allows programmers to quickly and easily develop web applications that safely and securely access security-sensitive system resources.

## SUMMARY

**[0008]** In general, in a first aspect, the invention ~~features a computer-implemented method that includes generating a risk rating for a computer program code component, where the component includes at least one component operation operable to cause execution of at least one restricted system operation, wherein the risk rating is based upon a digital certificate with which the component or a description associated with the component is signed; generating a description of the component operation; and prompting a user for permission to execute the at least one restricted system operation, wherein the prompt includes the risk rating and a description of the component operation.~~provides a computer-implemented method comprising providing, by a computer, a plugin interface for enabling browser-based code to execute restricted system operations that access native system resources of a user machine, the restricted system operations are executed by a plurality of computer program code components stored on the user machine, each of the computer code components comprise a native code portion and the plugin interface comprising a native code common library that enables invocation of the computer code components upon receiving a respective type of user permission associated with each of the computer code components; including, by the computer, a first reference to one of the computer program code components in computer program script code executed in a web browser on the user machine; configuring, by the computer, the plugin interface to receive a description of at least one component operation associated with the referenced computer program code component in response to the first reference, the at least one component operation operable to cause execution of at least one of the restricted system operations; enabling, by the computer, generation of a risk rating for the referenced computer program code component to be executed by the user machine, wherein the risk rating indicates a risk posed to the user machine by the referenced computer program code component should the user machine execute the referenced program code component, the risk rating associated with the at least one component operation and a risk level, the risk level is selected from at least two risk levels based upon a signed digital certificate associated with the component; generating, by the computer, a description of the at least one component operation related to the restricted system operation based on the interface definition; and prompting, by the computer via the plugin interface, a user for the respective type of user permission associated with the at least one restricted system operation, wherein the prompt is configured to display the risk rating associated with the component operation and the

description of the component operation wherein the description comprises at least one term specific to the referenced computer code component.

**[0009]** Embodiments of the invention may include one or more of the following features. Generating the risk rating may be in response to receiving a web page that includes computer program script code for causing execution of the computer program code component. The risk rating may be one of at least two risk levels, including a highest risk level and a lowest risk level. Prompting the user for permission may occur in response to a first reference of the component by computer program script code executed in response to a web browser receiving a web page associated with the script code. The computer program code component may be for execution in response to an invocation of a plugin executing in a web browser by computer program script code executed in response to the web browser receiving a web page associated with the script code. Prompting the user for permission may include displaying a named permission that corresponds to the at least one restricted system operation, and the named permission may be granted by the end user as a precondition to executing the restricted system operation.

**[0010]** In general, in a second aspect, the invention ~~features a computer-implemented method of enabling web browser-based code to execute a restricted system operation on a client computer. The method includes providing, at a server computer, computer program code to the client computer, the code including at least one component having at least one component operation for~~provides a computer-implemented method of enabling web browser-based code to execute a restricted system operation on a client computer, the method comprising transmitting, by a server computer, computer program code to the client computer, the code including a plugin interface for invoking restricted system operations accessing native resources of the client computer, the restricted system operations are executed by a plurality of computer code components stored on the client computer, each of the computer code components comprises a native code portion and the plugin interface comprises a native code common library that enables invocation of the computer code components upon receiving a respective type of user permission associated with each of the computer code components, including, by the server computer, a first reference to one of the computer program code components in the transmitted computer program code executed in a web browser on client computer, configuring, by the server computer, the plugin interface to receive at the client computer, in response to the first reference, a description of at least one component operation associated with the referenced computer program code component, the at least one component operation operable to cause execution of at least one of the restricted system operations, causing, by the server computer, via the native code common

library a display of a prompt at the client computer, the prompt for requesting a type of permission from the user to perform the at least one restricted system operation, and further operable to invoke the at least one restricted system operation in response to receiving permission from the user, and wherein the prompt is configured to display a risk rating associated with the component operation and the description of the component operation comprising at least one term specific to the at least one computer code component, the risk rating indicates a risk posed by the component to the client computer should the client computer execute the component and the risk rating is based upon a risk level, the risk level is selected from least two risk levels based upon a signed digital certificate associated with the component.

