

(19) **United States**(12) **Patent Application Publication**
Guta et al.(10) **Pub. No.: US 2025/0251845 A1**(43) **Pub. Date: Aug. 7, 2025**(54) **SYSTEMS AND METHODS FOR HOSTING A BROWSER WITHIN ANOTHER BROWSER**(71) Applicant: **Microsoft Technology Licensing, LLC**,
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Redmond, WA (US)(21) Appl. No.: **18/982,410**(22) Filed: **Dec. 16, 2024****Related U.S. Application Data**

(63) Continuation of application No. 17/818,148, filed on Aug. 8, 2022, now Pat. No. 12,204,740, which is a

continuation of application No. 16/566,689, filed on Sep. 10, 2019, now Pat. No. 11,442,599.

(60) Provisional application No. 62/858,900, filed on Jun. 7, 2019.

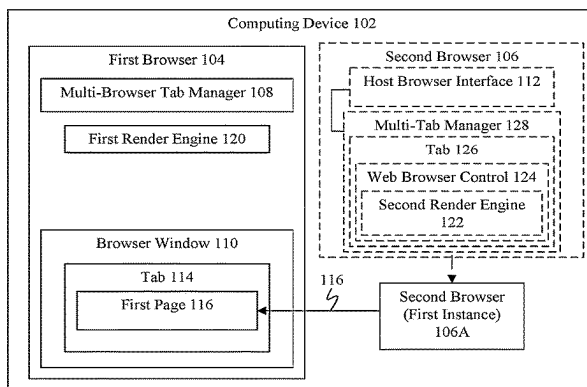
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(2020.01)

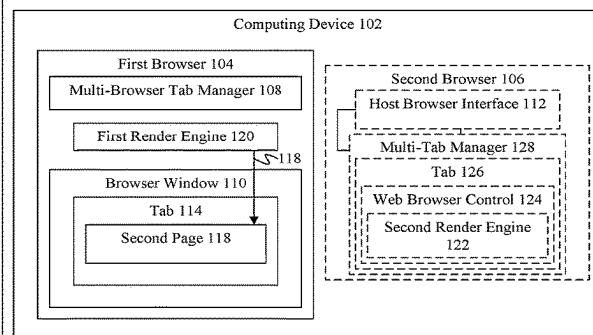
(57)

ABSTRACT

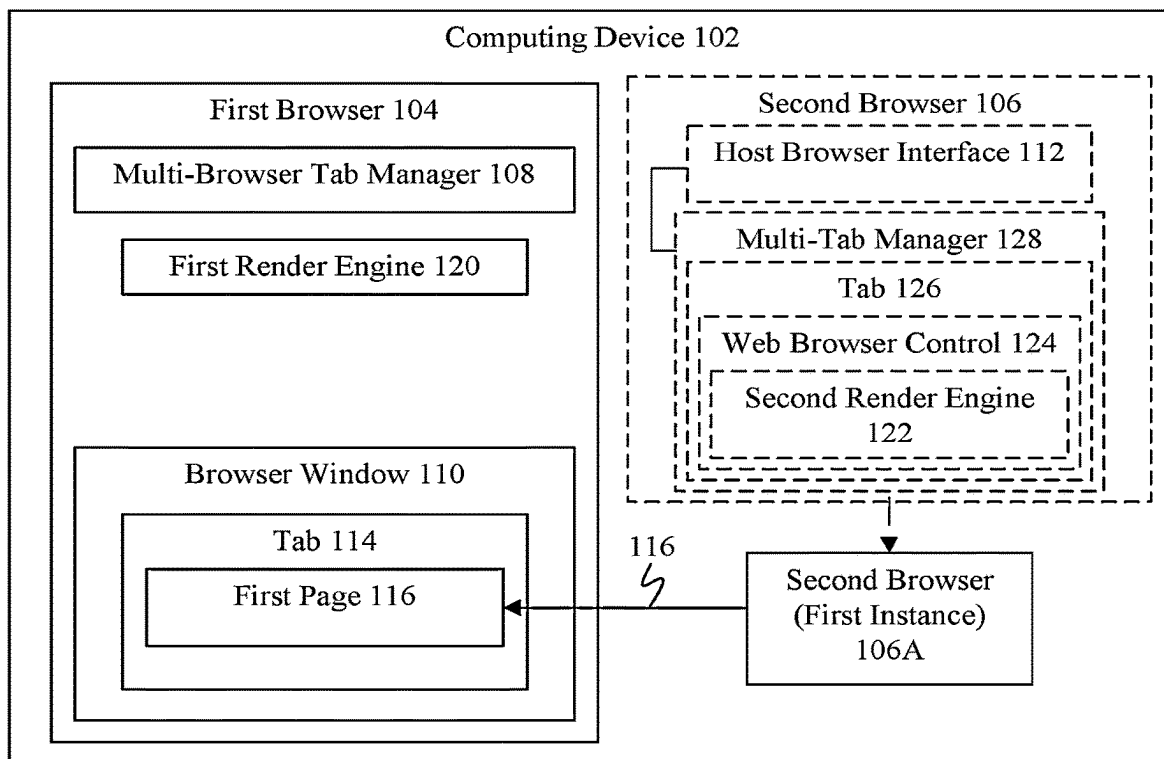
An integrated approach is provided to running web applications with various compatibilities that do not require third-party extensions or sacrifice user experience. When a page of an application incompatible with a first browser is to be executed, an instance of a second browser with which the page is compatible is separately invoked and/or executed without opening a window for that second browser. Instead, the second browser opens a page within the window of the first browser. Moreover, rendering and/or contextual information for a page opened via the second browser is provided to the first browser. Such information is utilized by the first browser to provide a visual experience to the user in which the web page is being hosted by the first browser, even though it is in fact being hosted by the second browser.



