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Milner et al.

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(54) **DETECTION OF MALICIOUS SOFTWARE PACKAGES**

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(51) **Int. Cl.**

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G06F 21/51	(2013.01)
G06F 21/56	(2013.01)

(52) **U.S. Cl.**

CPC ***G06F 21/51*** (2013.01); ***G06F 21/564*** (2013.01)

(58) **Field of Classification Search**

CPC G06F 21/51; G06F 21/564

See application file for complete search history.

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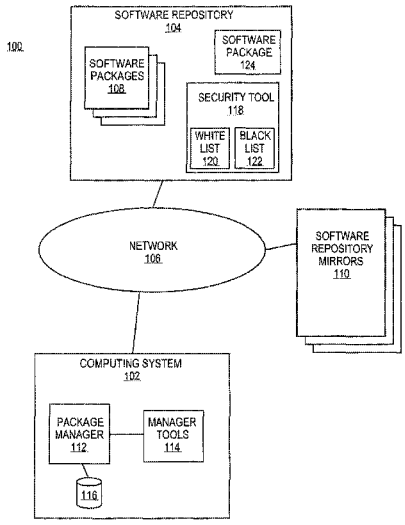
(57) **ABSTRACT**

Systems and methods for a security tool that verifies the security of a software package. An example method may involve identifying a plurality of components contained in a software package comprising one of a JAR file, an Android application package, a docker image, a container file, or a virtual machine image; comparing the components contained in the software package to a list of known components; classifying the software package as insecure when at least one of the components matches an insecure component, or as secure when each of the compared components matches a corresponding secure component on the list of known components; preventing addition of the software package to a software repository when the software package is classified as insecure; and when insecure, providing an interface to enable a user to request the components of the software package be added as a secure component on the list of known components.