~~invoking the restricted system operation; the computer program code may further include an implementation of the component, where the implementation is for causing display of a prompt for requesting permission from the user to perform the restricted system operation, and further for to invoking the restricted system operation in response to receiving permission from the user, and the prompt is based upon a risk rating associated with the component and upon the component operation. The prompt may include the risk rating associated with the component. The program code may be a web browser plugin. The component may be associated with a risk tier selected from a plurality of risk tiers, and the risk rating may be a brief phrase based upon the risk tier. The risk indicator may include a phrase based upon at least one operation provided by the component. The component may include an implementation function and an interface definition describing the implementation function. The prompt may display a request for permission on an output device of the computer. Receiving permission from the user may include receiving an affirmative response from the user via an input device of the client computer. The method may further include receiving a certificate of a signing authority associated with the component, and the risk rating may be further based upon the certificate. The restricted system operation may include accessing a file, accessing a network, accessing a display device, or a combination of these.~~

**[0011]** In general, in a third aspect, the invention ~~features a computer-implemented method of enabling web browser based code to execute a restricted system operation on a client computer. The method includes providing, at a server computer, computer program code to the client computer, the program code including at least one component having at least one component operation for invoking the restricted system operation, the code for execution by the web browser in response to an invocation of the component by script code associated with a web document, where the code is operable to invoke the restricted system operation in response to receiving an input from a user via the web browser, and the input is for causing an action associated with performing the operation, the action implicitly granting consent to perform the operation. The action may include at least one step in performing the operation.~~provides a computer-implemented method of enabling web browser-based code to execute a restricted system operation on a client computer, the method comprising transmitting, by a server computer, computer program code to the client computer, the transmitted program code comprising a plugin interface for enabling browser-based code on the client computer to execute restricted system operations that access native system resources of the client computer, the restricted system operations are executed by a plurality of computer program code components stored on the client

computer, each of the computer code components comprise a native code portion and the plugin interface comprising a native code common library that enables invocation of the computer code components upon implicitly receiving a respective type of user permission associated with each of the computer code components, including, by the server computer, a first reference to at least one of the computer code components in the transmitted computer program code such that when the transmitted computer program code is executed by the web browser one of the computer code components is invoked in response to the first reference by script code associated with a web document comprising the plugin interface, and enabling, by the server computer, automatic execution of at least one of the restricted system operations in response to receiving, in an absence of an explicit request for permission, an input from a user via the web browser, the input causing an execution of a component operation associated with the invoked component and the at least one restricted system operation, the input implicitly granting the respective type of consent associated with the invoked component to perform the at least one restricted system operation.

**[0012]** ~~In general, in a fourth aspect, the invention features~~ There is disclosed a computer-implemented method that includes receiving an invocation of a component operation from computer program script code

executed in response to receipt of a web page by a web browser, wherein the component includes at least one component operation operable to cause execution of a restricted system operation; and allowing the component operation to cause execution of the restricted system operation in response to receiving an input from a user via a web browser, where the input is for causing an action associated with performing the operation, the action is not an explicit grant of permission to perform the operation, and the action implicitly grants permission to perform the operation.

**[0013]** In general, in a ~~fifth~~ fourth aspect, the invention ~~features a computer-implemented method of enabling web browser-based code to execute a restricted system operation on a client computer. The method includes causing display of a prompt for requesting permission from a user to perform a restricted system operation in response to invocation of a component operation; and invoking the restricted system operation in response to receiving permission from the user, where the prompt refers to an object or service on which the component operation operates.~~provides a computer-implemented method of enabling web browser-based code to execute a restricted system operation on a client computer, the method comprising receiving, by the client computer, a webpage comprising the web browser code and a plugin interface facilitating the web browser code to access a plurality of computer code components that are stored on the client machine and execute restricted system operations accessing native system resources of the client machine, each of the computer code components comprise a native code portion, the plugin interface comprises a native code common library that permits invocation the computer code components upon receiving a respective type of permission associated with each of the computer code components, executing, by the client computer, a first reference to one of the computer program code components via computer program script code in a web browser, accessing, by the client computer, a description of an operation of the computer program code component that invokes at least one of the restricted system operations in response to the first reference, transmitting, by the client computer, the description to the plugin interface, displaying, by the client computer, a prompt for requesting permission from a user to perform the restricted system operation in response to the first reference of the computer program code component by the web browser code; and invoking the restricted system operation in response to receiving permission from the user, wherein the prompt refers to an object or service on which the component operation operates via a description of the component operation comprising at least one term specific to the computer code component associated with the first reference, the prompt comprises a risk rating associated with a component performing a component operation, the risk rating indicates a risk posed to the client computer by the