100

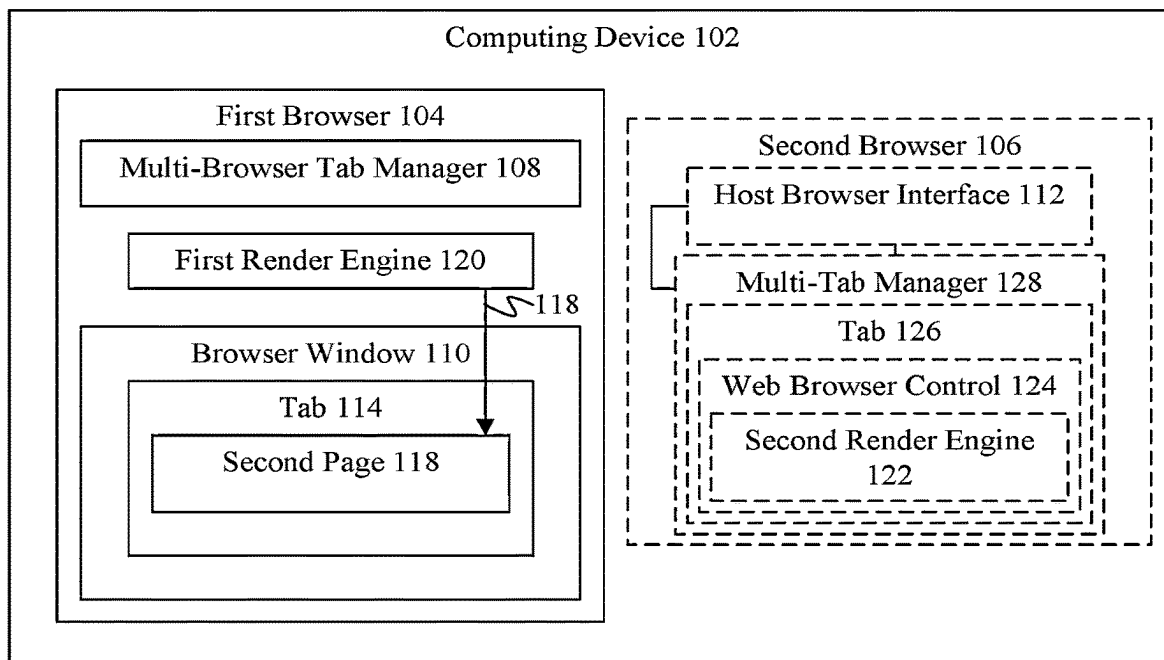


100



100

FIG. 1A



100

FIG. 1B

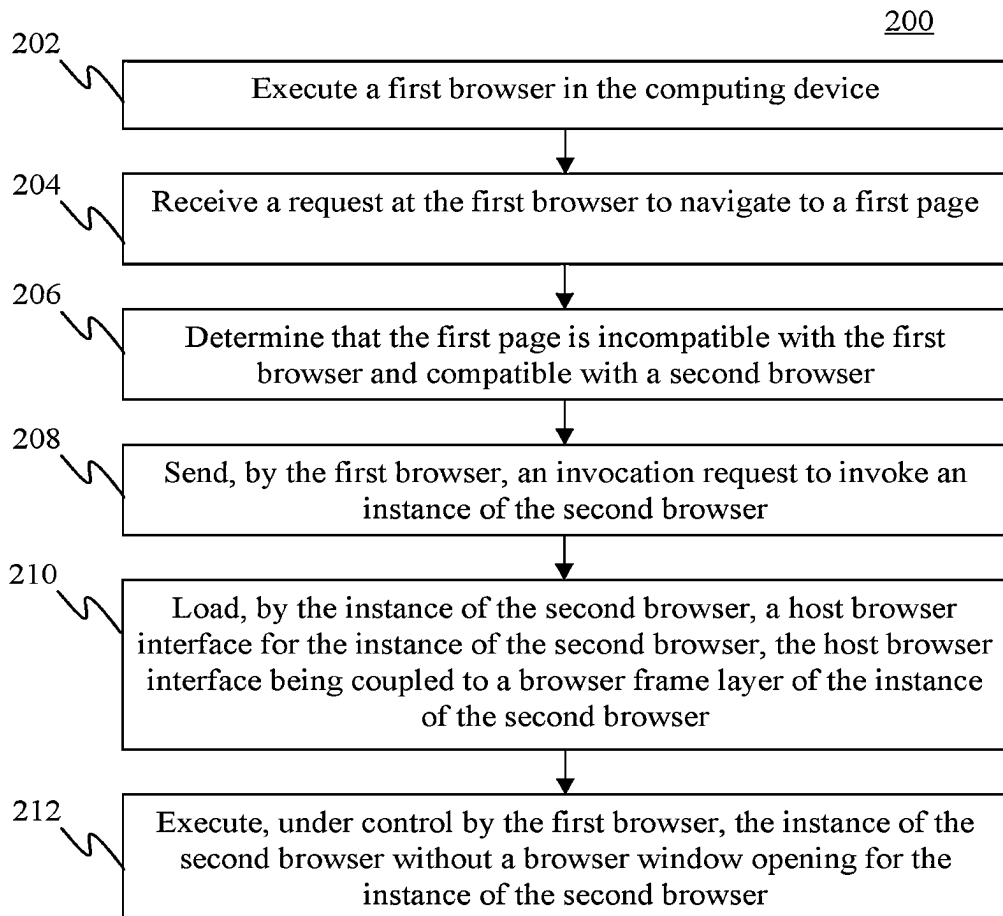


FIG. 2

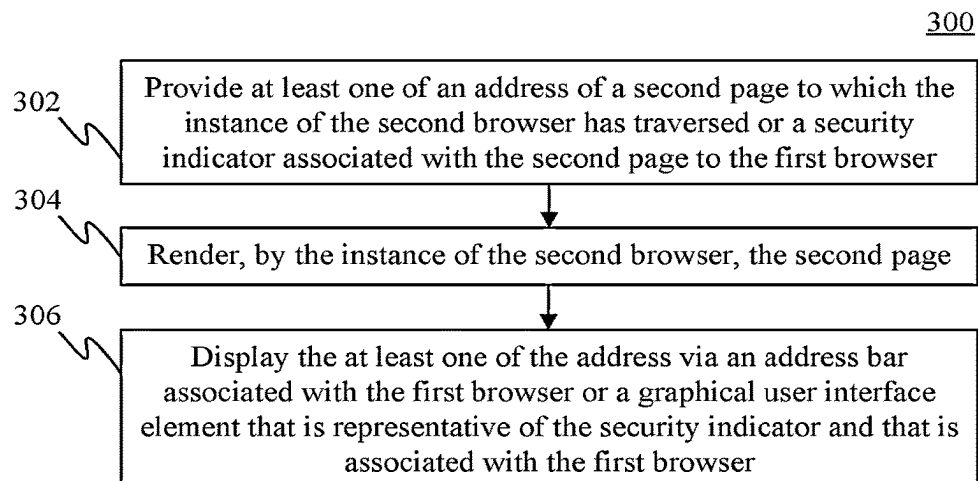


FIG. 3

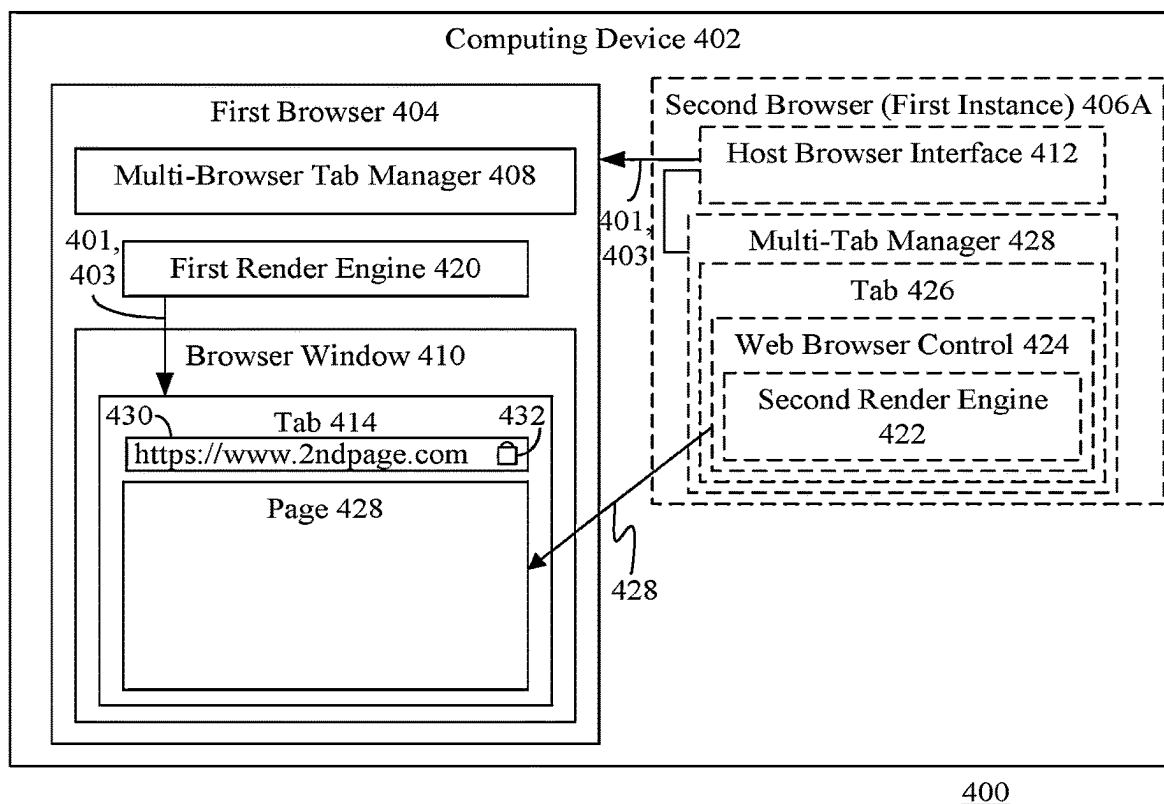


FIG. 4

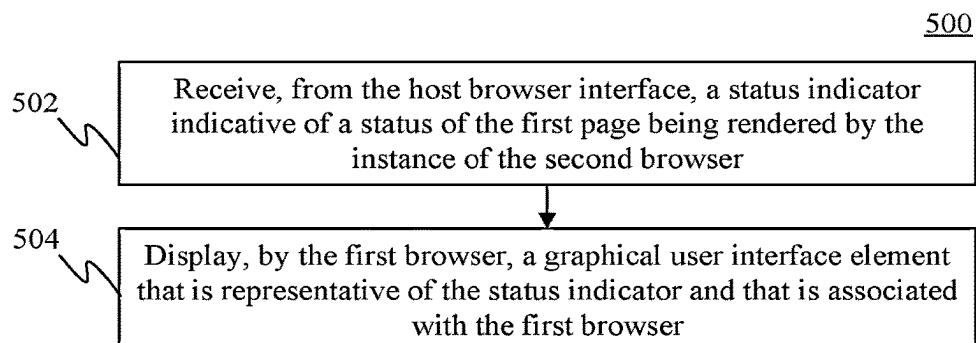


FIG. 5

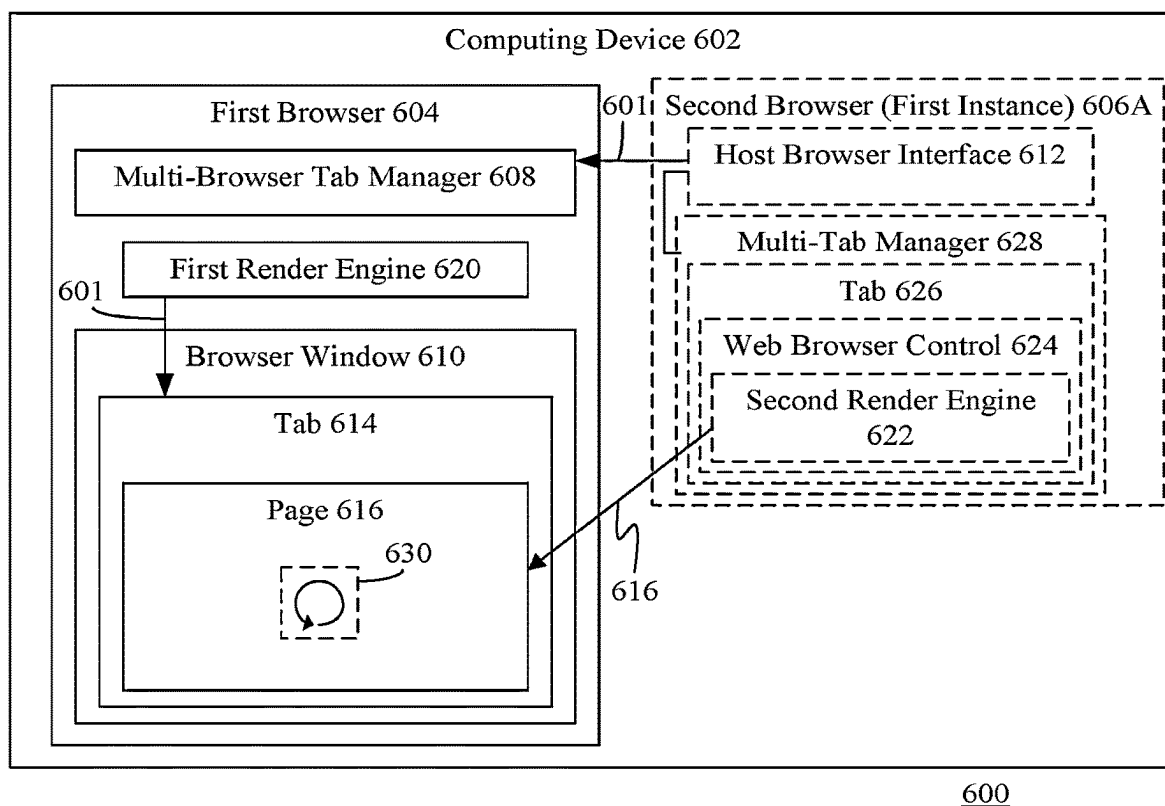


FIG. 6

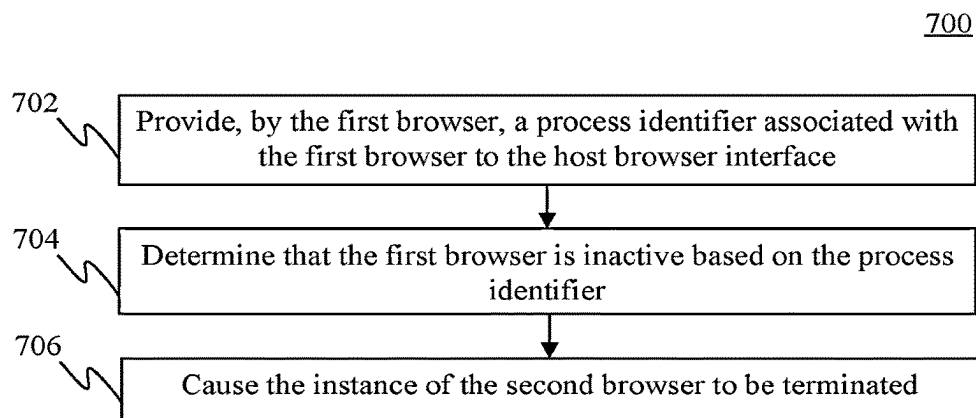


FIG. 7

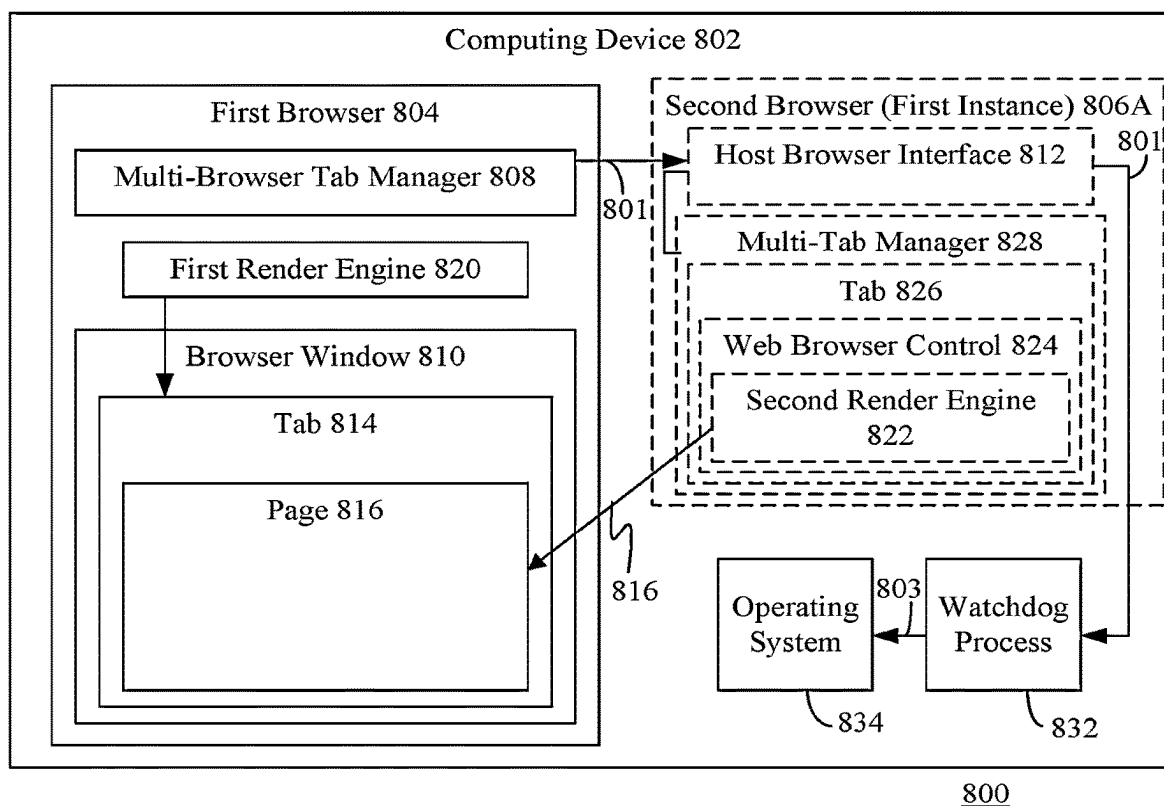


FIG. 8

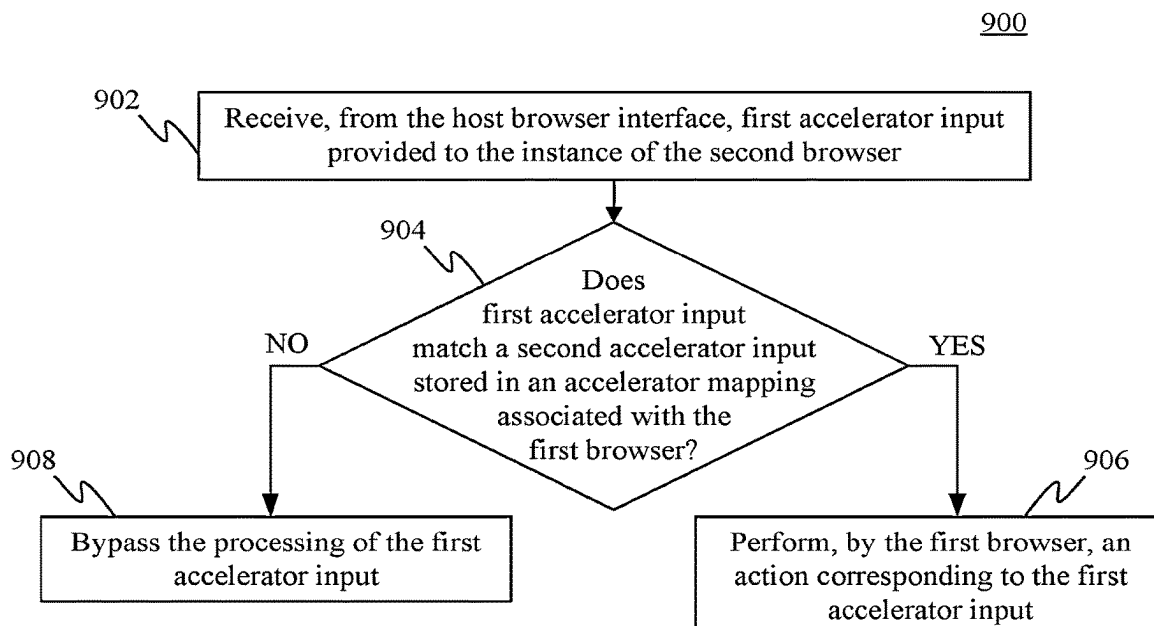
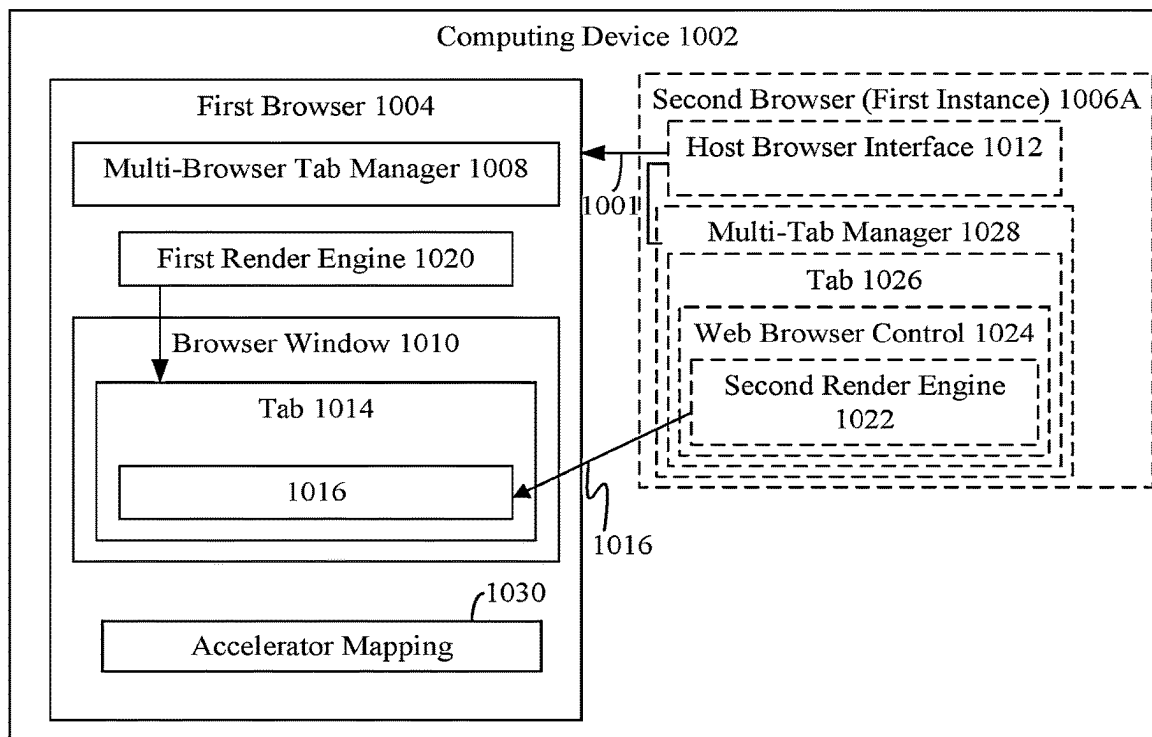