20 Claims, 7 Drawing Sheets



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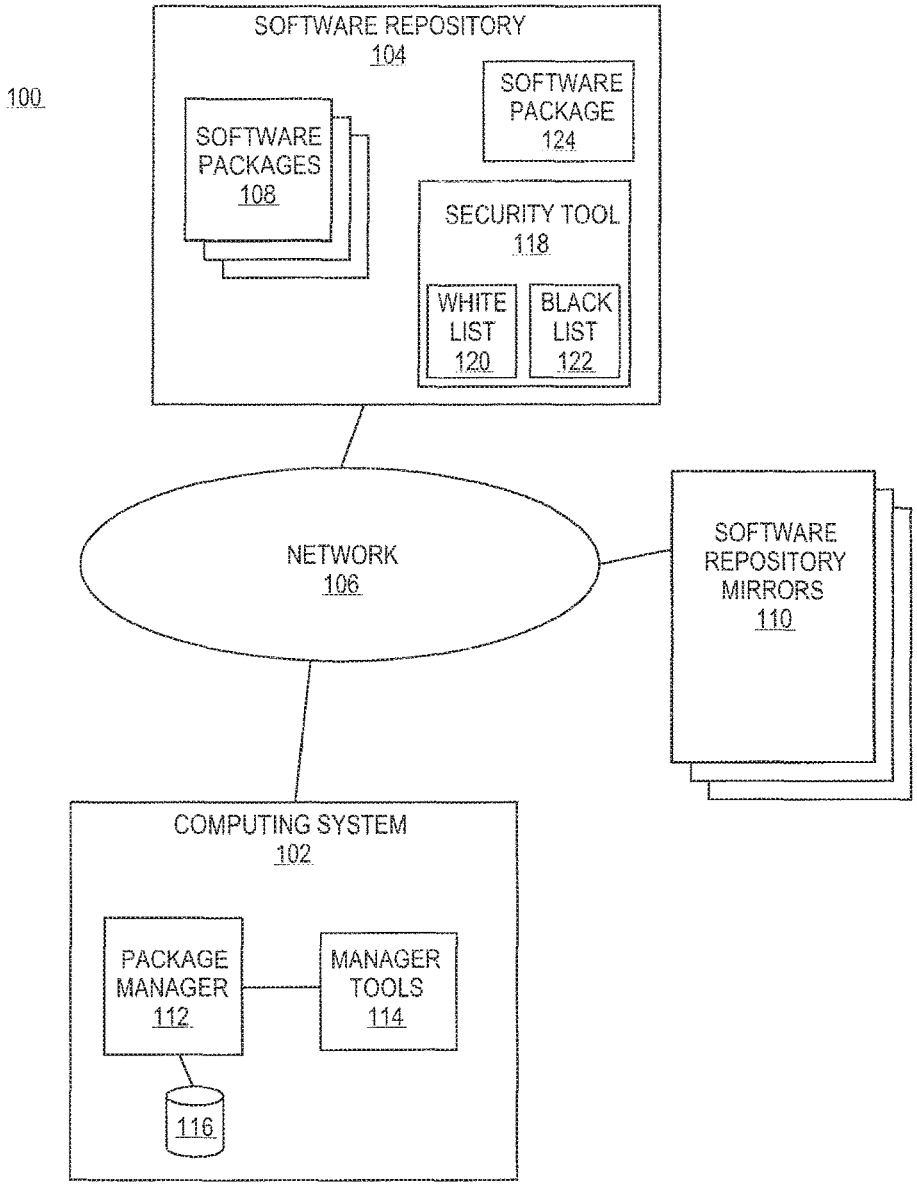
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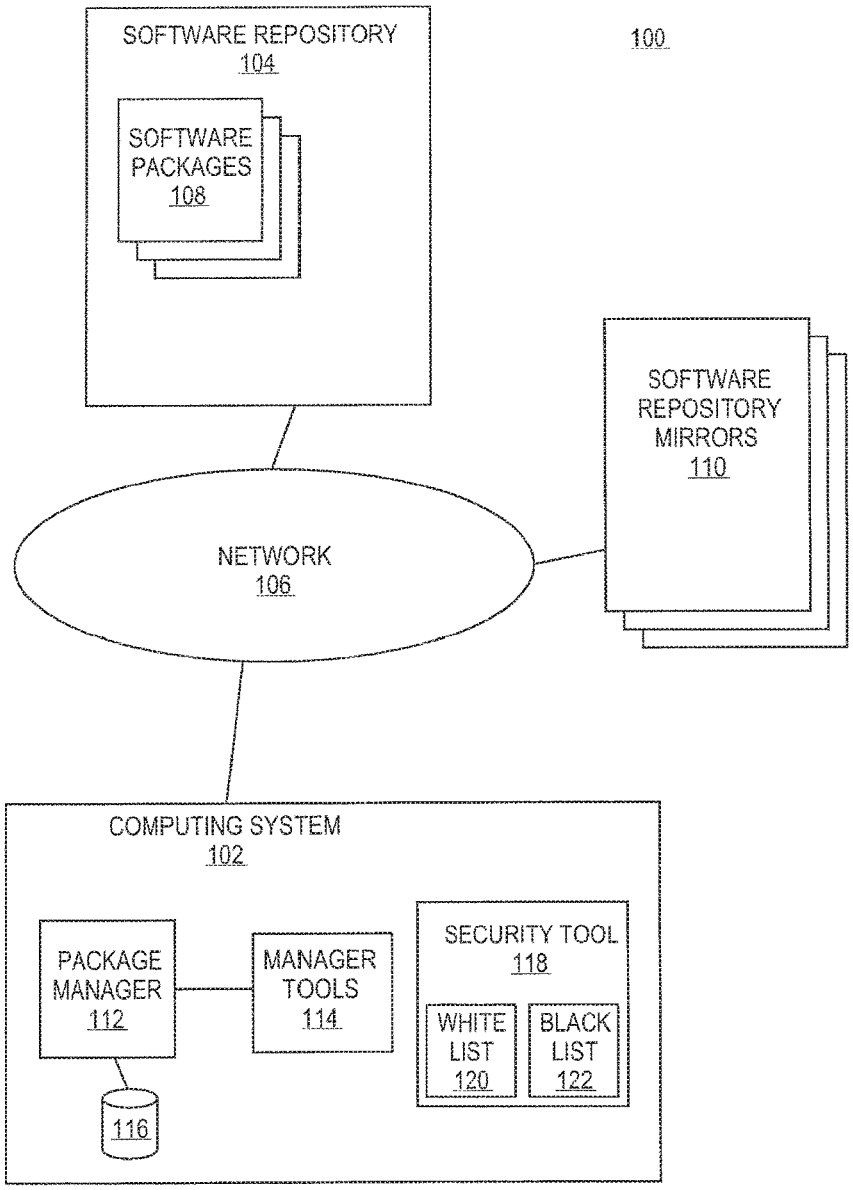
SOFTWARE REPOSITORY
104
SOFTWARE PACKAGES
108
SOFTWARE PACKAGE
124
SECURITY TOOL
118
WHITE LIST
120
BLACK LIST
122
NETWORK
106
SOFTWARE REPOSITORY MIRRORS
110
COMPUTING SYSTEM
102
PACKAGE MANAGER
112
MANAGER TOOLS
114
116