component, should the component be invoked by the client computer, the risk rating is based upon the component operation and a risk level, the risk level is selected from at least two risk levels based upon a certificate of a signing authority associated with the component.

**[0014]** In general, in a ~~sixth~~ fifth aspect, the invention ~~features a computer-readable medium that includes computer-executable instructions for enabling computer program code to be executed in a web browser to perform a security-restricted operation, the instructions for providing to the web browser via a computer network a component that includes an interface and a native language implementation that implements at least a portion of the interface, where the implementation is for invoking the native language implementation in response to invocation of the interface by the plugin code in the web browser, and the native language implementation is for prompting a user for permission to perform the operation, and further for invoking the operation in response to receiving permission from the user, wherein the prompt is based upon a risk indicator associated with the component, the prompt is further based upon at least one permission requirement associated with the component, and the prompt includes a description of an operation associated with the permission requirement, wherein the description refers to at least one application-specific feature of the component~~ provides a computer readable medium comprising computer-executable instructions for enabling computer program code to be executed in a web browser to perform a security-restricted operation, the instructions comprising, providing, by a server computer to the web browser via a computer network, a plugin interface that provides browser-based code access to a plurality of components, each of the components includes an interface and a native language implementation that implements at least a portion of the interface, the plugin interface comprises a native code common library that enables the computer program code executed in the web browser to perform at least one of the security-restricted operations via invocation of at least one of the plurality of components upon receiving a respective type of user permission associated with each of the computer code components, generating, by the server computer, a description of an operation of the at least one component that invokes the security restricted operation, wherein the implementation is operable to invoke the native language implementation in response to invocation of the component interface by the plugin interface in the web browser, and wherein the native language implementation is operable to prompt a user for the respective type of permission to perform the security-restricted operation, and further operable to invoke the security-restricted operation in response to receiving permission from the user, wherein the prompt is configured to display a risk indicator associated with the component, the risk indicator indicates a risk posed by the component to a computer executing the web browser should the computer executing the web browser implement the component, the risk indicator is further

based on the security restricted operation and a risk level, the risk level is selected from at least two risk levels based upon a certificate of a signing authority associated with a component, the prompt is further based upon at least one permission requirement associated with the component, and the prompt includes a description of an operation associated with the permission requirement wherein the description comprises at least one term specific to the at least one component.

**[0015]** Embodiments of the invention may include one or more of the following features. The computer readable medium may further include computer-executable instructions for receiving a certificate of a signing authority associated with the component, wherein the risk indicator is based

upon the certificate and the operation. The security restricted native operating system operation may be accessing a file, accessing a network, accessing a display device, or a combination of those.

**[0016]** In general, in a ~~seventh~~ sixth aspect, the invention ~~features a computer readable medium comprising computer-executable instructions for enabling browser-based program code associated with a web page to selectively access native operating system resources of a browser host computer. The method includes receiving a component that in turn includes an implementation function and an interface that enables the browser-based program code to invoke the implementation function, wherein the implementation function is operable to perform a restricted system operation on the browser host computer in response to receiving permission from a user of the browser host computer to access the restricted system operation; in response to invocation of the interface by the browser-based program code, prompting the user for permission to perform the restricted system operation; and invoking the implementation function to perform the restricted system operation in response to receiving an affirmative response from the user~~ provides a computer readable medium comprising computer-executable instructions for enabling browser-based program code associated with a web page to selectively access native operating system resources of a browser host computer, the method comprising, providing, by a server computer to the web browser via a computer network, a plugin interface that provides browser-based code access to a plurality of components, each of the components includes an interface and a native language implementation that implements at least a portion of the interface, the plugin interface comprises a native code common library that enables the computer program code executed in the web browser to perform at least one of the security-restricted operations via invocation of at least one of the plurality of components upon receiving a respective type of user permission associated with each of the computer code components, generating, by the server computer, a description of an operation of the at least one component that invokes the security restricted operation, wherein the implementation is operable to invoke the native language implementation in response to invocation of the component interface by the plugin interface in the web browser, and wherein the native language implementation is operable to prompt a user for the respective type of permission to perform the security-restricted operation, and further operable to invoke the security-restricted operation in response to receiving permission from the user, wherein the prompt is configured to display a risk indicator associated with the component, the risk indicator indicates a risk posed by the component to a computer executing the web browser should the computer executing the web browser implement the component, the risk indicator is further based on the security restricted operation and a risk level, the risk level is selected from at least two risk levels based upon a certificate of a signing authority associated with a component, the