FIG. 9



1000

FIG. 10

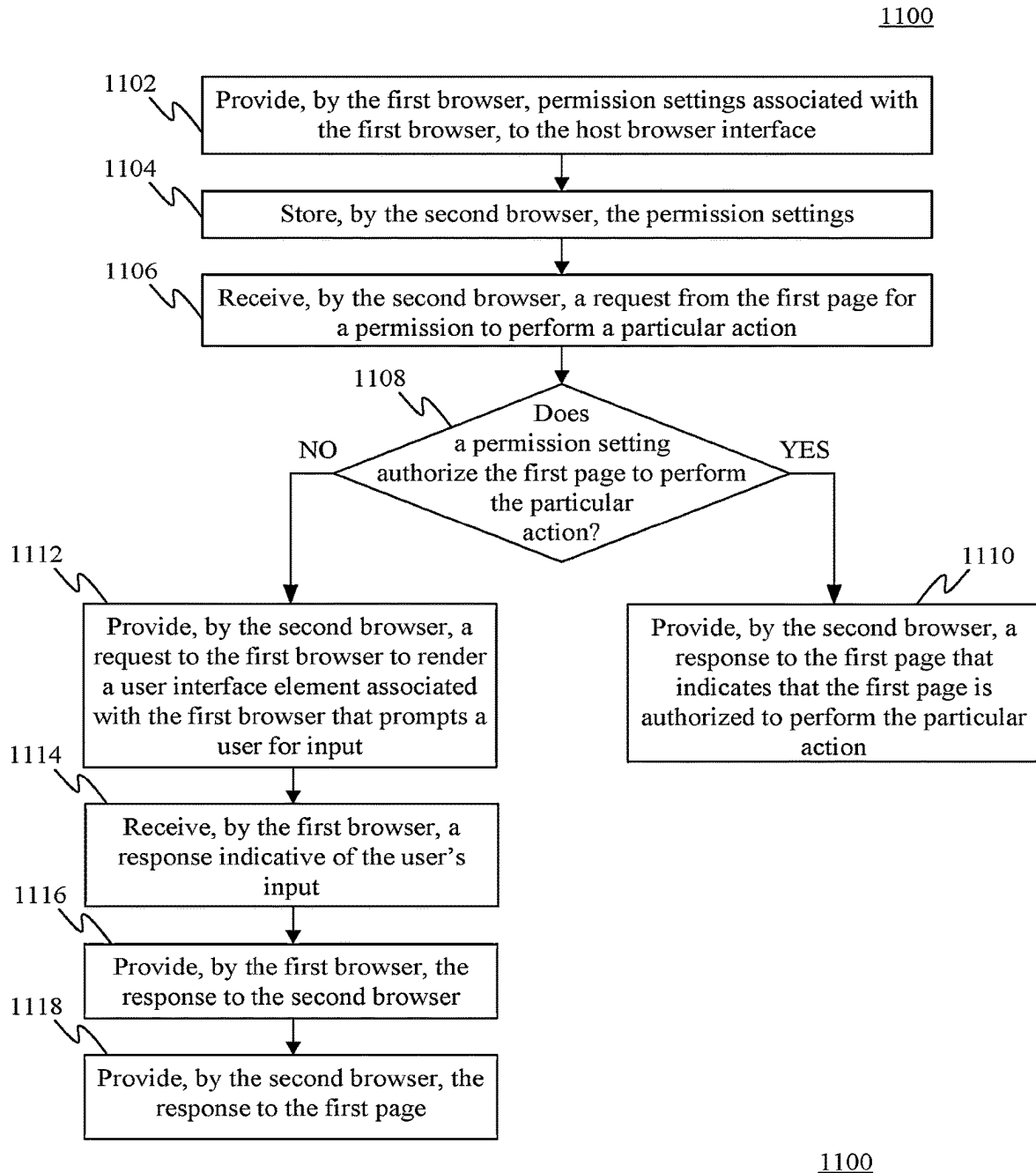
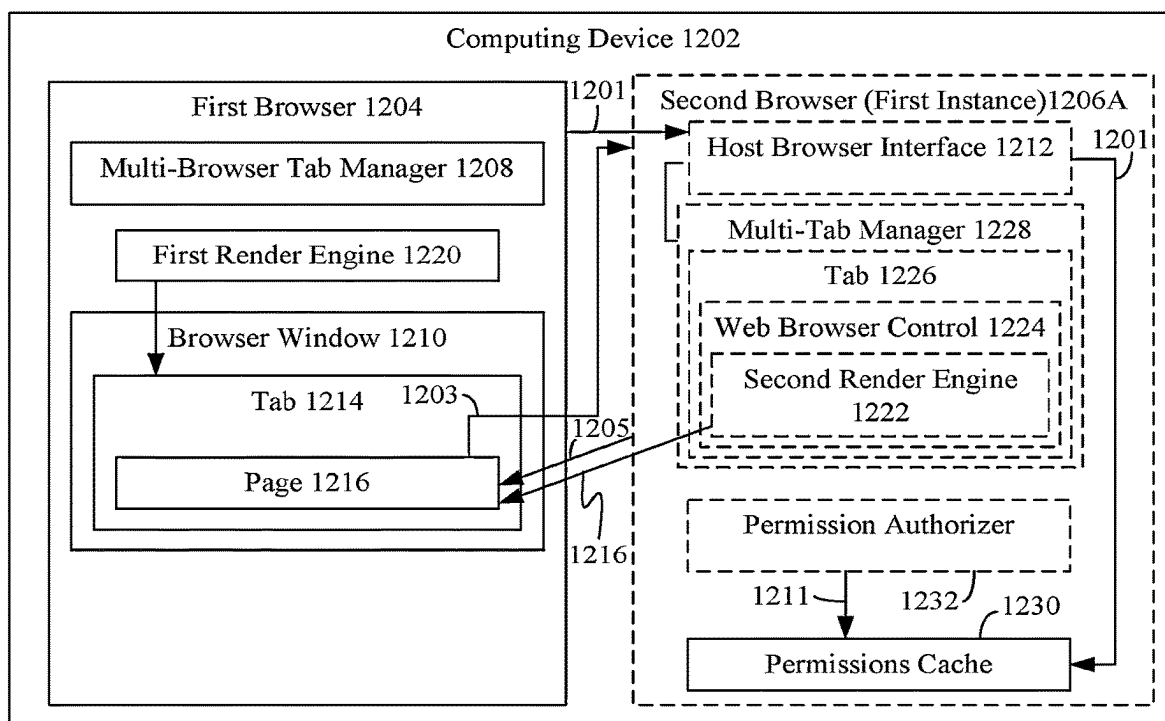
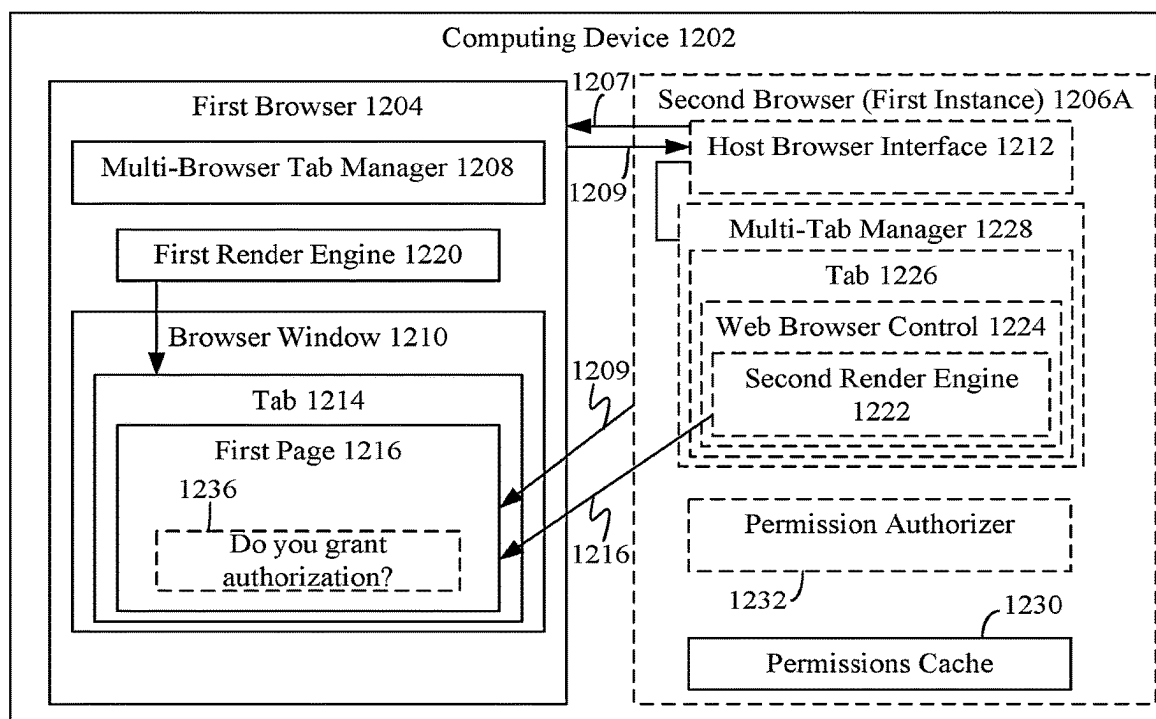


FIG. 11



1200A

FIG. 12A



1200B

FIG. 12B

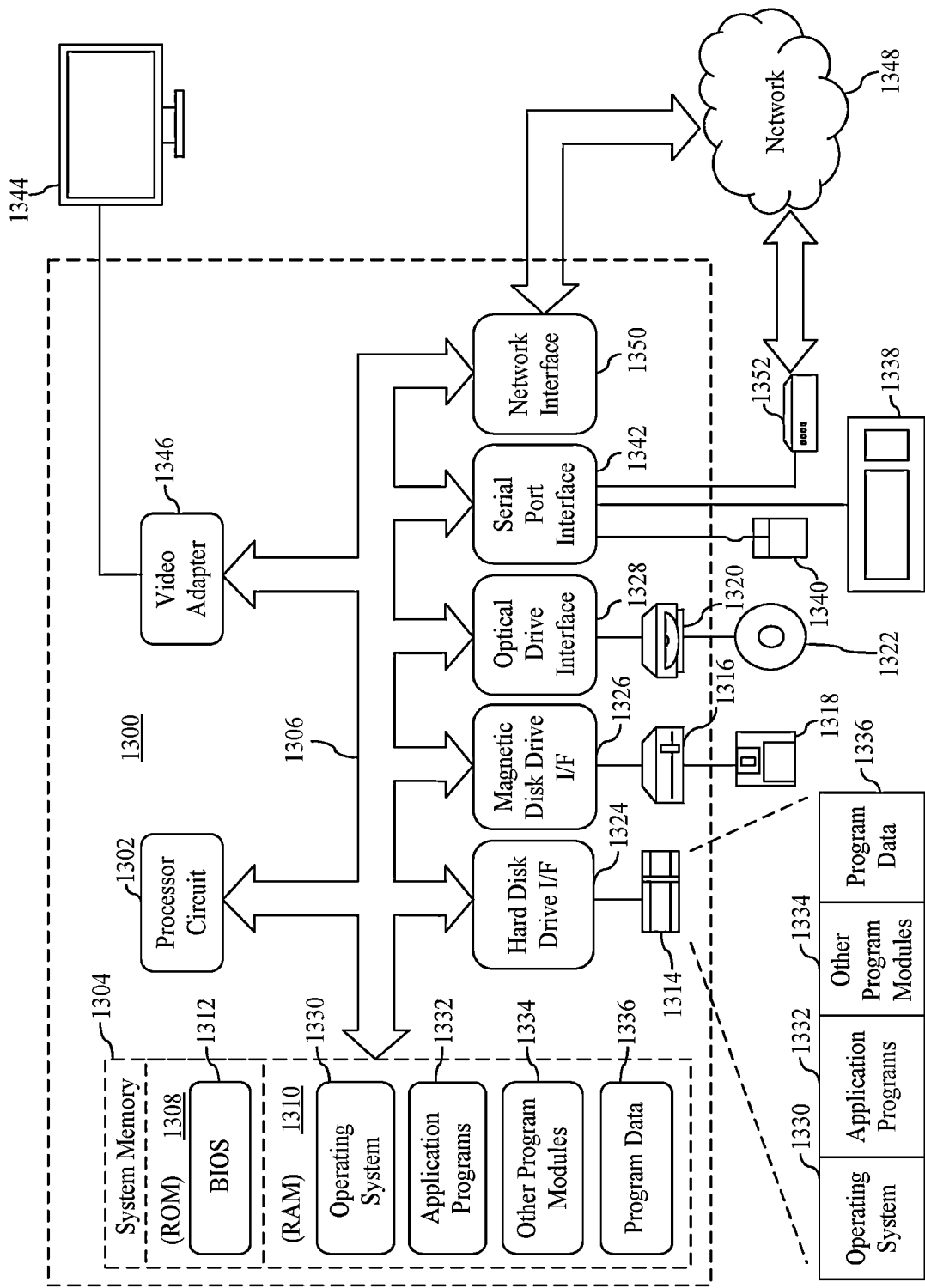


FIG. 13

SYSTEMS AND METHODS FOR HOSTING A BROWSER WITHIN ANOTHER BROWSER

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation of U.S. patent application Ser. No. 17/818,148, filed Aug. 8, 2022, which is a continuation of U.S. patent application Ser. No. 16/566,689, filed Sep. 10, 2019, now Issued U.S. Pat. No. 11,442,599, which claims the benefit of U.S. Provisional Patent Application No. 62/858,900, filed Jun. 7, 2019, entitled “Systems and Methods for Hosting a Browser Within Another Browser,” and which applications are incorporated herein by reference in their entireties. To the extent appropriate a claim of priority is made to each of the above disclosed applications.

BACKGROUND

[0002] A web browser (or “browser”) is a software application for accessing information on the World Wide Web. A web browser is installed on user devices to enable users of those devices to retrieve resources (e.g., individual web pages, images, videos, etc.) from a web server and display them on the user devices. Web browsers are also used to run applications (e.g., webmail, online retail sales, online auction), referred to as “web applications” or “web apps.” A web application is a client-server computer program in which the client (including the user interface and client-side logic) runs in a web browser. The client communicates with the server as needed to fulfill the functions of the web application at the user device.

[0003] As web browsers have progressed over the years, enterprises have developed content that takes advantage of the increasing capability of the advancing web browsers as well as the capabilities of new web browsers. In some cases, content, such as a web application, developed for a particular web browser type and/or browser version has not been updated to be compatible with more modern web browsers and/or browser versions. Accordingly, such content may be incompatible with newer web browsers and/or browser versions, and thus is forced to be run in less advanced browser types and/or versions.

SUMMARY

[0004] 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 or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter.

[0005] Methods, systems, apparatuses, and computer-readable storage mediums described herein enable an integrated approach to running web applications with various compatibilities that do not require third-party extensions or sacrifice user experience. In embodiments, when a page of an application incompatible with a first web browser is to be executed, an instance of a second web browser with which the page is compatible is separately invoked and/or executed without opening a window for that second browser. Instead, the second browser opens a page within the window of the first browser. This enables an effective and efficient user experience by enabling the running of different web applications that have different web browser compatibilities in a

same browser window. Moreover, rendering and/or contextual information for a page opened via the second browser is provided to the first browser. Such information is utilized by the first browser to provide a visual experience to the user in which the web page is being hosted by the first browser, even though it is in fact being hosted by the second browser.

[0006] Further features and advantages of embodiments, as well as the structure and operation of various embodiments, are described in detail below with reference to the accompanying drawings. It is noted that the methods and systems are not limited to the specific embodiments described herein. Such embodiments are presented herein for illustrative purposes only. Additional embodiments will be apparent to persons skilled in the relevant art(s) based on the teachings contained herein.

BRIEF DESCRIPTION OF THE DRAWINGS/FIGURES

[0007] The accompanying drawings, which are incorporated herein and form a part of the specification, illustrate embodiments of the present application and, together with the description, further serve to explain the principles of the embodiments and to enable a person skilled in the pertinent art to make and use the embodiments.

[0008] FIG. 1A and FIG. 1B show block diagrams of a system for managing page compatibility between a first (primary) browser and a second (secondary) browser in a computing device, according to an example embodiment.

[0009] FIG. 2 shows a flowchart of a method in a computing device for hosting a browser within another browser in accordance with an example embodiment.

[0010] FIG. 3 shows a flowchart of a method for displaying, by a first browser, a navigation URL and/or a security indicator received from a second browser in accordance with an example embodiment.

[0011] FIG. 4 shows a block diagram of a system for displaying, by a first browser, a navigation URL and/or a security indicator received from a second browser in accordance with an example embodiment.

[0012] FIG. 5 shows a flowchart of a method for displaying, by a first browser, a graphical user interface element based on a status indicator received from a second browser in accordance with an example embodiment.

