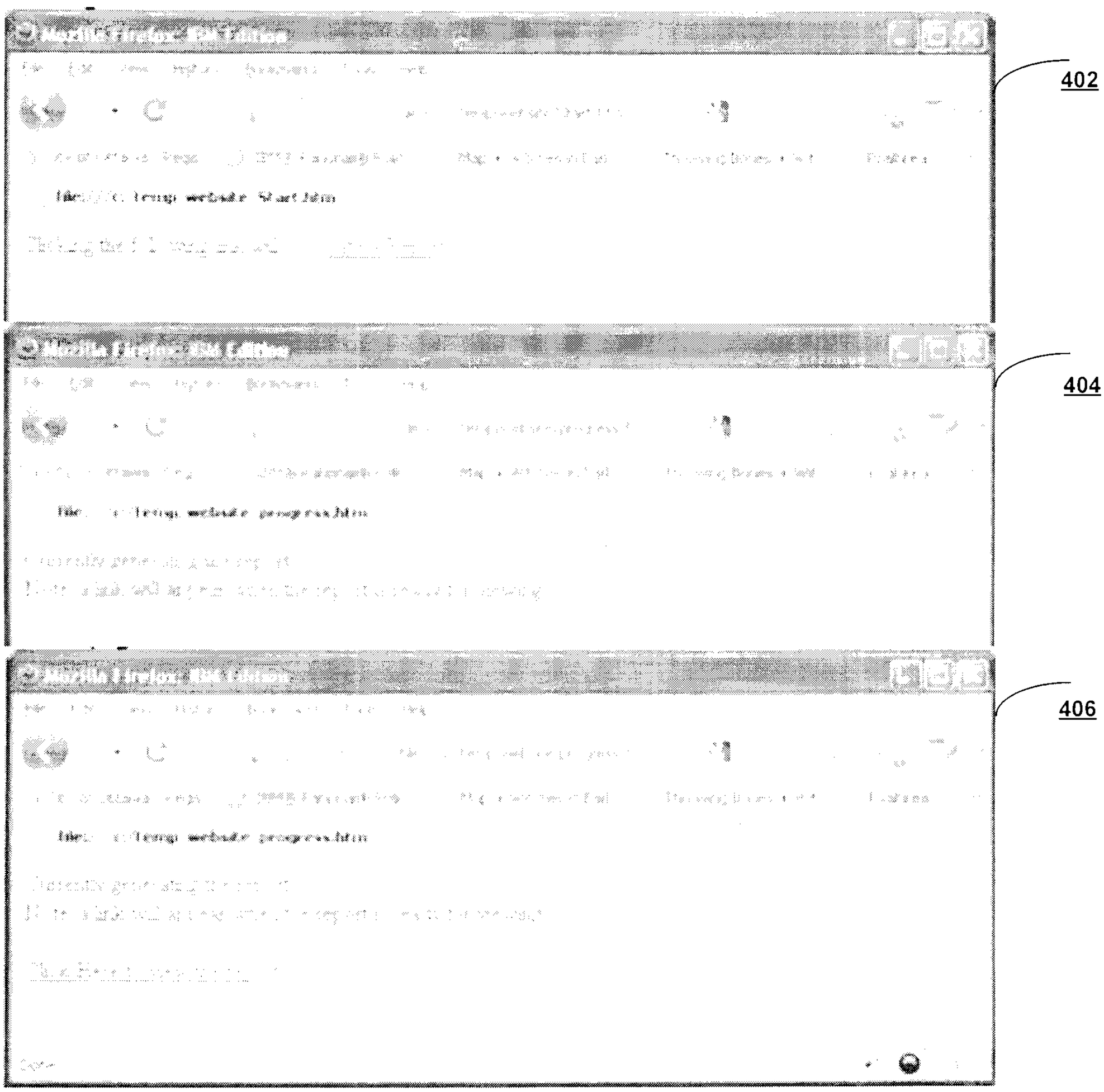


FIG. 5

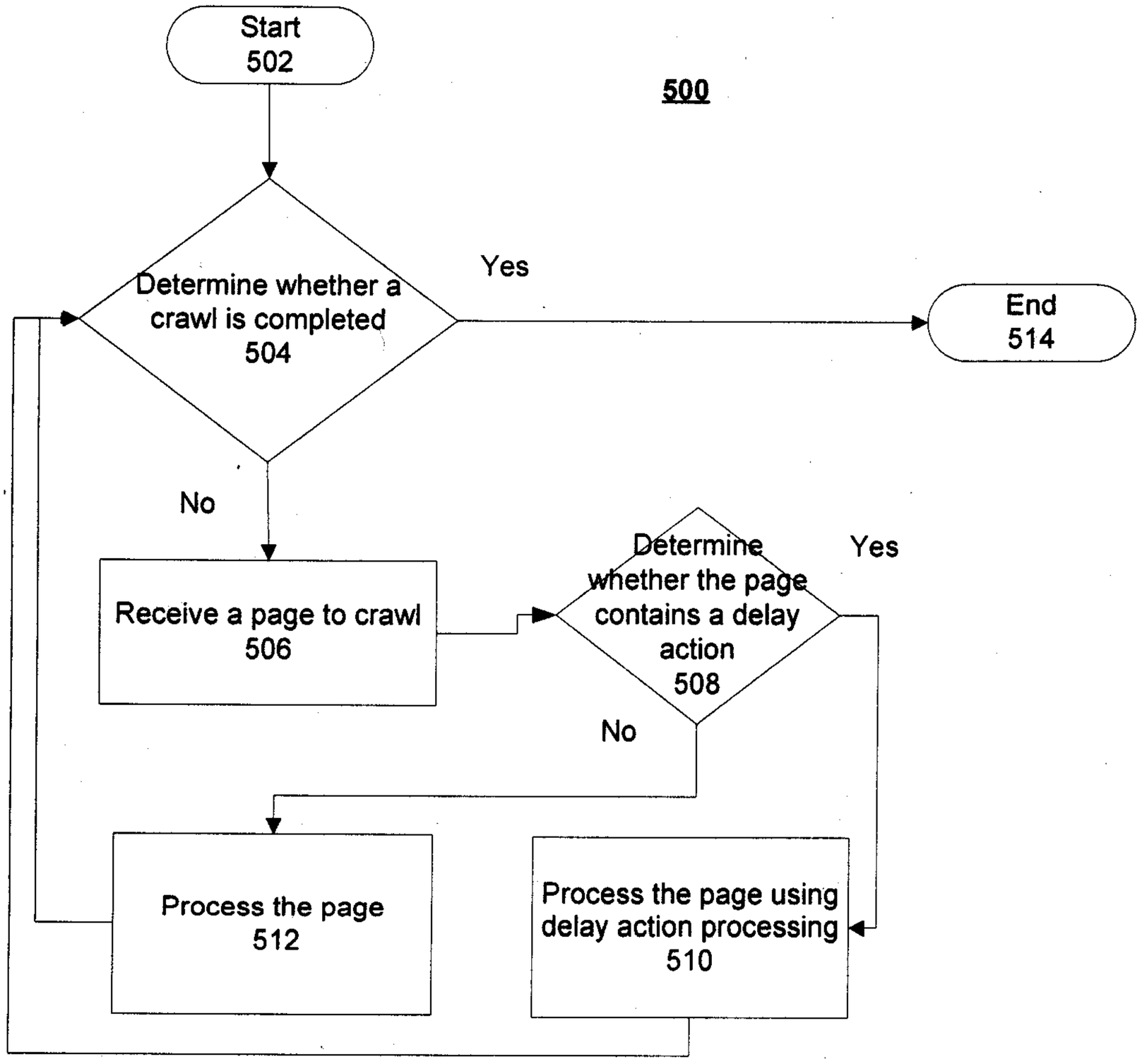

500
Start
502
Determine whether a crawl is completed
504
Yes
End
514
No
Receive a page to crawl
506
Determine whether the page contains a delay action
508
Yes
No
Process the page
512
Process the page using delay action processing
510

