INITIAL SERVER-SIDE CONTENT RENDERING FOR CLIENT-SCRIPT WEB PAGES

BACKGROUND

In a distributed computing system containing multiple entities such as a client component ("client") and a server component ("server"), typically the server provides the client the layout of a Web page, and the client runs a script to produce the initial content for the Web page. The content of the Web page can be dynamic: often, after the initial content of the Web page is rendered by the client-side script, the content of the Web page may be subsequently re-rendered by the client-side script in response to user actions and input from other entities in the distributed computing system.

FIGURE 1 illustrates an exemplary distributed computing system 100 including at least one client 102 and at least one server 104. Upon receiving a request for displaying a Web page from the client 102, the server 104 may send the client 102 an HTML file such as HTML A (106) and a script 108. HTML A (106) contains layout information and static content of the Web page. The execution of the script 108 generates initial content of the requested Web page. Sometimes, the HTML A (106) and the script 108 may be integrated in a same file.

As shown in FIGURE 1, upon receiving the HTML A (106) and the script 108, the client 102 executes the script 108 to dynamically generate the initial content for the Web page. Often, the script 108 may need specific data from the server 104 to generate the initial content. The client 102 thus sends a request 110 for the needed data from the server 104, which then returns the requested data 112 to the client 102. Upon receiving the data 112, the script 108 executes and uses the data 112 to modify HTML A (106) to obtain HTML B (114). HTML B (114) includes both the layout and the initial content for the Web page. The content of the Web page may change later, for example, based on input provided by a user.

Such a client-side content rendering mechanism presents some problems. For example, search engines usually do not run scripts. Therefore, when a search engine queries the client 102 for the Web page, the search engine obtains what is offered by HTML A (106), i.e., the layout information and static content of the Web page. The search engine cannot obtain the actual content of the Web page that is important for indexing purposes. In addition, a Web browser on the client 102 may not have the ability to run scripts or the Web browser's ability to run scripts is disabled. As a result, the Web browser on the client 102 cannot run the script 108 to generate HTML B (114) and hence the initial content for the Web page.

While specific disadvantages of existing systems have been illustrated and described in this Background Section, those skilled in the art and others will recognize that the subject matter claimed herein is not limited to any specific implementation for solving any or all of the described disadvantages.

SUMMARY

This summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This summary is not intended to identify key features of the claimed subject matter, nor is it intended to be used as an aid in determining the scope of the claimed subject matter.

Aspects of the invention solve the above-identified problems by simulating and executing on the server a client-side script that renders initial content of a Web page. The simulation creates on the server a client-side execution environment for the script generating the initial content of the Web page. As a result, the initial rendering of the Web page sent to a client by a server already contains the initial content that is usually generated on the client.

One aspect of the invention includes a distributed computing system containing at least one server and at least one client. The server provides one or more Web pages for the client to display. The server uses a document object model (DOM) simulator to model a file containing the source code of a Web page. Such a file can be an HTML file, for example. The server may further include a script engine ("server-side script engine") that simulates or that is the same as the script engine used by the client.

The server uses the DOM simulator to provide a DOM of the layout and static content of a Web page and of scripts for the Web page. The server then extracts from the DOM the script that is responsible for rendering the initial content of the Web page. Such

a script may be generated by sequentially ordering contents extracted from the DOM that exist in script tags and scripting source code in the DOM. The server then uses the server-side script engine to execute the extracted script on the DOM. As a result of executing the script, the DOM now contains the initial content of the Web page. The server then extracts the initial content of the Web page from the DOM. Finally, the server sends the initial content of the Web page to the client for display.

In summary, aspects of the invention enable a server in a distributed computing system to provide initial content of a Web page, wherein the initial content is usually rendered by a client-side script. Therefore, a client can display the initial content of the Web page even if the Web browser of the client cannot run the client-side script to generate the initial content. As a result, search engines that generally do not run scripts still can obtain the initial content of a Web page for indexing purpose.