[0013] FIG. 6 shows a block diagram of a system for displaying, by a first browser, a graphical user interface element based on a status indicator received from a second browser in accordance with an example embodiment.

[0014] FIG. 7 shows a flowchart of a method for monitoring a first browser in accordance with an example embodiment.

[0015] FIG. 8 shows a block diagram of a system for monitoring a first browser in accordance with an example embodiment.

[0016] FIG. 9 shows a flowchart of a method for handling, by a first browser, accelerator input received from a second browser in accordance with an example embodiment.

[0017] FIG. 10 shows a block diagram of a system for handling, by a first browser, accelerator input received from a second browser in accordance with an example embodiment.

[0018] FIG. 11 shows a flowchart of a method for providing permission settings of a first browser to a second browser in accordance with an example embodiment.

[0019] FIGS. 12A and 12B show block diagrams of systems configured to enable permission settings of a first browser to be provided to a second browser in accordance with an example embodiment.

[0020] In an embodiment FIG. 13 is a block diagram of an example processor-based computer system that may be used to implement various embodiments.

[0021] The features and advantages of the embodiments described herein will become more apparent from the detailed description set forth below when taken in conjunction with the drawings, in which like reference characters identify corresponding elements throughout. In the drawings, like reference numbers generally indicate identical, functionally similar, and/or structurally similar elements. The drawing in which an element first appears is indicated by the leftmost digit(s) in the corresponding reference number.

DETAILED DESCRIPTION

I. Introduction

[0022] The following detailed description discloses numerous example embodiments. The scope of the present patent application is not limited to the disclosed embodiments, but also encompasses combinations of the disclosed embodiments, as well as modifications to the disclosed embodiments.

[0023] References in the specification to “one embodiment,” “an embodiment,” “an example embodiment,” etc., indicate that the embodiment described may include a particular feature, structure, or characteristic, but every embodiment may not necessarily include the particular feature, structure, or characteristic. Moreover, such phrases are not necessarily referring to the same embodiment. Further, when a particular feature, structure, or characteristic is described in connection with an embodiment, it is submitted that it is within the knowledge of one skilled in the art to effect such feature, structure, or characteristic in connection with other embodiments whether or not explicitly described.

[0024] In the discussion, unless otherwise stated, adjectives such as “substantially” and “about” modifying a condition or relationship characteristic of a feature or features of an embodiment of the disclosure, are understood to mean that the condition or characteristic is defined to within tolerances that are acceptable for operation of the embodiment for an application for which it is intended.

[0025] Numerous exemplary embodiments are described as follows. It is noted that any section/subsection headings provided herein are not intended to be limiting. Embodiments are described throughout this document, and any type of embodiment may be included under any section/subsection. Furthermore, embodiments disclosed in any section/subsection may be combined with any other embodiments described in the same section/subsection and/or a different section/subsection in any manner.

II. Example Embodiments

[0026] As described above, as web browsers have progressed over the years, enterprises have developed content that takes advantage of the increasing capability of the advancing web browsers as well as the capabilities of new web browsers. In some cases, content, such as a web application, developed for a particular web browser type

and/or browser version has not been updated to be compatible with more modern web browsers and/or browser versions. Accordingly, such content may be incompatible with newer web browsers and/or browser versions, and thus is forced to be run in less advanced browser types and/or versions. This is inconvenient for users who are forced to maintain old versions of web browsers so that the content incompatible with more recent browser technology can continue to be accessed.

[0027] In the case of a web application, a potential solution to this problem is that the web application be given dual solutions, meaning that multiple versions of the web application are developed and maintained (e.g., for each browser type/version of interest). However, such an approach consumes resources and time. Furthermore, users would need to know which browser version is compatible with which web application version. Another solution introduces the notion of auto-switching, where web applications would open up a new browser application and switch to that browser application based on a specification format that allowed administrators to specify a list of web app sites and the compatible browsers. However, this solution is visible to the user and very distracting. Another solution introduces the notion of invoking a new browser window for a browser compatible with a web app from an open browser window for an incompatible browser in which the web app was attempted to be opened. While this may be an improvement over other solutions, it has shortfalls including the need to switch between separate browsers in separate windows.

[0028] Embodiments described herein help address these and other issues related to content compatibility with web browsers. In particular, embodiments described herein enable an integrated approach to running web applications with various compatibilities that do not require third-party extensions or sacrifice user experience. In embodiments, when a page of an application incompatible with a first web browser is to be executed, an instance of a second web browser with which the page is compatible is separately invoked and/or executed without opening a window for that second browser. Instead, the second browser opens a page within the window of the first browser. This enables an effective and efficient user experience by enabling the running of different web applications that have different web browser compatibilities in a same browser window. Moreover, rendering and/or contextual information for a page opened via the second browser is provided to the first browser. Such information is utilized by the first browser to provide a visual experience to the user in which the web page is being hosted by the first browser, even though it is in fact being hosted by the second browser.

[0029] Such embodiments may be implemented in various ways. For instance, FIG. 1A and FIG. 1B show block diagrams of a system 100 for managing page compatibility between a first (primary) browser 104 and a second (secondary) browser 106, according to an example embodiment. As shown in FIG. 1A and FIG. 1B, system 100 includes a computing device 102 that includes first browser 104 and a second browser 106. First browser 104 includes a first render engine 120 and a multi-browser tab manager 108, and has an open browser window 110. Second browser 106 includes a second render engine 122 and a host browser interface 112. In FIG. 1A, second browser 106 has invoked a running instance (or process) of itself, referred to as second browser (first instance) 106A. Furthermore, browser window 110

includes a tab **114** displaying a first page **116** that is rendered by second render engine **122** of second browser (first instance) **106A**. In FIG. 1B, no instance of second browser **106** executes. Instead, tab **114** displays a second page **118** rendered by first render engine **120** of first browser **104**. FIGS. 1A and 1B are further described as follows.

[0030] Computing device **102** is a computing device via which a user is enabled to run applications and visit web pages compatible with various web browsers. Computing device **102** may be any type of mobile computing device, such as a Microsoft® Surface® device, a personal digital assistant (PDA), a laptop computer, a notebook computer, a tablet computer such as an Apple iPad™, a netbook, a smart phone (such as an Apple iPhone, a phone implementing the Google® Android™ operating system, etc.), a wearable computing device (e.g., a head-mounted device including smart glasses such as Google® Glass™, a virtual headset such as Oculus Rift® by Oculus VR, LLC or HoloLens® by Microsoft Corporation, etc.), a stationary computing device such as a desktop computer or PC (personal computer), or other browser-enabled device.

[0031] First browser **104** and second browser **106** are web browsers, which are software applications configured for accessing information on the World Wide Web. For instance, first browser **104** and second browser **106** may be configured to receive links to web pages, to retrieve the web pages at the addresses indicated by the links, and to render pages for display to a user of computing device **102**. Examples of first browser **104** and second browser **106** include Internet Explorer® or Microsoft Edge®, both developed by Microsoft Corp. of Redmond, Washington, Mozilla Firefox®, developed by Mozilla Corp. of Mountain View, California, Safari®, developed by Apple Inc. of Cupertino, California, and Google® Chrome™ developed by Google Inc. of Mountain View, California. In embodiments, first and second browsers **104** and **106** are different from each other. For instance, first and second browsers **104** and **106** may be different web browser types (e.g., Google® Chrome™ and Microsoft Edge®). Alternatively, first and second browsers **104** and **106** may be different versions of a same web browser. Moreover, second browser **106** may be integrated into and considered to be a component of an operating system executing on computing device **102**.

[0032] As shown in FIGS. 1A and 1B, second browser **106** comprises a host browser interface **112** and a multi-tab manager **128**. Multi-tab manager **128** (also referred to as the browser frame layer) may be configured to manage one or more tabs (e.g., tab **126**). Tab **126** may comprise a web browser control **124** and/or other layers of functionality. Web browser control **124** (also referred to as WebOC) enables browsing, document viewing, and data downloading capabilities to second browser **106**. It enables the user to browse sites via the Internet, as well as folders in the local file system of computing device **102** and on a network. Web browser control **124** supports Web browsing through both point-and-click hyperlinking and uniform resource locator (URL) navigation. Web pages shown via multi-tab manager **128**, tab **126**, and/or web browser control **124** are rendered via second render engine **122**.

[0033] First render engine **120** and second render engine **122** of first browser **104** and second browser **106**, respectively, are each configured to generate a display of content in browser tabs of browser windows, including transforming HTML (hypertext markup language) documents and other

resources of a web page into an interactive visual representation. In an embodiment, each of first and second engines **120** and **122** may be configured to perform page layout and rendering of content. Examples of browser engines include Gecko™ used in the Mozilla Firefox® web browser, the WebKit™ engine used by the Apple Safari browser, Trident™ (MSHTML) used in Internet Explorer™, and Blink™ used in the Google Chrome and Microsoft Edge Browsers.

[0034] Note that second browser **106** shown in dotted line represents the executable file(s) for second browser **106** that may be invoked to generate executing instances (or processes) of second browser **106**, such as second browser (first instance) **106A** shown in FIG. 1A. It is noted that executing instances of second browser **106** do include host browser interface **112**, multi-tab manager **128**, tab **126**, web browser control **124**, and second render engine **122**, even though they are not shown illustrated in such instances for reasons of brevity.

[0035] As described above, web pages may be compatible with some browsers but not others. For instance, first page **116** may be compatible with second browser **106** but not compatible with first browser **104**. In such case, an instance of second browser **106**, such as second browser (first instance) **106A** of FIG. 1A, may be invoked to render first page **116** within browser window **110** of first browser **104**. In this way, pages compatible with second browser **106**, but not with first browser **104**, may still be displayed to users within first browser **104** without opening a separate browser window for second browser **106**, thus providing an improved user experience. This may be accomplished in various ways.

[0036] In particular, first browser **104** includes multi-browser tab manager **108**. Multi-browser tab manager **108** is configured to receive navigation requests to pages of web applications and determine whether a page to which such a request is directed is compatible with second browser **106** but not first browser **104**, such as by conferring with a browser compatibility list. The browser compatibility list may list particular items of content, web applications, file extensions, and/or other identifiers for content that second browser **106** is compatible with (e.g., is capable of rendering) and that first browser **104** is not compatible with. If multi-browser tab manager **108** determines that a requested page is compatible with first browser **104** (e.g., is not identified in the browser compatibility list as incompatible with first browser **104**), then first browser **104** receives the web address and renders the page within first browser **104** as normal. However, if multi-browser tab manager **108** determines that the page is compatible with second browser **106**, but not first browser **104** (e.g., is identified in the browser compatibility list as compatible with second browser **106** but incompatible with first browser **104**), then second browser (first instance) **106A** is invoked to receive the web address of the page and to render the page within first browser **104**.

[0037] For example, an interface of multi-browser tab manager **108** of first browser **104** may issue an invocation request (e.g., an API call) to second browser **106** that causes second browser (first instance) **106A** to be invoked and to be hosted by first browser **104**. The invocation request may include one or more parameters (e.g., command line parameter(s)) that cause second browser (first instance) **106A** to load host browser interface **112**. For instance, the parameter (s) may specify the name of host browser interface **112**

and/or a location from which to load host browser interface **112**. The invocation request may be sent via an API call, or in another manner, which when received by second browser **106**, causes second browser **106** to invoke second browser (first instance) **106A**. Host browser interface **112** may be hooked into multi-tab manager **128**, thereby providing the functionality of multi-tab manager **128**, tab **126**, web browser control **124** and/or second render engine **122** within first browser **104**. Such functionality includes, but is not limited to, virtual tab (or “vtab” switching), browser helper objects (BHOs), and/or other extensions. Vtab switching is functionality that enables content launched in a new tab to appear to be rendered in the same tab from which the new tab was launched. For example, suppose a web page in a first secure container (e.g., an enterprise’s private webpage) displays a URL for a web page hosted by a second secure container (e.g., a public web page hosted externally to the enterprise network). When the URL is clicked on, a new tab is launched to display the content of the web page corresponding to the URL. However, with vtab switching, it is made to appear as if the web page is being rendered in the same tab in which the enterprise web page is rendered. Host browser interface **112** may be implemented as a dynamic link library (DLL), which is loaded into the process of second browser’s (first instance) **106A** (e.g., from a DLL library stored on computing device **102**) in response to first browser **104** invoking second browser **106**.

[0038] Note that when second browser (first instance) **106A** is invoked, second browser (first instance) **106A** does not open a browser window as normally would occur. Instead, such a browser window opening is suppressed. The invocation request may include a parameter specifying that second browser (first instance) **106A** does not open a browser window, but instead instructing second browser (first instance) **106A** to direct any rendering and/or contextual information for a page to first browser **104**, so the page may be opened in the open tab of first browser **104** in which the initial navigation request was received. The rendering information and/or contextual information may be provided to first browser **104** via host browser interface **112**.

[0039] Host browser interface **112** of second browser (first instance) **106A** may be further configured to receive navigation requests inside pages opened by second browser (first instance) **106A** in tab **114**, and determine whether pages to which such requests are directed are compatible with second browser **106** but not first browser **104**. For instance, host browser interface **112** may confer with a browser compatibility list to make the determination. The browser compatibility list accessed by host browser interface **112** may be the same page compatibility used by multi-browser tab manager **108** or a different one. Upon determination that a page is compatible with second browser **106** and not first browser **104**, host browser interface **112** renders the page hosted within tab **114** of first browser **104**, again without opening a browser window for second browser (first instance) **106A**.

[0040] For instance, as shown in FIG. 1A, first page **116** was determined to be compatible with second browser **106**, but not first browser **104**. As such, browser window **110** of first browser **104** displays first page **116** within tab **114**, rendered there by second render engine **122** of second browser (first instance) **106A**. Alternatively, as shown in FIG. 1B, a second page **118** (opened from a link within first page **116**, or by a history navigation) was determined to be compatible with first browser **104**. As such, browser window

110 displays second page **118** within tab **114**, rendered there by first render engine **120**. In the case of FIG. 1B, because second page **118** is compatible with first browser **104**, second browser (first instance) **106A** is not needed and may therefore be closed, thereby freeing up memory and reducing processor demand in computing device **102**.

[0041] Accordingly, pages may be opened in tab **114** by first browser **104** or instances of second browser **106**, depending on browser capability for the pages, in any page sequence.

[0042] FIG. 2 shows a flowchart **200** of a method in a computing device for hosting a browser within another browser, according to an example embodiment. In an embodiment, flowchart **200** may be implemented by multi-browser tab manager **108** of first browser **104**. For purposes of illustration, flowchart **200** is described with continued reference to FIG. 1. Other structural and operational embodiments will be apparent to persons skilled in the relevant art(s) based on the following discussion.

[0043] Flowchart **200** of FIG. 2 begins with step **202**. In step **202**, a first browser is executed in the computing device, the first browser having an open browser window. For instance, as shown in FIG. 1A, first browser **104** executes in computing device **102**. First browser **104** has browser window **110** open. In embodiments, a user of computing device **102** may have invoked first browser **104**, or first browser **104** may have been invoked by the invocation of a web application.

[0044] In step **204**, a request is received at the first browser to navigate to a first page. For instance, and with reference to FIG. 1A, multi-browser tab manager **108** may receive a request to navigate to first page **116**. In embodiments, the navigation request may be initiated by a user of computing device **102**, such as by a link click in a currently opened page in tab **114** or other open tab (causing tab **114** to open), or by a history navigation (e.g., by the user selecting a browser back button or forward button) with tab **114** the active tab. The navigation request includes an address to first page **116**, such as in the form of a uniform resource location (URL) or other address type.