FIG. 6

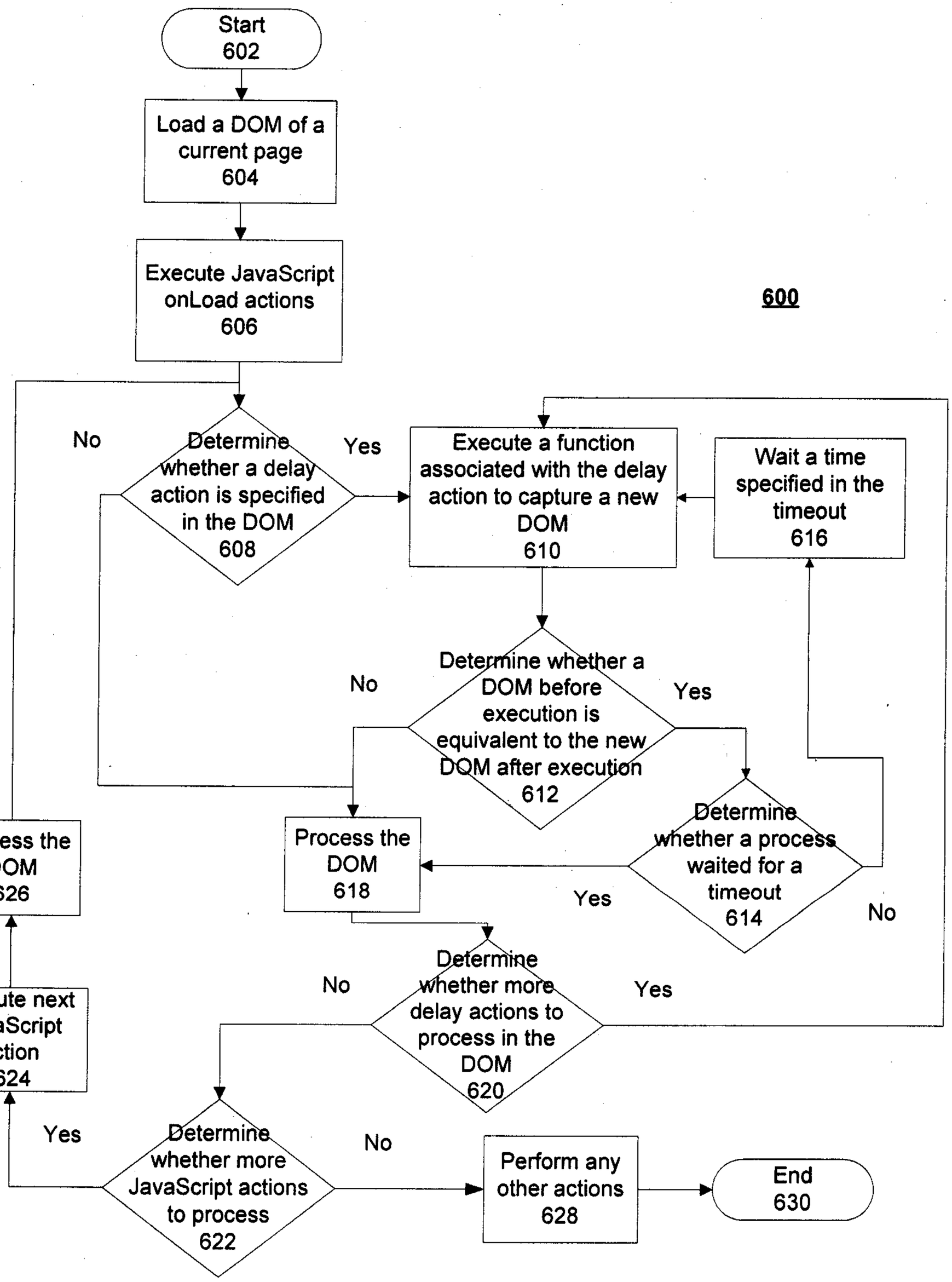
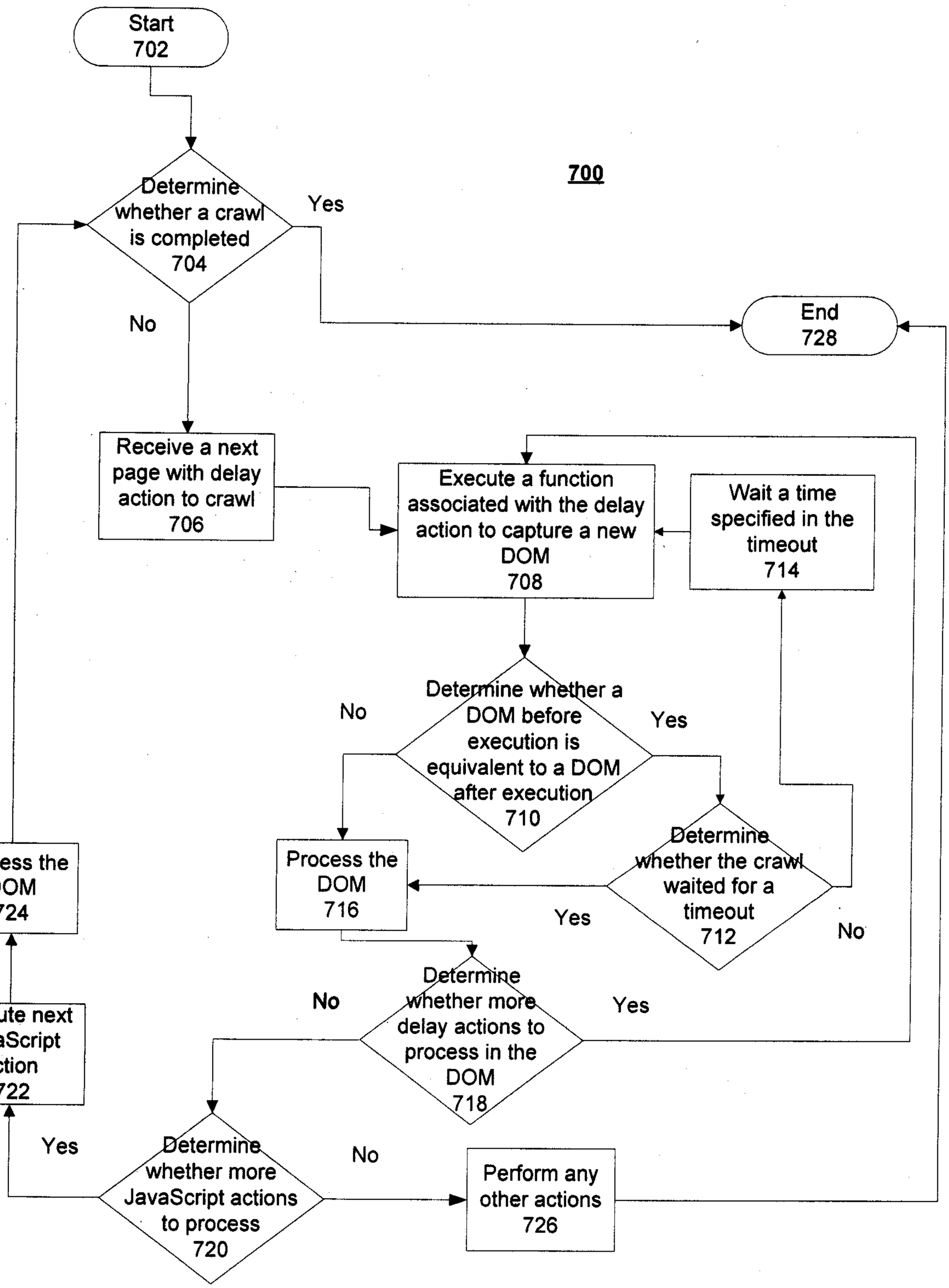

Start
602
Load a DOM of a current page
604
Execute JavaScript onLoad actions
606
600
No
Determine whether a delay action is specified in the DOM
608
Yes
Execute a function associated with the delay action to capture a new DOM
610
Wait a time specified in the timeout
616
Determine whether a DOM before execution is equivalent to the new DOM after execution
612
No
Yes
Process the DOM
618
Determine whether a process waited for a timeout
614
Yes
No
Determine whether more delay actions to process in the DOM
620
No
Yes
Process the DOM
626
Execute next JavaScript action
624
Determine whether more JavaScript actions to process
622
Yes
No
Perform any other actions
628
End
630

FIG. 7


700
Start
702
Determine whether a crawl is completed
704
Yes
No
End
728
Receive a next page with delay action to crawl
706
Execute a function associated with the delay action to capture a new DOM
708
Wait a time specified in the timeout
714
Determine whether a DOM before execution is equivalent to a DOM after execution
710
No
Yes
Process the DOM
716
Determine whether the crawl waited for a timeout
712
Yes
No
Determine whether more delay actions to process in the DOM
718
No
Yes
Process the DOM
724
Execute next JavaScript action
722
Determine whether more JavaScript actions to process
720
Yes
No
Perform any other actions
726