DESCRIPTION OF THE DRAWINGS

The foregoing aspects and many of the attendant advantages of this invention will become more readily appreciated as the same become better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

FIGURE 1 is a block diagram illustrating an exemplary client-side rendering of initial content of a Web page;

FIGURE 2 is a block diagram illustrating an exemplary server-side rendering of initial content of a Web page; and

FIGURE 3 is a block diagram illustrating an exemplary computer system for server-side rendering of initial content of a Web page.

DETAILED DESCRIPTION

The following text illustrates and describes exemplary embodiments of the invention. However, those of ordinary skill in the art will appreciate that various changes can be made therein without departing from the spirit and scope of the invention.

Embodiments of the invention may be described in the general context of computer-executable instructions, such as program modules, being executed by a computer including at least a processor and a memory. Generally described, program modules include routines, programs, widgets, objects, components, data structures, and the like that perform particular tasks or implement particular abstract data types. Embodiments of the invention may also be practiced in a distributed computing system

including multiple entities. Each of the entities has the potential of functioning as a server providing a service as well as a client receiving the service provided by a server. The service can be, for example, providing a Web page. The entities may be local to a same computer system or are linked remotely through a communications network. In the distributed computing system, program modules may be located on local and/or remote computer storage media.

Exemplary embodiments of the invention utilize existing server-side technology to simulate on a server a client-side execution environment for a client-side script generating the initial content of a Web page. For example, a document object model ("DOM") simulator is needed to generate a DOM modeling a file containing the source code of a Web page. Such a file may be an HTML file, for example. The DOM simulates the object model of the HTML. The DOM can also be an XML DOM, a technology that is available on almost any server platform. In addition, a server-side script engine is needed that simulates or functions the same as the client-side script engine. For example, if the client uses JavaScript as its script engine, the server needs to provide a script engine that is capable of executing JavaScript files. The server-side script engine may be a simulation of the client-side script engine or the client-side script engine itself. Once a DOM and a proper server-side script engine are available, the server-side script engine executes the client-side script such as the script 108 illustrated in FIGURE 1 against the DOM to generate initial content for the Web page.

FIGURE 2 illustrates an exemplary implementation of a server-side process 200 for rendering an initial page such as the HTML B (114) for a Web page, wherein the initial page has all the initial content of the Web page. FIGURE 2 is illustrated with reference to the distributed computing system 100 illustrated in FIGURE 1. As shown in FIGURE 2, the server 104 starts with a traditional initial rendering, i.e., providing HTML A (106) that contains layout information and static content of a Web page. See block 202. A DOM 204 simulating HTML A (106) then is generated. The DOM 204 may be generated by injecting HTML A (106) into a DOM parser, which can be a full HTML parser or an XML parser if HTML A (106) is compliant with XHTML standard. As known by those of ordinary skill in the art, a parser, whether it is a DOM parser, an HTML parser, or an XML parser, is a computer program that analyzes the grammatical structure of an input with respect to a given set of formal grammar. Typically, a parser transforms the input into a data structure that catches the implied hierarchy of the input. The data structure can

be, for example, a tree or even a graph. The data structure can be used for code generation, semantic checking, or simply to ease the further understanding of the input.

Besides simulating layout information and static content of a Web page, the DOM 204 also simulates scripts 205 for the Web page, including the script 108 for generating initial content of the Web page. The server 104 then extracts the script 108 from the DOM 204. See block 206. The script 108 is also called the client script because the script 108 was designed to run by the client 102. In exemplary embodiments of the invention, the server 104 constructs the script 108 by scanning the DOM 204 for <script> tags and by fetching or resolving <script src=...> scripts. The script 108 is built using the sequential order of the content in the <script> tags and the scripts designated in <script src=...>.

The server 104 then executes the script 108 on the DOM 204. See block 208. In an exemplary embodiment of the invention, the script 108 is executed in an enriched execution environment where the DOM 204 is available to the script 108 as built-in objects, accessible through the same paths as if the script 108 were on the client 102. As a result, the DOM 204 appears to the script 108 almost exactly as if the DOM 204 were a client-side DOM of HTML A (106).