[0045] In step **206**, a determination is made that the first page is incompatible with the first browser and compatible with a second browser. In an embodiment, multi-browser tab manager **108** may be configured to determine that first page **116** is compatible with second browser **106** and incompatible with first browser **104**.

[0046] In embodiments, multi-browser tab manager **108** may determine that the first page is compatible with the first browser or the second browser based on an administrator defined list, such as by accessing a browser compatibility list as described above. However, this is not intended to be limiting and multi-browser tab manager **108** may make this determination in other ways, as would be apparent to persons skilled in the relevant art(s) from the teachings herein.

[0047] In step **208**, the first browser sends an invocation request to invoke an instance of the second browser. For example, with reference to FIG. 1A, multi-browser tab manager **108** may send an invocation request to second browser **106**. For instance, invocation request may be sent via an API call, and second browser **106** may include an API interface configured to receive the API call.

[0048] In step **210**, responsive to receiving the invocation request, a host browser interface for the instance of the second browser is loaded by the instance of the second

browser, the host browser interface being coupled to a browser frame layer of the instance of the second browser. For example, with reference to FIG. 1A, responsive to receiving the invocation request, host browser interface 112 for second browser (first instance) 106A is loaded by second browser (first instance) 106A. Host browser interface 112 is coupled to browser frame layer 128 of second browser (first instance) 106A, thereby enabling first browser 104 to host the functionality of browser frame layer 128, tab 126, web browser control 124 and/or second render engine 122.

[0049] In step 212, the instance of the second browser is executed under control by the first browser without a browser window opening for the instance of the second browser. For example, with reference to FIG. 1A, second browser (first instance) 106A is executed under control by first browser 104 without a browser window opening for second browser (first instance) 106A.

[0050] In accordance with one or more embodiments, an address of the first page is provided to the instance of the second browser, and the instance of the second browser renders the first page, the first page being hosted within a tab in the browser window of the first browser. For example, with reference to FIG. 1A, an address of first page 116 is provided to second browser (first instance) 106A, and second browser (first instance) 106A renders first page 116 within tab 114 in browser window 110 of first browser 104.

[0051] In accordance with one or more embodiments, host browser interface 112 is a DLL loaded at initialization of second browser (first instance) 106A.

[0052] In accordance with one or more embodiments, functionality of the instance of the second browser is hosted within the first browser, the functionality including at least one of virtual tab switching, browser helper objects, and one or more browser extensions.

[0053] As described above, second browser (first instance) 106A provides rendering information and/or contextual information for a page being rendered by second render engine 122 to first browser 104. The information is utilized by first browser 104 to provide a visual experience to the user in which the web page is being hosted by first browser 104, even though it is in fact being hosted by second browser (first instance) 106A. The foregoing is described below.

A. Navigation URLs

[0054] Suppose a user viewing a web page (via second browser (first instance) 106A) that includes a URL to another web page (e.g., another incompatible web page). When a user clicks on the URL, first browser 104 may indicate URL in its address bar. Thus, in accordance with an embodiment, host browser interface 114 provides the URL to first browser 104 upon the user clicking on the URL and/or upon second browser (first instance) 106A navigating to that URL. In response to receiving the URL, first browser 104 causes the URL to be displayed in its address bar. Additional information may also be provided to first browser 104. For instance, if the web page associated with the URL is secure (e.g., the web page utilizes a Secure Socket Layer (SSL) or Transport Layer Security (TLS)), host browser interface 112 may provide an indication to first browser 104 that the web page is secure, and first browser 104 may reflect this via its GUI. For instance, first browser 104 may display “https://” before the URL in its address bar. In another example, first browser 104 may display a lock icon via its GUI.

[0055] Similarly, when first browser 104 invokes second browser 106 to render an incompatible web page, first browser 104 provides the URL (and/or additional information, such as security information) to second browser 106. First browser 104 may also provide a listing of URLs that were traversed via first browser 104 to host browser interface 112 of second browser (first instance) 106A, and second browser (first instance) 106 may provide a listing of URLs that were traversed via second browser (first instance) 106 to first browser 104. This enables first browser 104 and/or second browser (first instance) 106 to perform a navigation of history of URLs traversed by both first browser 104 and/or second browser (first instance) 106. Additional details regarding the foregoing techniques is described in application Ser. No. 16/403,186 (Attorney Docket No. 406335-US-NP), filed on May 3, 2019, and entitled “Page Display by Hosted Browser Within Controlling Browser,” the entirety of which is incorporated by reference.

[0056] FIG. 3 shows a flowchart 300 of a method for displaying, by a first browser, a navigation URL and/or a security indicator received from a second browser in accordance with an example embodiment. In an embodiment, flowchart 300 may be implemented by a system 400 shown in FIG. 4, although the method is not limited to that implementation. As shown in FIG. 4, system 400 includes a computing device 402 that includes first browser 404 and an instance of second browser 406A. First browser 404 includes a first render engine 420 and a multi-browser tab manager 408, and has an open browser window 410 that includes one or more tabs (e.g., tab 414). Second browser 406A includes a multi-tab manager 428, second render engine 422 and a host browser interface 412. Multi-tab manager 428 may be configured to manage one or more tabs (e.g., tab 426). Tab 426 may comprise a web browser control 424 and/or other layers of functionality. Second render engine 422 may be managed by web browser control 424. Computing device 402, first browser 404, multi-browser tab manager 408, first render engine 420, browser window 410, tab 414, second browser (first instance) 406A, host browser interface 412, multi-tab manager 428, tab 426, web browser control 424, and second render engine 422 are examples of computing device 102, first browser 104, multi-browser tab manager 108, first render engine 120, browser window 110, tab 114, second browser (first instance) 106A, host browser interface 112, multi-tab manager 128, tab 126, web browser control 124, and second render engine 122, as respectively described above with reference to FIGS. 1A and 1B. In the embodiment shown in FIG. 4, second browser (first instance) 406A has traversed to another web page (e.g., page 428), for example, via a user clicking on a hyperlink displayed on a first page (e.g., page 116, shown in FIG. 1A).

[0057] Flowchart 300 begins with step 302. In step 302, at least one of an address of a second page to which the instance of the second browser has traversed or a security indicator associated with the second page is provided to the first browser. For example, with reference to FIG. 4, second browser (first instance) 406A provides at least one of an address (e.g., a URL) 401 of a second page or a security indicator 403 associated with the second page to first browser 404 via host browser interface 412.

[0058] In step 304, the second page is rendered by the instance of the second browser, the second page being hosted within the tab in the browser window of the first browser. For example, with reference to FIG. 4, second

render engine 422 of second browser (first instance) 406A renders second page 428. Second page 428 is hosted within tab 414 of browser window 410 of first browser 404.

[0059] In step 306, the at least one of the address via an address bar associated with the first browser or a graphical user interface element that is representative of the security indicator and that is associated with the first browser is displayed. For example, with reference to FIG. 4, first render engine 420 renders address 401 (e.g., <https://www.2ndpage.com>) via an address bar 430 displayed via tab 414 and/or renders a graphical user interface element 432 that is representative of the security indicator 403 within address bar 430. In the example shown in FIG. 4, security indicator 430 indicates that second page 428 is a secure website. Accordingly, graphical user interface element 432 (which is shown as a lock) represents that second page 428 is secure. First render engine 420 renders its version of the lock, and not the version of the lock (or graphical user interface element used by second browser (first instance) 406A to represent a secure website) utilized by second browser (first instance) 606A, thereby enabling a seamless integration of second browser (first instance) 406A within first browser 404.

B. User Interface Element Control

[0060] Referring again to FIG. 1, in accordance with an embodiment, host browser interface 112 may provide status information to first browser 104. The status information may indicate whether a web page being loaded and/or rendered by second render engine 112 is large in size and/or is taking a long time to load. Based on the status information, first browser 104 causes a user interface element to be rendered to indicate the status. For example, the user interface element may be a spinning wheel or ring (also referred to as a “throbber”) utilized by first browser 104. The user interface element utilized by second browser (first instance) 106A to reflect this status (i.e., the second browser’s version of the throbber) is not displayed. Instead, the user interface element utilized by first browser 104 is utilized.

[0061] In another example, the status information may indicate whether a web page being loaded and/or rendered by second render engine 112 is favorited by the user. Based on this information, first browser 104 causes a user interface element to be rendered to indicate the favorited status. For example, the user interface element may be a star shown in the address bar of first browser 104. The user interface element utilized by second browser (first instance) 106A to reflect this status (i.e., the second browser’s version of the star) is not displayed. Instead, the user interface element utilized by first browser 104 is utilized. The foregoing techniques advantageously enables a seamless integration of second browser (first instance) 106A within first browser 104.

[0062] It is noted that the status information described above is purely exemplary and that the status information may include any type of information that first browser 104 utilize to display its own version of a particular user interface element.

[0063] FIG. 5 shows a flowchart 500 of a method for displaying, by a first browser, a graphical user interface element based on a status indicator received from a second browser in accordance with an example embodiment. In an embodiment, flowchart 500 may be implemented by a system 600 shown in FIG. 6, although the method is not limited to that implementation. As shown in FIG. 6, system

600 includes a computing device 602 that includes first browser 604 and an instance of second browser 606A. First browser 604 includes a first render engine 620 and a multi-browser tab manager 608, and has an open browser window 610 that includes one or more tabs (e.g., tab 614). Second browser 606A includes a multi-tab manager 628, second render engine 622 and a host browser interface 612. Multi-tab manager 628 may be configured to manage one or more tabs (e.g., tab 626). Tab 626 may comprise a web browser control 624 and/or other layers of functionality. Second render engine 622 may be managed by web browser control 624. Computing device 602, first browser 604, multi-browser tab manager 608, first render engine 620, browser window 610, tab 614, second browser (first instance) 606A, host browser interface 612, multi-tab manager 628, tab 626, web browser control 624, and second render engine 622 are examples of computing device 102, first browser 104, multi-browser tab manager 108, first render engine 120, browser window 110, tab 114, second browser (first instance) 106A, host browser interface 112, multi-tab manager 128, tab 126, web browser control 124, and second render engine 122, as respectively described above with reference to FIGS. 1A and 1B. In the embodiment shown in FIG. 6, second browser (first instance) 606A has traversed to a first page (e.g., page 616). Page 616 is an example of page 116, as described above with reference to FIG. 1A.

[0064] Flowchart 500 begins with step 502. In step 502, a status indicator indicative of a status of the first page being rendered by the instance of the second browser is received from the host browser interface. For example, with reference to FIG. 6, second browser (first instance) 606A provides a status indicator 601 indicative of a status of page 616 being rendered by second render engine 622 of second browser (first instance) 606A via host browser interface 612.

[0065] In step 504, a graphical user interface element that is representative of the status indicator and that is associated with first browser is displayed. For example, with reference to FIG. 6, first render engine 620 displays a graphical user interface element 630 representative of status indicator 601 and that is associated with first browser 604. For example, status indicator 601 may indicate that page 616 is taking a long time to load. Accordingly, first render engine 620 displays a throbber (i.e., graphical user interface element 630) in tab 614 to indicate to the user that page 616 is loading. First render engine 620 renders its version of the throbber, and not the version of the throbber utilized by second browser (first instance) 606A, thereby enabling a seamless integration of second browser (first instance) 606A within first browser 604.

C. Watchdog Process

[0066] Referring again to FIG. 1A, during initialization of second browser (first instance) 106A, a watchdog process may be launched. The watchdog process may be configured to determine whether first browser 104 is still active (or open). For instance, during initialization first browser 104 may provide its process identification (PID) to second browser (first instance) 106A via host browser interface 112. The watchdog process may periodically monitor the PID to determine whether it is still pointing to first browser 104. In the event that the PID is no longer pointing to first browser 104 (e.g., due to first browser 104 being closed due to first

browser **104** self-terminating or crashing, etc.), the watchdog process may cause second browser (first instance) **106A** to terminate.

[0067] FIG. 7 shows a flowchart **700** of a method for monitoring a first browser in accordance with an example embodiment. In an embodiment, flowchart **700** may be implemented by a system **800** shown in FIG. 8, although the method is not limited to that implementation. As shown in FIG. 8, system **800** includes a computing device **802** that includes first browser **804** and an instance of second browser **806A**. First browser **804** includes a first render engine **820** and a multi-browser tab manager **808**, and has an open browser window **810** that includes one or more tabs (e.g., tab **814**). Second browser **806A** includes a multi-tab manager **828**, second render engine **822** and a host browser interface **812**. Multi-tab manager **828** may be configured to manage one or more tabs (e.g., tab **826**). Tab **826** may comprise a web browser control **824** and/or other layers of functionality. Second render engine **822** may be managed by web browser control **824**. Computing device **802**, first browser **804**, multi-browser tab manager **808**, first render engine **820**, browser window **810**, tab **814**, second browser (first instance) **806A**, host browser interface **812**, multi-tab manager **828**, tab **826**, web browser control **824**, and second render engine **822** are examples of computing device **102**, first browser **104**, multi-browser tab manager **108**, first render engine **120**, browser window **110**, tab **114**, second browser (first instance) **106A**, host browser interface **112**, multi-tab manager **128**, tab **126**, web browser control **124**, and second render engine **122**, as respectively described above with reference to FIGS. 1A and 1B. In the embodiment shown in FIG. 8, second browser (first instance) **806A** has traversed to a first page (e.g., page **816**). Page **816** is an example of page **116**, as described above with reference to FIG. 1A. As further shown in FIG. 7, computing device **802** may also comprise a watchdog process **830** and an operating system **832**. Watchdog process **830** and operating system **832** execute on computing device **802**. Watchdog process **830** may be initiated responsive to first browser **804** being initiated.

[0068] Flowchart **700** begins with step **702**. In step **702**, a process identifier associated with the first browser is provided to the host browser interface by the first browser. For example, with reference with FIG. 8, first browser **804** provides a process identification (e.g., PID **801**) to host browser interface **812** of second browser (first instance) **806A**.

[0069] In step **704**, a determination is made that the first browser is inactive based on the process identifier. For example, with reference to FIG. 8, host browser interface **812** provides PID **801** to watchdog process **830**. Watchdog process **830** may periodically monitor PID **801** to determine whether it is still pointing to first browser **804**. Watchdog process **830** determines that first browser **804** is inactive when PID **801** is no longer pointing to first browser **804** (e.g., due to first browser **804** being closed due to first browser **104** self-terminating or crashing, etc.). Watchdog process **830** may receive the value of PID **801** continuously, or may check a value of PID **801** periodically or according to any other schedule.

[0070] In step **706**, in response to determining that the first browser is no longer active, the instance of the second browser is caused to be terminated. For example, with reference to FIG. 8, in response to determining that first

browser **804** is no longer active, watchdog process **830** provides a command **803** to operating system **832**. Responsive to receiving command **803**, operating system **832** terminates second browser (first instance) **806A**.

D. Accelerator Handling

[0071] Referring again to FIG. 1A, accelerator handling starts with a keydown message on whatever thread has focus and iterates through various accelerator tables until a match is found, in which case it is ‘handled’ and the search for other matching accelerators stops. If an accelerator (also referred to as keyboard shortcuts, such as, but not limited to, Ctrl+C (to copy text), Ctrl+P (to paste text), etc.) is not handled, it will be forwarded to other threads to loop through more accelerator tables for handling until there are no threads left or it gets handled. An unhandled keydown accelerator is converted to a character and goes through another accelerator handling process before the character is delivered to the focused window.