prompt is further based upon at least one permission requirement associated with the component, and the prompt includes a description of an operation associated with the permission requirement wherein the description comprises at least one term specific to the at least one component.

**[0017]** ~~In general, in an eighth aspect, the invention features~~There is also disclosed a computer-readable medium comprising computer executable code for displaying a prompt for permission to execute a component of the computer executable code, wherein the prompt is based upon a risk indicator associated with the component, the prompt is further based upon at least one permission requirement associated with the component, and the prompt includes a description of an operation associated with a permission requirement, where the description refers to at least one application-specific feature; and in response to receiving an affirmative response to the prompt from the user, granting permission to the component to execute an operation specified by the permission requirement.

**[0018]** In general, in a ~~ninth~~ seventh aspect, the invention ~~features~~ provides a system that includes a processor; ~~a memory coupled to the processor; and program instructions provided to the memory and executable by the processor to provide, at a server computer, computer program code to the client computer, the program code including at least one component having at least one component operation for invoking the restricted system operation, and the code for execution by the web browser in response to an invocation of the component by script code associated with a web document, where the code is~~ a memory coupled to the processor having stored thereon processor-executable program instructions for transmitting computer program code to a client computer, the program code comprising a plugin interface for enabling browser-based code to execute restricted system operations that access native system resources of the client computer, the restricted system operations are executed by a plurality of computer program code components stored on the client computer, each of the computer program code components having a native code portion and the plugin interface comprising a native code common library that permits invocation of the computer program code components upon receiving implicitly a respective type of user permission associated with each of the computer program code components, the transmitted code for execution by a web browser on the client computer comprises a first reference to at least one of the computer code components implementing at least one of the restricted system operations, wherein the transmitted code is further operable to invoke the at least one restricted system operation implemented by the at least one computer code component

in response to receiving an input from a user via the web browser, and the input is for causing an action associated with the at least one component in absence of an explicit request for permission to perform the restricted system operation, the action implicitly granting user consent of the respective type associated with the at least one component to perform the restricted system operation.

~~for invoking the restricted system operation in response to receiving an input from a user via the web browser, and the input is for causing an action associated with performing the operation, the action implicitly granting consent to perform the operation.~~

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0019]** The present application can be best understood by reference to the following description taken in conjunction with the accompanying drawing figures, in which like parts may be referred to by like numerals:

**[0020]** **Figures 1A-1E** are illustrative drawings of a system for executing components in a web browser in accordance with embodiments of the invention.

**[0021]** **Figure 2** is an illustrative drawing of information about a component in accordance with embodiments of the invention.

**[0022]** **Figure 3** is an illustrative drawing of a prompt for requesting permission to execute a component in accordance with embodiments of the invention.

**[0023]** **Figures 4** and **5** are illustrative drawings of a file upload component in accordance with embodiments of the invention.

**[0024]** **Figure 6** illustrates a typical computing system that may be employed to implement processing functionality in embodiments of the invention.

## DETAILED DESCRIPTION

**[0025]** The following description is presented to enable a person of ordinary skill in the art to make and use the invention, and is provided in the context of particular applications and their requirements. Various modifications to the embodiments will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other embodiments and applications without departing from the spirit and scope of the invention. Moreover, in the following description, numerous details are set forth for the purpose of explanation. However, one of ordinary skill in the art will realize that the invention might be practiced without the use of these