As illustrated in FIGURE 1, conventionally, the script 108 may send a request 110 for the data 112 to be rendered in the Web page. Because of security limitations on most Web browsers, the requested data 112 usually is stored on the server 104 that provides the initial rendering of the Web page. Therefore, the request 110 typically travels through a network that connects the client 102 and the server 106. Now, because the server 104 is simulating the client-side script execution environment, it would not be efficient or required to still let the data request 110 sent by the script 108 travels on the network that connects the client 102 and the server 104. Therefore, an exemplary embodiment of the invention provides a redirection mechanism that queries local data storage on the server 104 directly instead of sending the data request 110 through the network. The query may be performed in a manner that is transparent to the script 108. In some scenarios, a client 102 uses an XmlHttpRequest object for retrieving data for a Web page. Exemplary embodiments of the invention may implement a different XmlHttpRequest object that directs the request 110 for the data 112 on the server 104 to the right data object on the server 104 without making a network call. Alternatively, embodiments of the invention may stub out client-side functionalities in the script 108 that are no longer applicable on

the server 104. For example, functionalities of a client-side timer in the script 108 may be muffled such that the timer does not raise any event when the script 108 is executed on the server 104.

The execution of the script 108 modifies the DOM 204. The DOM 204 now contains both the layout information and the initial content for the Web page; i.e., the DOM 204 now simulates the HTML B (114) illustrated in FIGURE 1. The server 108 then extracts the text representation of the DOM 204 and sends it to the client 102. See block 210. The text representation forms the HTML B (114). Thus, the client 102 receives an initial rendering from the server 104—HTML B (104)—that contains the full initial content of the Web page. The content of the Web page may be updated later on the client-side in response to, for example, user input.

In embodiments of the invention, the client 102 and the server 104 may locate on the same computer or on different computers in the distributed computing system 100. FIGURE 3 depicts an exemplary computer system 300 for the server 104, suitable for use in implementing aspects of the invention. The server 104 connects to a network 301 using a network interface 302. The network interface 302 includes the necessary hardware and software to allow the server 104 to communicate with other computing devices connected to the network 302 by use of one or more suitable communication protocols, such as TCP/IP protocol. For example, if the client 102 exists on another computer system in the distributed computing system 100, the server 104 communicates with the client 102 through the network interface 302.

The server 104 further includes a processor 304, memory 306, and an input/output interface 308, all communicatively connected together and to the network interface 302 by a communication bus 310. The processor 304 is configured to operate in accordance with computer program instructions stored in a memory, such as the memory 306. Program instructions may also be embodied in a hardware format, such as a programmed digital signal processor.

The memory 306 may be comprised of any type of storage facility, and may include, by way of example, RAM, ROM, and/or removable computer-readable media. The memory 306 may store an operating system 312 for controlling the operation of the server 104. The operating system 312 may be a general-purpose operating system such as a Microsoft server operating system, UNIX, or LINUX, for example.

As noted above, in exemplary embodiments of the invention, the server 104 builds an environment to simulate and execute a client-side script 108 that generates the initial content of a Web page. The simulation environment may include a DOM simulator to simulate the object model of a file, such as an HTML file, containing the source code of a Web page. The simulation environment may further include a server-side script engine that functions the same as the script engine used by the client 102. Therefore, as shown in FIGURE 3, the memory 306 of the server 104 additionally stores program code and data that provide a DOM simulator 314 and a server-side script engine 316. The DOM simulator 314 comprises computer-executable instructions that, when executed by the processor 304, simulates the object models provided by a file such as an HTML that contains the source code of a Web page. The server-side script engine 316 comprises computer-executable instructions that, when executed by the processor 304, simulates or behaves the same as the script engine used by the client 102.

For ease of illustration, FIGURE 3 does not show other typical components of a computing system, such as a video display adapter, power supply, computer monitor, etc. However, those skilled in the art of computers will recognize a wide selection of commercially-available components that can be used to construct and operate a computer system such as illustrated in FIGURE 3.