[0072] Second browser (first instance) **106A** may define an accelerator as any key press, release or character when the “Ctrl” “Alt”, or “F1-F24” keys are pressed, and has special casing for handling key presses like “Tab” and “Esc.”

[0073] There may be multiple threads per window that handle accelerators, for example, the tab thread (e.g., tab **126**), the frame thread of second browser **106** (e.g., multi-tab manager **128**) and the frame thread of first browser **104** (e.g., multi-browser tab manager **108**). The thread that receives accelerator input is based on which window associated with the thread is in focus. For instance, if a web page is being rendered by second render engine **122** and the window in which the web page is being rendered is active, then that window will receive the accelerator input. Similarly, if a web page is being rendered by first render engine **120** and the window in which the web page is being rendered is active, then that window will receive the accelerator input.

[0074] If a window associated with second browser (first instance) **106A** receives accelerator input, second browser (first instance) **106A** may perform a particular action depending on the accelerator input received. For instance, in a scenario in which second browser (first instance) **106A** is running in a standalone mode (i.e., it is not invoked by first browser **104**), if the accelerator input matches accelerator input in a mapping for second browser (first instance) **106A**, then second browser (first instance) **106A** handles the accelerator input and performs the action corresponding to the accelerator input (as specified in the mapping). If there is no match, then second browser (first instance) **106A** drops the accelerator input.

[0075] In a scenario in which first browser **104** invokes second browser (first instance) **106A**, host browser interface **112** may provide the accelerator input to first browser **104**, and first browser **104** determines whether the accelerator input matches accelerator input in a mapping for first browser **104**. If the accelerator input matches accelerator input in a mapping for first browser **104**, then first browser **104** handles the accelerator input and performs the action corresponding to the accelerator input (as specified in the mapping). If there is no match, then first browser **104** drops the accelerator input.

[0076] In accordance with an embodiment, the accelerator input for a particular action performed by second browser (first instance) **106A** does not match the accelerator input for the same particular action performed by first browser **104**. In

accordance with such an embodiment, first browser **104** may translate accelerator input received from second browser (first instance) **106A** into the accelerator input accepted by first browser **104** for that same action.

[0077] FIG. 9 shows a flowchart **900** of a method for handing, by a first browser, accelerator input received from a second browser in accordance with an example embodiment. In an embodiment, flowchart **900** may be implemented by a system **1000** shown in FIG. 10, although the method is not limited to that implementation. As shown in FIG. 10, system **1000** includes a computing device **1002** that includes first browser **1004** and an instance of second browser **1006A**. First browser **1004** includes a first render engine **1020** and a multi-browser tab manager **1008**, and has an open browser window **1010** that includes one or more tabs (e.g., tab **1014**). Second browser **1006A** includes a multi-tab manager **1028**, second render engine **1022** and a host browser interface **1012**. Multi-tab manager **1028** may be configured to manage one or more tabs (e.g., tab **1026**). Tab **1026** may comprise a web browser control **1024** and/or other layers of functionality. Second render engine **1022** may be managed by web browser control **1024**. Computing device **1002**, first browser **1004**, multi-browser tab manager **1008**, first render engine **1020**, browser window **1010**, tab **1014**, second browser (first instance) **1006A**, host browser interface **1012**, multi-tab manager **1028**, tab **1026**, web browser control **1024**, and second render engine **1022** are examples of computing device **102**, first browser **104**, multi-browser tab manager **108**, first render engine **120**, browser window **110**, tab **114**, second browser (first instance) **106A**, host browser interface **112**, multi-tab manager **128**, tab **126**, web browser control **124**, and second render engine **122**, as respectively described above with reference to FIGS. 1A and 1B. In the embodiment shown in FIG. 10, second browser (first instance) **1006A** has traversed to a first page (e.g., page **1016**). Page **1016** is an example of page **116**, as described above with reference to FIG. 1A. As further shown in FIG. 7, first browser **1004** maintains an accelerator mapping **1030**. Accelerator mapping **1030** may be a data structure (e.g., a table) that maps different accelerator inputs to different actions.

[0078] Flowchart **900** begins with step **902**. In step **902**, a first accelerator input provided to the instance of the second browser is received from the host browser interface. For example, with reference to FIG. 10, second browser (first instance) **1006A** may receive accelerator input (e.g., CTRL+C, CTRL+P, etc.) via an input device utilized by a user (e.g., a keyboard). First browser **1004** receives the accelerator input (shown as accelerator input **1001**) from second browser (first instance) **1006A** via host browser interface **1012**.

[0079] In step **904**, a determination is made as to whether the first accelerator input matches a second accelerator input stored in an accelerator mapping associated with the first browser. For example, with reference to FIG. 10, first browser **1004** determine whether accelerator input **1001** matches an accelerator input stored in accelerator mapping **1030** associated with first browser **1004**. In response to determining that the first accelerator input matches an accelerator input stored in accelerator mapping **1030**, flow continues to step **906**. Otherwise, flow continues to step **908**.

[0080] In step **906**, the first browser performs an action corresponding to the first accelerator input. For example, with reference to FIG. 10, first browser **1004** performs an

action (e.g., copying text, rendering a print dialog screen, etc.) corresponding to first accelerator input **1001**.

[0081] In step **908**, the processing of the first accelerator input is bypassed. For example, with reference to FIG. 10, first browser **1004** bypasses the processing of accelerator input **1001**. For example, first browser **1004** ignores or drops accelerator input **1001**, as it does not match any of the accelerator inputs maintained by accelerator mapping **1030**.

E. User Permissions

[0082] Referring again to FIG. 1, first browser **104** and second browser **106** may maintain the same or different models for site permissions-permissions such as allowing/denying popups, allowing certain pages to use your physical location using geolocation APIs, and denying others, etc. For instance, first browser **104** and second browser **106** may not only maintain separate permissions but may have separate models. For example, second browser **106** may enable the user to configure swathes of sites in “zones” to be allowed or disallowed to use popups, and enable the user to individually add other sites to be allowed to provide popups even if it would normally be disallowed, but the user can’t make an exception and disallow a site that would normally allow them. First browser **104** may allow the user to make both kinds of exceptions, and also adds the ability to do profile-based permissions, but doesn’t really have zone-based permissions.

[0083] Embodiments described herein may project the settings of first browser **104** onto second browser (first instance) **106A** when second browser (first instance) **106A** is hosted by first browser **104**, merging second browser **106**’s notion of zones with first browser **104**’s notion of user profiles and sophisticated permissions overrides to create a permissions scheme that is compatible with the dual browser scenario. This involves parsing the permissions of first browser **104** for the current profile, transmitting them to host browser interface **112** of second browser (first instance) **106A**, merging them with the zone settings of second browser (first instance) **106A**, and altering second browser (first instance) **106A** to first look up the settings override when operating as an application being hosted by first browser **104**. This may be updated dynamically whenever a user changes a setting.

[0084] During initialization of second browser **106**, first browser **104** may provide its site permission settings (and a version number thereof) to second browser **106** via host browser interface **112**. Alternatively, second browser **106** may generate a version number for the received site permission settings. Multi-tab manager **128** may store the settings along with its version number. First browser **104** may provide updated site permission settings to second browser **106** responsive to the user changing the settings. Multi-tab manager **128** may store such updated site permission settings along with an updated version number.

[0085] When a content process (e.g., a window in which the web site is being rendered by second render engine **122**) requires site permission settings, it may retrieve the settings from multi-tab manager **128** and store them in its own permissions cache. The settings (and version thereof) for a particular user permission may be stored in its own permissions cache.

[0086] When a script executing on a particular web site being rendered by second browser (first instance) **106A** requests permission from a user (e.g., geolocation permis-

sions), second browser (first instance) **106A** may first determine whether it has the most current permission settings. For instance, second browser (first instance) **106A** may determine whether the version number maintained by the permissions cache of the content process of second browser (first instance) **106A** matches the version number maintained by multi-tab manager **128**. If the version numbers match, second browser **106** checks the permission settings in the permissions cache to see if the user has already enabled geolocation sharing. If the version numbers do not match, multi-tab manager **128** may provide the updated configuration settings (and version number thereof) to the corresponding permissions cache.

[0087] If the permissions settings indicate that the user has in fact enabled geolocation sharing, then second browser **106** may provide a response indicating as such to the script. However, if permission settings indicate that the user has not enabled geolocation sharing, second browser (first instance) **106** may provide the request to first browser **104** via host browser interface **112**. The request may specify the prompt to be displayed to the user. First browser **104** renders a user interface control (e.g., a dialog box) that includes the prompt and one or more user interface elements for responding to the prompt (e.g., a “yes” button, a “no” button, etc.). Upon submitting a response, first browser **104** provides a response indicative of the user’s selection to second browser **106** via host browser interface **112**. Second browser (first instance) **106A** then provides the response to the script. Accordingly, the user interface control utilized by second browser (first instance) **106A** to prompt the user for his or her geolocation (i.e., the second browser’s version of the prompt) is not displayed. Instead, the user interface control utilized by first browser **104** is utilized. The foregoing techniques advantageously enables a seamless integration of second browser (first instance) **106A** within first browser **104**.

[0088] In another example, second browser (first instance) **106** may provide an indication to first browser **104** (via host browser interface **112**) to indicate whether a pop-up has been blocked by second browser **106**. Based on this information, first browser **104** causes a user interface element to be rendered to indicate that a pop-up has been blocked and may also enable the user to adjust the pop-up blocking settings with respect to the website from which the pop-up was blocked. The user interface element utilized by second browser (first instance) **106A** to reflect this (i.e., the second browser’s version of the pop-up blocker indicator) is not displayed. Instead, the user interface element utilized by first browser **104** is utilized. The foregoing techniques advantageously enables a seamless integration of second browser (first instance) **106A** within first browser **104**.

[0089] In accordance with an embodiment, second browser (first instance) **106A** may support zone-based security, where each website is categorized based on its website address as belonging to a particular zone, namely, Internet, intranet, trusted, or restricted. Second browser (first instance) **106A** uses the zone information for a given site to allow or deny that site the ability to perform some requested functionality. For example, because the Internet zone is considered less secure than the intranet zone, a webpage from the Internet zone is not allowed to display content (e.g., a pop-up), whereas a webpage from an intranet zone is allowed to display content.

[0090] In a scenario in which first browser **104** hosts second browser (first instance) **106A**, the zone-based secu-

rity settings may take priority over the settings maintained by first browser **104**. For instance, when a permission setting is requested, second browser (first instance) **106A** may first determine whether it maintains a zone-based security setting for that permission. If such a setting exists, second browser (first instance) **106A** utilizes the setting. If such a setting doesn’t exist, then second browser (first instance) **106A** utilizes the settings provided by first browser **104**.

[0091] In accordance with an embodiment, second browser (first instance) **106A** may maintain a first permissions cache for use in standalone mode and a second permissions cache for use when first browser **104** hosts second browser (first instance) **106A**. When executing in standalone mode, second browser (first instance) **106A** accesses the first permissions cache, which stores the permission settings for first browser **106A**. When second browser (first instance) **106A** is invoked by first browser **104**, second browser (first instance) **106A** utilizes the second permissions cache, which stores the permission settings of first browser **104**.

[0092] As indicated above, each permission setting may be associated with its own permission cache. For example, permission settings for geolocation may be maintained in one permission cache, whereas permission settings for pop-up blocking may be maintained in another permission cache. Each of these permission caches may be stored by domain name. For instance, the permission cache for geolocation may store geolocation settings for a plurality of different domain names. The permission cache may be sorted, for example, alphabetically by domain names. In accordance with an embodiment, second browser (first instance) **106A** performs a binary search to find permission settings associated with a particular domain name.

[0093] FIG. 11 shows a flowchart **1100** of a method for providing permission settings of a first browser to a second browser in accordance with an example embodiment. In an embodiment, flowchart **1100** may be implemented by systems **1200A** and **1200B** shown in FIGS. **12A** and **12B**, although the method is not limited to those implementations. As shown in FIGS. **12A** and **12B**, systems **1200A** and **1200B** include a computing device **1202** that includes first browser **1204** and an instance of second browser **1206A**. First browser **1204** includes a first render engine **1220** and a multi-browser tab manager **1208**, and has an open browser window **1210** that includes one or more tabs (e.g., tab **1214**). Second browser **1206A** includes a multi-tab manager **1228**, second render engine **1222** and a host browser interface **1212**. Multi-tab manager **1228** may be configured to manage one or more tabs (e.g., tab **1226**). Tab **1226** may comprise a web browser control **1224** and/or other layers of functionality. Second render engine **1222** may be managed by web browser control **1224**. Computing device **1202**, first browser **1204**, multi-browser tab manager **1208**, first render engine **1220**, browser window **1210**, tab **1214**, second browser (first instance) **1206A**, host browser interface **1212**, multi-tab manager **1228**, tab **1226**, web browser control **1224**, and second render engine **1222** are examples of computing device **102**, first browser **104**, multi-browser tab manager **108**, first render engine **120**, browser window **110**, tab **114**, second browser (first instance) **106A**, host browser interface **112**, multi-tab manager **128**, tab **126**, web browser control **124**, and second render engine **122**, as respectively described above with reference to FIGS. **1A** and **1B**. In the embodiments shown in FIGS. **12A** and **12B**, second browser

(first instance) **1206A** has traversed to a first page (e.g., page **1216**). Page **1216** is an example of page **116**, as described above with reference to FIG. 1A. As further shown in FIGS. **12A** and **12B**, second browser (first instance) **1206A** maintains a permissions cache **1230** and a permission authorizer **1232**, which is executed by computing device **1202**.

[0094] Flowchart **1100** begins with step **1102**. In step **1102**, permissions settings associated with the first browser are provided by the first browser to the host browser interface. For example, with reference to FIG. **12A**, first browser **1204** provides its permission settings **1201** to host browser interface **1212** of second browser (first instance) **1206A**. Permission settings **1201** may be provided to second browser (first instance) **1206A** when second browser (first instance) **1206A** is initialized. Permission settings **1201** may comprise a subset (e.g., some or all) of the settings maintained by first browser **1204**.

[0095] In step **1104**, the permission settings are stored by the second browser. For example, with reference to FIG. **12A**, second browser (first instance) **1206A** stores permission settings **1201** in permissions cache **1230**.

[0096] In step **1106**, a request from the first page for a permission to perform a particular action is received by the second browser. For example, with reference to FIG. **12A**, second browser (first instance) **1206A** may receive a request **1203** from page **1216** (e.g., a script executing on page **1216**) for a permission to perform a particular action (e.g., obtain a geolocation of computing device **1202**).

[0097] In step **1108**, a determination is made as to whether a permission setting of the permission settings authorizes the first page to perform the action. For example, with reference to FIG. **12A**, permission authorizer **1232** provides a query **1211** to permissions cache **1230** to determine whether a permission setting of permission settings **1201** stored in permissions cache **1230** authorizes page **1216** to perform an action. If a determination is made that the permission setting authorizes the first page to perform the action, flow continues to step **1110**. Otherwise, flow continues to step **1112**.

[0098] In step **1110**, a response to the first page that indicates that the first page is authorized to perform the particular action is provided by the second browser. For example, with reference to FIG. **12A**, second browser (first instance) **106A** provides a response **1205** to page **1216** that indicates that page **1216** is authorized to perform the particular action (e.g., obtain geolocation information).

[0099] In step **1112**, the second browser provides a request to the first browser to render a user interface element associated with the first browser that prompts a user for input, the input specifying whether the first page is authorized to perform the particular action. For example, with reference to FIG. **12B**, second browser (first instance) **1206A** provides a request **1207** (via host browser interface **1212**) to render a user interface element **1236** that prompts a user for input. First render engine **1210** renders its version of user interface element **1236**, and not the version of the user interface element utilized by second browser (first instance) **1206A**, thereby enabling a seamless integration of second browser (first instance) **1206A** within first browser **1204**.

[0100] In step **1114**, a response indicative of the user's input is received by the first browser. For example, with reference to FIG. **12B**, first browser **1204** may receive an input from the user specifying whether or not permission is granted or denied.

[0101] In accordance with one or more embodiments, the permissions cache is updated with the corresponding permission setting. For example, with reference to FIG. **12**, permissions cache **1230** is updated with the corresponding permission setting.

[0102] In step **1116**, the first browser provides the response to the second browser. For example, with reference to FIG. **12B**, first browser **1204** provides a response **1209** that represents the user's input to second browser (first instance) **1206A** via host browser interface **1212**.

[0103] In step **1118**, the second browser provides the response to the first page. For example, with reference to FIG. **12B**, second browser (first instance) **1206A** provides response **1209** to page **1218**.

III. Additional Embodiments

[0104] Referring again to FIG. 1A, in certain embodiments, second browser **106** may not be properly invoked (e.g., host browser interface **112** is not properly loaded). This may occur, for example, if second browser **106** is an incorrect or older version and/or the operating system in which second browser **106** is incorporated is an incorrect or older version that does not support the browser hosting functionality described herein. In this case, second browser **106** is launched in a standalone mode (i.e., first browser **104** does not invoke second browser **106** and does not host second browser **106**).

IV. Example Computer System Implementation

[0105] Computing device **102**, first browser **104**, second browser **106**, second browser (first instance) **106A**, multi-browser tab manager **108**, first render engine **120**, tab **114**, host browser interface **112**, multi-tab manager **128**, tab **126**, web browser control **124**, second render engine **122**, computing device **402**, first browser **404**, second browser (first instance) **406A**, multi-browser tab manager **408**, first render engine **420**, tab **414**, host browser interface **412**, multi-tab manager **428**, tab **426**, web browser control **424**, second render engine **422**, computing device **602**, first browser **604**, second browser (first instance) **606A**, multi-browser tab manager **608**, first render engine **620**, tab **614**, host browser interface **612**, multi-tab manager **628**, tab **626**, web browser control **624**, second render engine **622**, computing device **802**, first browser **804**, second browser (first instance) **806A**, multi-browser tab manager **808**, first render engine **820**, tab **814**, host browser interface **812**, multi-tab manager **828**, tab **826**, web browser control **824**, second render engine **822**, watchdog process **832**, operating system **834**, computing device **1002**, first browser **1004**, second browser (first instance) **1006A**, multi-browser tab manager **1008**, first render engine **1020**, tab **1014**, host browser interface **1012**, multi-tab manager **1028**, tab **1026**, web browser control **1024**, second render engine **1022**, accelerator mapping **1030**, computing device **1202**, first browser **1204**, second browser (first instance) **1206A**, multi-browser tab manager **1208**, first render engine **1220**, tab **1214**, host browser interface **1212**, multi-tab manager **1228**, tab **1226**, web browser control **1224**, second render engine **1222**, permission analyzer **1232**, and permissions cache **1230** (and/or any of the components described therein), and/or flowchart **200**, **300**, **500**, **700**, **900**, and **1100**, may be implemented in hardware, or hardware combined with one or both of software and/or firmware. For example, computing device **102**,

first browser 104, second browser 106, second browser (first instance) 106A, multi-browser tab manager 108, first render engine 120, tab 114, host browser interface 112, multi-tab manager 128, tab 126, web browser control 124, second render engine 122, computing device 402, first browser 404, second browser (first instance) 406A, multi-browser tab manager 408, first render engine 420, tab 414, host browser interface 412, multi-tab manager 428, tab 426, web browser control 424, second render engine 422, computing device 602, first browser 604, second browser (first instance) 606A, multi-browser tab manager 608, first render engine 620, tab 614, host browser interface 612, multi-tab manager 628, tab 626, web browser control 624, second render engine 622, computing device 802, first browser 804, second browser (first instance) 806A, multi-browser tab manager 808, first render engine 820, tab 814, host browser interface 812, multi-tab manager 828, tab 826, web browser control 824, second render engine 822, watchdog process 832, operating system 834, computing device 1002, first browser 1004, second browser (first instance) 1006A, multi-browser tab manager 1008, first render engine 1020, tab 1014, host browser interface 1012, multi-tab manager 1028, tab 1026, web browser control 1024, second render engine 1022, accelerator mapping 1030, computing device 1202, first browser 1204, second browser (first instance) 1206A, multi-browser tab manager 1208, first render engine 1220, tab 1214, host browser interface 1212, multi-tab manager 1228, tab 1226, web browser control 1224, second render engine 1222, permission analyzer 1232, and permissions cache 1230 (and/or any of the components described therein), and/or flowchart 200, 300, 500, 700, 900, and 1100 may be implemented as computer program code/instructions configured to be executed in one or more processors and stored in a computer readable storage medium.

[0106] Alternatively, computing device 102, first browser 104, second browser 106, second browser (first instance) 106A, multi-browser tab manager 108, first render engine 120, tab 114, host browser interface 112, multi-tab manager 128, tab 126, web browser control 124, second render engine 122, computing device 402, first browser 404, second browser (first instance) 406A, multi-browser tab manager 408, first render engine 420, tab 414, host browser interface 412, multi-tab manager 428, tab 426, web browser control 424, second render engine 422, computing device 602, first browser 604, second browser (first instance) 606A, multi-browser tab manager 608, first render engine 620, tab 614, host browser interface 612, multi-tab manager 628, tab 626, web browser control 624, second render engine 622, computing device 802, first browser 804, second browser (first instance) 806A, multi-browser tab manager 808, first render engine 820, tab 814, host browser interface 812, multi-tab manager 828, tab 826, web browser control 824, second render engine 822, watchdog process 832, operating system 834, computing device 1002, first browser 1004, second browser (first instance) 1006A, multi-browser tab manager 1008, first render engine 1020, tab 1014, host browser interface 1012, multi-tab manager 1028, tab 1026, web browser control 1024, second render engine 1022, accelerator mapping 1030, computing device 1202, first browser 1204, second browser (first instance) 1206A, multi-browser tab manager 1208, first render engine 1220, tab 1214, host browser interface 1212, multi-tab manager 1228, tab 1226, web browser control 1224, second render engine 1222, permission analyzer 1232, and permissions cache 1230

(and/or any of the components described therein), and/or flowchart 200, 300, 500, 700, 900, and 1100 may be implemented as hardware logic/electrical circuitry.

[0107] For instance, in an embodiment, one or more, in any combination, of computing device 102, first browser 104, second browser 106, second browser (first instance) 106A, multi-browser tab manager 108, first render engine 120, tab 114, host browser interface 112, multi-tab manager 128, tab 126, web browser control 124, second render engine 122, computing device 402, first browser 404, second browser (first instance) 406A, multi-browser tab manager 408, first render engine 420, tab 414, host browser interface 412, multi-tab manager 428, tab 426, web browser control 424, second render engine 422, computing device 602, first browser 604, second browser (first instance) 606A, multi-browser tab manager 608, first render engine 620, tab 614, host browser interface 612, multi-tab manager 628, tab 626, web browser control 624, second render engine 622, computing device 802, first browser 804, second browser (first instance) 806A, multi-browser tab manager 808, first render engine 820, tab 814, host browser interface 812, multi-tab manager 828, tab 826, web browser control 824, second render engine 822, watchdog process 832, operating system 834, computing device 1002, first browser 1004, second browser (first instance) 1006A, multi-browser tab manager 1008, first render engine 1020, tab 1014, host browser interface 1012, multi-tab manager 1028, tab 1026, web browser control 1024, second render engine 1022, accelerator mapping 1030, computing device 1202, first browser 1204, second browser (first instance) 1206A, multi-browser tab manager 1208, first render engine 1220, tab 1214, host browser interface 1212, multi-tab manager 1228, tab 1226, web browser control 1224, second render engine 1222, permission analyzer 1232, and permissions cache 1230 (and/or any of the components described therein), and/or flowchart 200, 300, 500, 700, 900, and 1100 may be implemented together in a SoC. The SoC may include an integrated circuit chip that includes one or more of a processor (e.g., a central processing unit (CPU), microcontroller, microprocessor, digital signal processor (DSP), etc.), memory, one or more communication interfaces, and/or further circuits, and may optionally execute received program code and/or include embedded firmware to perform functions.

[0108] FIG. 13 depicts an exemplary implementation of a computing device 1300 in which embodiments may be implemented. For example, computing devices 102, 402, 602, 802, 1002, and/or 1202 may be implemented in one or more computing devices similar to computing device 1300 in stationary or mobile computer embodiments, including one or more features of computing device 1300 and/or alternative features. The description of computing device 1300 provided herein is provided for purposes of illustration, and is not intended to be limiting. Embodiments may be implemented in further types of computer systems, as would be known to persons skilled in the relevant art(s).

[0109] As shown in FIG. 13, computing device 1300 includes one or more processors, referred to as processor circuit 1302, a system memory 1304, and a bus 1306 that couples various system components including system memory 1304 to processor circuit 1302. Processor circuit 1302 is an electrical and/or optical circuit implemented in one or more physical hardware electrical circuit device elements and/or integrated circuit devices (semiconductor

material chips or dies) as a central processing unit (CPU), a microcontroller, a microprocessor, and/or other physical hardware processor circuit. Processor circuit **1302** may execute program code stored in a computer readable medium, such as program code of operating system **1330**, application programs **1332**, other programs **1334**, etc. Bus **1306** 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. System memory **1304** includes read only memory (ROM) **1308** and random-access memory (RAM) **1310**. A basic input/output system **1312** (BIOS) is stored in ROM **1308**.

[0110] Computing device **1300** also has one or more of the following drives: a hard disk drive **1314** for reading from and writing to a hard disk, a magnetic disk drive **1316** for reading from or writing to a removable magnetic disk **1318**, and an optical disk drive **1320** for reading from or writing to a removable optical disk **1322** such as a CD ROM, DVD ROM, or other optical media. Hard disk drive **1314**, magnetic disk drive **1316**, and optical disk drive **1320** are connected to bus **1306** by a hard disk drive interface **1324**, a magnetic disk drive interface **1326**, and an optical drive interface **1328**, respectively. The drives and their associated computer-readable media provide nonvolatile storage of computer-readable instructions, data structures, program modules and other data for the computer. Although a hard disk, a removable magnetic disk and a removable optical disk are described, other types of hardware-based computer-readable storage media can be used to store data, such as flash memory cards, digital video disks, RAMs, ROMs, and other hardware storage media.

[0111] A number of program modules may be stored on the hard disk, magnetic disk, optical disk, ROM, or RAM. These programs include operating system **1330**, one or more application programs **1332**, other programs **1334**, and program data **1336**. Application programs **1332** or other programs **1334** may include, for example, computer program logic (e.g., computer program code or instructions) for implementing any of the features of computing device **102**, first browser **104**, second browser **106**, second browser (first instance) **106A**, multi-browser tab manager **108**, first render engine **120**, tab **114**, host browser interface **112**, multi-tab manager **128**, tab **126**, web browser control **124**, second render engine **122**, computing device **402**, first browser **404**, second browser (first instance) **406A**, multi-browser tab manager **408**, first render engine **420**, tab **414**, host browser interface **412**, multi-tab manager **428**, tab **426**, web browser control **424**, second render engine **422**, computing device **602**, first browser **604**, second browser (first instance) **606A**, multi-browser tab manager **608**, first render engine **620**, tab **614**, host browser interface **612**, multi-tab manager **628**, tab **626**, web browser control **624**, second render engine **622**, computing device **802**, first browser **804**, second browser (first instance) **806A**, multi-browser tab manager **808**, first render engine **820**, tab **814**, host browser interface **812**, multi-tab manager **828**, tab **826**, web browser control **824**, second render engine **822**, watchdog process **832**, operating system **834**, computing device **1002**, first browser **1004**, second browser (first instance) **1006A**, multi-browser tab manager **1008**, first render engine **1020**, tab **1014**, host browser interface **1012**, multi-tab manager **1028**, tab **1026**, web browser control **1024**, second render engine **1022**, accelerator mapping **1030**, computing device **1202**, first

browser **1204**, second browser (first instance) **1206A**, multi-browser tab manager **1208**, first render engine **1220**, tab **1214**, host browser interface **1212**, multi-tab manager **1228**, tab **1226**, web browser control **1224**, second render engine **1222**, permission analyzer **1232**, and permissions cache **1230** (and/or any of the components described therein), and/or flowchart **200**, **300**, **500**, **700**, **900**, and **1100**, and/or further embodiments described herein.

[0112] A user may enter commands and information into computing device **1300** through input devices such as keyboard **1338** and pointing device **1340**. Other input devices (not shown) may include a microphone, joystick, game pad, satellite dish, scanner, a touch screen and/or touch pad, a voice recognition system to receive voice input, a gesture recognition system to receive gesture input, or the like. These and other input devices are often connected to processor circuit **1302** through a serial port interface **1342** that is coupled to bus **1306**, but may be connected by other interfaces, such as a parallel port, game port, or a universal serial bus (USB).

[0113] A display screen **1344** is also connected to bus **1306** via an interface, such as a video adapter **1346**. Display screen **1344** may be external to, or incorporated in computing device **1300**. Display screen **1344** may display information, as well as being a user interface for receiving user commands and/or other information (e.g., by touch, finger gestures, virtual keyboard, etc.). In addition to display screen **1344**, computing device **1300** may include other peripheral output devices (not shown) such as speakers and printers.

[0114] Computing device **1300** is connected to a network **1348** (e.g., the Internet) through an adaptor or network interface **1350**, a modem **1352**, or other means for establishing communications over the network. Modem **1352**, which may be internal or external, may be connected to bus **1306** via serial port interface **1342**, as shown in FIG. **13**, or may be connected to bus **1306** using another interface type, including a parallel interface.

[0115] As used herein, the terms “computer program medium,” “computer-readable medium,” and “computer-readable storage medium” are used to refer to physical hardware media such as the hard disk associated with hard disk drive **1314**, removable magnetic disk **1318**, removable optical disk **1322**, other physical hardware media such as RAMs, ROMs, flash memory cards, digital video disks, zip disks, MEMs, nanotechnology-based storage devices, and further types of physical/tangible hardware storage media. Such computer-readable storage media are distinguished from and non-overlapping with communication media (do not include communication media). Communication media embodies computer-readable instructions, data structures, program modules or other data in a modulated data signal such as a carrier wave. The term “modulated data signal” means a signal that has one or more of its characteristics set or changed in such a manner as to encode information in the signal. By way of example, and not limitation, communication media includes wireless media such as acoustic, RF, infrared and other wireless media, as well as wired media. Embodiments are also directed to such communication media that are separate and non-overlapping with embodiments directed to computer-readable storage media.

[0116] As noted above, computer programs and modules (including application programs **1332** and other programs **1334**) may be stored on the hard disk, magnetic disk, optical

disk, ROM, RAM, or other hardware storage medium. Such computer programs may also be received via network interface 1350, serial port interface 1342, or any other interface type. Such computer programs, when executed or loaded by an application, enable computing device 1300 to implement features of embodiments discussed herein. Accordingly, such computer programs represent controllers of the computing device 1300.