Although aspects of the invention have been described in language specific to structural features and/or methodological acts, it is to be understood that the subject matter defined in the appended claims is not necessarily limited to the specific features or acts described above. Rather, the specific features and acts described above are disclosed as example forms of implementing the claims.

CLAIMS

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. In a distributed computing system (100), including at least one server (104) and at least one client (102), a computer-implemented method for enabling the server (104) to provide initial content (114) of a Web page for the client (102), wherein the initial content (114) of the Web page was designed to be generated by a client-side script (108), comprising:

(a) providing a document object model ("DOM") (204), wherein the DOM (204) models layout and static content of the Web page, wherein the DOM (204) also models scripts (205) of the Web page;

(b) extracting from the DOM (204) the script (108);

(c) executing the script (108) on the DOM (204) to cause the DOM (204) to contain the initial content (114) of the Web page;

(d) extracting the initial content (114) from the DOM (204); and

(e) sending the initial content (114) of the Web page to the client (102).

2. The method of Claim 1, wherein extracting from the DOM a script includes sequentially ordering content extracted from and contained by script tags and scripting source code in the DOM.

3. The method of Claim 1, wherein executing the script on the DOM further includes:

if the script makes a request for data on the server, using a redirection mechanism to redirect the request as a request for data local to the server, instead of sending the request over a network connecting the client and the server.

4. The method of Claim 1, wherein the initial content of the Web page sent to the client further includes the layout and static content that has been processed by the script.

5. In a distributed computing system (100) including at least one server (104) and at least one client (102), a computer system (300) for enabling the server (104) to provide initial content (114) of a Web page for the client (102), wherein the initial content (114) of the Web page was designed to be generated by a client-side script (108), comprising:

(a) a memory (306); and

(b) a processor (304), coupled with the memory (306), executes computer-executable instructions for:

(1) executing a document object ("DOM") simulator (314) to provide a DOM (204) for layout and static content of the Web page and for scripts (205) of the Web page;

(2) extracting from the DOM (204) the script (108);

(3) executing the script (108) on the DOM (204) to cause the DOM (204) to contain the initial content (114) of the Web page, using a server-side script engine (316) that functions the same as a script engine used on the client (102);

(4) extracting the initial content (114) from the DOM (204); and

(5) sending the initial content (114) of the Web page to the client (102).

6. The computer system of Claim 5, wherein the processor executes computer-executable instructions to extract from the DOM the script by sequentially ordering content extracted from and contained by script tags and scripting source code in the DOM.

7. The computer system of Claim 5, wherein executing the script on the DOM, if the script makes a request for data on the server, the processor uses a redirection mechanism to redirect the request as a request for data local to the server, instead of sending the request over a network connecting the client and the server.

8. The computer system of Claim 5, wherein the initial content of the Web page sent to the client includes the layout and static content that has been processed by the script.

9. In a distributed computing system (100) including at least one server (104) and at least one client (102), a computer system (300) for enabling the server (104) to provide initial content (114) of a Web page for the client (102), wherein the initial content (114) of the Web page was designed to be generated by a client-side script (108), comprising:

(a) a memory (306); and

(b) a processor (304), coupled with the memory (306), executes computer-executable instructions for:

(1) providing a DOM (204) for layout and static content of the Web page and for scripts (205) of the Web page;

(2) extracting from the DOM (204) the script (108);

(3) executing the script (108) on the DOM (204) to cause the DOM (204) to contain the initial content (114) of the Web page;

(4) extracting the initial content (114) from the DOM (204); and

(5) sending the initial content (114) of the Web page to the client (102).

10. The computer system of Claim 9, wherein the processor executes computer-executable instructions to extract from the DOM the script by sequentially ordering content extracted from and contained by script tags and scripting source code in the DOM.

11. The computer system of Claim 9, wherein executing the script on the DOM, if the script makes a request for data on the server, the processor uses a redirection mechanism to redirect the request as a request for data local to the server, instead of sending the request over a network connecting the client and the server.

12. The computer system of Claim 9, wherein the initial content of the Web page includes the layout and static content that has been processed by the script.