[0117] Embodiments are also directed to computer program products comprising computer code or instructions stored on any computer-readable medium. Such computer program products include hard disk drives, optical disk drives, memory device packages, portable memory sticks, memory cards, and other types of physical storage hardware.

III. Additional Example Embodiments

[0118] A method in a computing device is described herein. The method comprises: executing a first browser in the computing device, the first browser having an open browser window; receiving a request at the first browser to navigate to a first page; determining that the first page is incompatible with the first browser and compatible with a second browser; sending, by the first browser, an invocation request to invoke an instance of the second browser; responsive to receiving the invocation request, loading, by the instance of the second browser, a host browser interface for the instance of the second browser, the host browser interface being coupled to a browser frame layer of the instance of the second browser; and executing, under control by the first browser, the instance of the second browser without a browser window opening for the instance of the second browser.

[0119] In one embodiment of the foregoing method, the method further comprises: providing an address of the first page to the instance of the second browser; and rendering, by the instance of the second browser, the first page, the first page being hosted within a tab in the browser window of the first browser.

[0120] In one embodiment of the foregoing method, the method further comprises: providing at least one of an address of a second page to which the instance of the second browser has traversed or a security indicator associated with the second page to the first browser; rendering, by the instance of the second browser, the second page, the second page being hosted within the tab in the browser window of the first browser; and displaying the at least one of the address via an address bar associated with the first browser or a graphical user interface element that is representative of the security indicator and that is associated with the first browser.

[0121] In one embodiment of the foregoing method, the method further comprises: receiving, from the host browser interface, a status indicator indicative of a status of the first page being rendered by the instance of the second browser; and displaying, by the first browser, a graphical user interface element that is representative of the status indicator and that is associated with the first browser.

[0122] In one embodiment of the foregoing method, the method further comprises: providing, by the first browser, a process identifier associated with the first browser to the host browser interface; determining that the first browser is inactive based on the process identifier; and in response to determining that the first browser is no longer active, causing the instance of the second browser to be terminated.

[0123] In one embodiment of the foregoing method, the method further comprises: receiving, from the host browser interface, first accelerator input provided to the instance of the second browser; determining whether the first accelerator input matches a second accelerator input stored in an accelerator mapping associated with the first browser; in response to determining that the first accelerator input matches the second accelerator input, performing, by the first browser, an action corresponding to the first accelerator input; and in response to determining that the first accelerator input does not match the second accelerator input, bypassing the processing of the first accelerator input.

[0124] In one embodiment of the foregoing method, the method further comprises: providing, by the first browser, permission settings associated with the first browser, to the host browser interface; storing, by the second browser, the permission settings; receiving, by the second browser, a request from the first page for a permission to perform a particular action; determining whether a permission setting of the permission settings authorizes the first page to perform the particular action; in response to determining that the permission setting authorizes the first page to perform the particular action, providing, by the second browser, a response to the first page that indicates that the first page is authorized to perform the particular action; and in response to determining that the permission setting does not authorize the first page to perform the particular action: providing, by the second browser, a request to the first browser to render a user interface element associated with the first browser that prompts a user for input, the input specifying whether the first page is authorized to perform the particular action; receiving, by the first browser, a response indicative of the user's input; providing, by the first browser, the response to the second browser; and providing, by second browser, the response to the first page.

[0125] In one embodiment of the foregoing method, functionality of the instance of the second browser is hosted within the first browser, the functionality including at least one of: virtual tab switching; browser helper objects; and one or more browser extensions.

[0126] A system is also described herein. The system includes at least one processor circuit; and at least one memory that stores program code configured to be executed by the at least one processor circuit, the program code comprising: a first browser configured to: receive a request at a first browser to navigate to a first page, the first browser having an open browser window; determine that the first page is incompatible with the first browser and compatible with a second browser; and send an invocation request; to invoke an instance of the second browser; and a second browser configured to: invoke an instance thereof responsive to receiving the invocation request, the instance of the second browser being configured to: load a host browser interface for the instance of the second browser, the host browser interface being coupled to a browser frame layer of the instance of the second browser, the first browser being further configured to control execution of the instance of the second browser without a browser window opening for the instance of the second browser.

[0127] In one embodiment of the foregoing system, the first browser is further configured to provide an address of the first page to the instance of the second browser, and wherein the instance of the second browser is configured to

render the first page, the first page being hosted within a tab in the browser window of the first browser.

[0128] In one embodiment of the foregoing system, the instance of the second browser is further configured to provide at least one of an address of a second page to which the instance of the second browser has traversed or a security indicator associated with the second page to the first browser, and render the second page, the second page being hosted within the tab in the browser window of the first browser, and the first browser is configured to display the at least one of the address via an address bar associated with the first browser or a graphical user interface element that is representative of the security indicator and that is associated with the first browser.

[0129] In one embodiment of the foregoing system, the first browser is further configured to: receive, from the host browser interface, a status indicator indicative of a status of the first page being rendered by the instance of the second browser; and display a graphical user interface element that is representative of the status indicator and that is associated with the first browser.

[0130] In one embodiment of the foregoing system, the first browser is further configured to provide a process identifier associated with the first browser to the host browser interface, and the instance of the second browser is further configured to: determine that the first browser is inactive based on the process identifier; and in response to determining that the first browser is no longer active, cause the instance of the second browser to be terminated.

[0131] In one embodiment of the foregoing system, the host browser interface is a dynamic linked library.

[0132] In one embodiment of the foregoing system, the invocation request comprises one or more parameters that specify at least one of a name of the host browser interface or a location from which to load the host browser interface.

[0133] In one embodiment of the foregoing system, the invocation request comprises a parameter that instructs the instance of the second browser to: suppress an opening of the browser window of the instance of the second browser; provide at least one of rendering information or contextual information associated with the instance of the second browser to the first browser; and cause the first page to be opened in a tab of the first browser.

[0134] A computer-readable storage medium having program instructions recorded thereon that, when executed by at least one processor of a computing device, perform a method. The method includes: executing a first browser in the computing device, the first browser having an open browser window; receiving a request at the first browser to navigate to a first page; determining that the first page is incompatible with the first browser and compatible with a second browser; sending, by the first browser, an invocation request to invoke an instance of the second browser; responsive to receiving the invocation request, loading, by the instance of the second browser, a host browser interface for the instance of the second browser, the host browser interface being coupled to a browser frame layer of the instance of the second browser; and executing, under control by the first browser, the instance of the second browser without a browser window opening for the instance of the second browser.

[0135] In one embodiment of the foregoing computer-readable storage medium, the method further comprises: providing an address of the first page to the instance of the

second browser; and rendering, by the instance of the second browser, the first page, the first page being hosted within a tab in the browser window of the first browser.

[0136] In one embodiment of the foregoing computer-readable storage medium, the method further comprises: providing at least one of an address of a second page to which the instance of the second browser has traversed or a security indicator associated with the second page to the first browser; rendering, by the instance of the second browser, the second page, the second page being hosted within the tab in the browser window of the first browser; and displaying the at least one of the address via an address bar associated with the first browser or a graphical user interface element that is representative of the security indicator and that is associated with the first browser.

[0137] In one embodiment of the foregoing computer-readable storage medium, the method further comprises: receiving, from the host browser interface, a status indicator indicative of a status of the first page being rendered by the instance of the second browser; and displaying, by the first browser, a graphical user interface element that is representative of the status indicator and that is associated with the first browser.

[0138] In one embodiment of the foregoing computer-readable storage medium, the method further comprises: providing, by the first browser, a process identifier associated with the first browser to the host browser interface; determining that the first browser is inactive based on the process identifier; and in response to determining that the first browser is no longer active, causing the instance of the second browser to be terminated.

[0139] In one embodiment of the foregoing computer-readable storage medium, the host browser interface is a dynamic linked library.

IV. Conclusion

[0140] While various embodiments of the present invention have been described above, it should be understood that they have been presented by way of example only, and not limitation. It will be understood by those skilled in the relevant art(s) that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined in the appended claims. Accordingly, the breadth and scope of the present invention should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the following claims and their equivalents.

1-20. (canceled)

21. A method comprising:

executing, on a computing device, a first instance of a first browser running in a first process;

receiving a request at the first browser to navigate to a first web page;

determining, by the first browser, whether the first web page is incompatible with the first browser and compatible with a second browser;

invoking an instance of the second browser in a second process separate from the first process in response to determining that the first web page is incompatible with the first browser, the instance of the second browser in the second process being executed on the computing device;

controlling, by the first browser, the instance of the second browser to render the first web page; and

displaying the first web page rendered by the second browser in an open browser window of the first instance of the first browser, the first web page being provided to the first browser from the second browser in the second process.

22. The method of claim **21**, wherein the instance of the second browser is suppressed from opening a browser window.

23. The method of claim **21**, further comprising:
providing an address of the first web page to the instance of the second browser; and
rendering the first web page by a browser engine of the second browser, the rendered first web page being hosted within a tab in the open browser window of the first browser.

24. The method of claim **23**, further comprising:
providing, to the first browser, at least one of:
an address of a second web page to which the instance of the second browser has traversed; or
a security indicator associated with the second web page;
rendering, by the instance of the second browser, the second web page;
displaying the second web page rendered by the instance of the second browser in the open browser window of the first browser;
displaying, in the open browser window of the first browser, at least one of:
the address of the second web page in an address bar associated with the first browser; or
a graphical user interface element associated with the first browser, the graphical user interface element being representative of the security indicator.

25. The method of claim **23**, further comprising:
receiving, by the instance of the first browser, a status indicator indicative of a status of the first web page being rendered by the instance of the second browser; and
displaying, in the open browser window of the first browser, a graphical user interface element that is representative of the status indicator and that is associated with the first browser.

26. The method of claim **21**, further comprising:
providing, by the first browser, a process identifier associated with the first browser to the instance of the second browser;
determining that the first browser is inactive based on the process identifier; and
terminating the instance of the second browser in response to determining that the first browser is inactive.

27. The method of claim **21**, further comprising:
receiving a first accelerator input provided to the instance of the second browser;
determining whether the first accelerator input matches a second accelerator input stored in an accelerator mapping associated with the first browser;
in response to determining that the first accelerator input matches the second accelerator input, performing, by the first browser, an action corresponding to the first accelerator input; and
in response to determining that the first accelerator input does not match the second accelerator input, bypassing the processing of the first accelerator input.

28. The method of claim **21**, further comprising:
providing, by the first browser to the instance of the second browser, a plurality of permission settings associated with the first browser;
storing, by the instance of the second browser, the plurality of permission settings;
receiving, by the instance of the second browser, a request from the first web page for a permission to perform a particular action;
determining whether a permission setting of the permission settings authorizes the first web page to perform the particular action;
in response to determining that the permission setting authorizes the first web page to perform the particular action, providing, by the second browser, a response to the first web page that indicates that the first web page is authorized to perform the particular action; and
in response to determining that the permission setting does not authorize the first web page to perform the particular action:
providing, by the second browser, a request to the first browser to render a user interface element associated with the first browser that prompts a user for input, the input specifying whether the first web page is authorized to perform the particular action;
receiving, by the first browser, a response indicative of the input;
providing, by the first browser, the response to the instance of the second browser; and
providing, by the second browser, the response to the first web page.

29. The method of claim **21**, wherein functionality of the instance of the second browser is hosted within the first browser, the functionality including at least one of:

- virtual tab switching;
- browser helper objects; and
- one or more browser extensions.

30. A system comprising:
a processor circuit; and
a memory storing program code configured to be executed by the processor circuit, the program code comprising:
a first browser configured to:
receive a request to navigate to a first web page;
determine whether the first web page is incompatible with the first browser and compatible with a second browser; and
invoke an instance of the second browser in a second process separate from a first process executing the first browser, the instance of the second browser in the second process being stored in the memory and executed by the processor circuit; and
a second browser configured to:
render the first web page; and
provide the rendered first web page to the first browser to be displayed in an open browser window of a first instance of the first browser from the second browser in the second process.

31. The system of claim **30**, wherein the instance of the second browser is suppressed from opening a browser window.

32. The system of claim **30**, wherein the first browser is further configured to provide an address of the first web page to the instance of the second browser, and

wherein the second browser is further configured to render the first web page using a browser engine of the second browser, the rendered first web page being hosted within a tab of the open browser window of the first browser.

33. The system of claim **32**, wherein the second browser is further configured to:

provide, to the first browser, at least one of:

- an address of a second web page to which the instance of the second browser has traversed; or
- a security indicator associated with the second web page;

render the second web page, and

wherein the first browser is further configured to:

- display the second web page rendered by the instance of the second browser in the open browser window of the first browser;
- display, in the open browser window of the first browser, at least one of:
 - the address of the second web page in an address bar associated with the first browser; or
 - a graphical user interface element associated with the first browser, the graphical user interface element being representative of the security indicator.

34. The system of claim **32**, wherein the first browser is further configured to:

- receive a status indicator indicative of a status of the first web page being rendered by the instance of the second browser; and
- display, in the open browser window of the first browser, a graphical user interface element that is representative of the status indicator and that is associated with the first browser.

35. The system of claim **30**, wherein the first browser is further configured to provide a process identifier associated with the first browser to the instance of the second browser, and

- wherein the second browser is configured to:
 - determine that the first browser is inactive based on the process identifier; and
 - terminate the instance of the second browser in response to determining that the first browser is inactive.

36. The system of claim **30**, wherein the first browser communicates with the second browser through a dynamic-link library loaded in the second process of the instance of the second browser.

37. A computer-readable storage medium having program instructions recorded thereon that, when executed by a processor of a computing device, perform a method comprising:

- executing, on a computing device, a first instance of a first browser running in a first process;
- receiving a request at the first browser to navigate to a first web page;

determining, by the first browser, whether the first web page is incompatible with the first browser and compatible with a second browser;

invoking an instance of the second browser in a second process separate from the first process in response to determining that the first web page is incompatible with the first browser, the instance of the second browser in the second process being executed on the computing device;

controlling, by the first browser, the instance of the second browser to render the first web page; and

displaying, the first web page rendered by the second browser in an open browser window of the first instance of the first browser, the first web page being provided to the first browser from the instance of the second browser in the second process.

38. The computer-readable storage medium of claim **37**, wherein the method further comprises:

- providing an address of the first web page to the instance of the second browser; and
- rendering the first web page by a browser engine of the second browser, the rendered first web page being hosted within a tab in the open browser window of the first browser.

39. The computer-readable storage medium of claim **38**, wherein the method further comprises:

- providing, to the first browser, at least one of:
 - an address of a second web page to which the instance of the second browser has traversed; or
 - a security indicator associated with the second web page;
- rendering, by the instance of the second browser, the second web page;
- displaying the second web page rendered by the instance of the second browser in the open browser window of the first browser;
- displaying, in the open browser window of the first browser, at least one of:
 - the address of the second web page in an address bar associated with the first browser; or
 - a graphical user interface element associated with the first browser, the graphical user interface element being representative of the security indicator.

40. The computer-readable storage medium of claim **38**, wherein the method further comprises:

- receiving, by the instance of the first browser, a status indicator indicative of a status of the first web page being rendered by the instance of the second browser; and
- displaying, in the open browser window of the first browser, a graphical user interface element that is representative of the status indicator and that is associated with the first browser.

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