FIG. 1A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104
100
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SOFTWARE REPOSITORY MIRRORS
110
NETWORK
106
COMPUTING SYSTEM
102
PACKAGE MANAGER
112
MANAGER TOOLS
114
SECURITY TOOL
118
WHITE LIST
120
BLACK LIST
122
116

FIG. 1B

205

210

NAME	VERSION	SIZE	HASH	VENDOR	CVE REFERENCE	
PKGA.JAR	V.1	100MB	512,85d2a...	ABC,INC	ACERT, INC. CVE-2008-1234	• • •
PKGAI.JAR	V.2	10MB	512,85a1a...	AMC,INC	ACERT, INC CVE-2008-1234	• • •
• • •	• • •	• • •	• • •	• • •		

200

122

FIG. 2

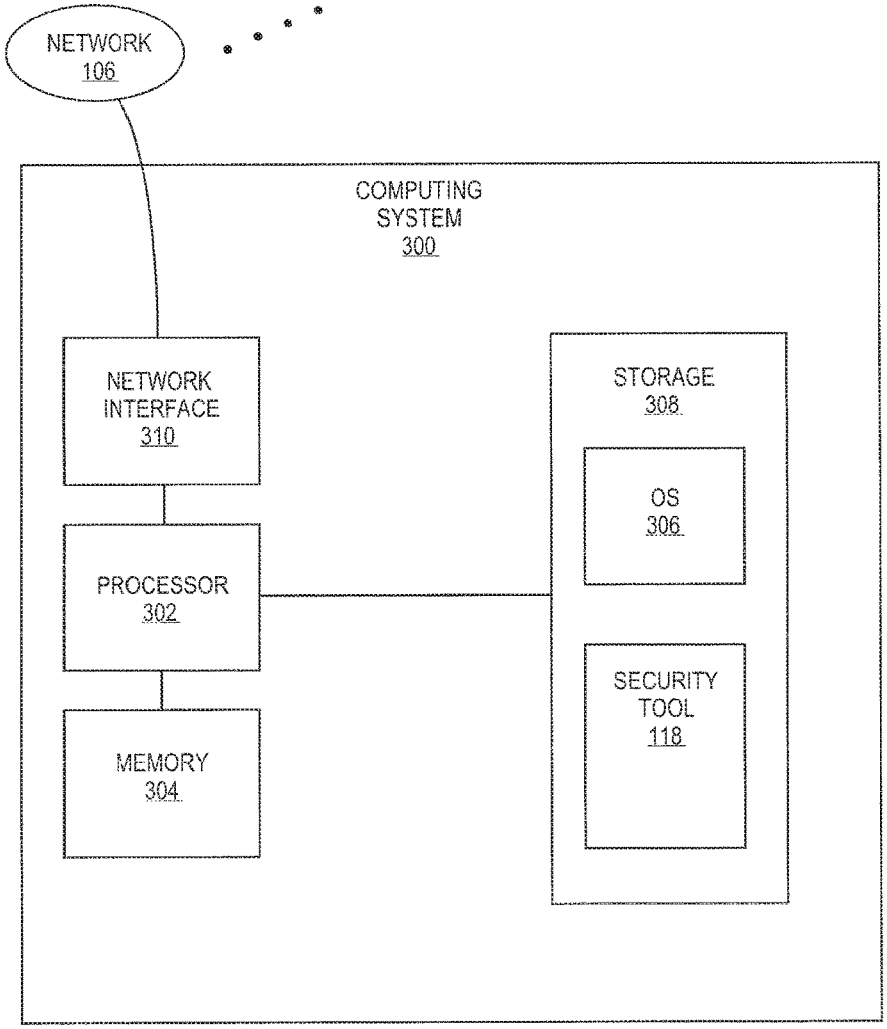
NETWORK
106
COMPUTING
SYSTEM
300
NETWORK
INTERFACE
310
PROCESSOR
302
MEMORY
304
STORAGE
308
OS
306
SECURITY
TOOL
118

FIG. 3

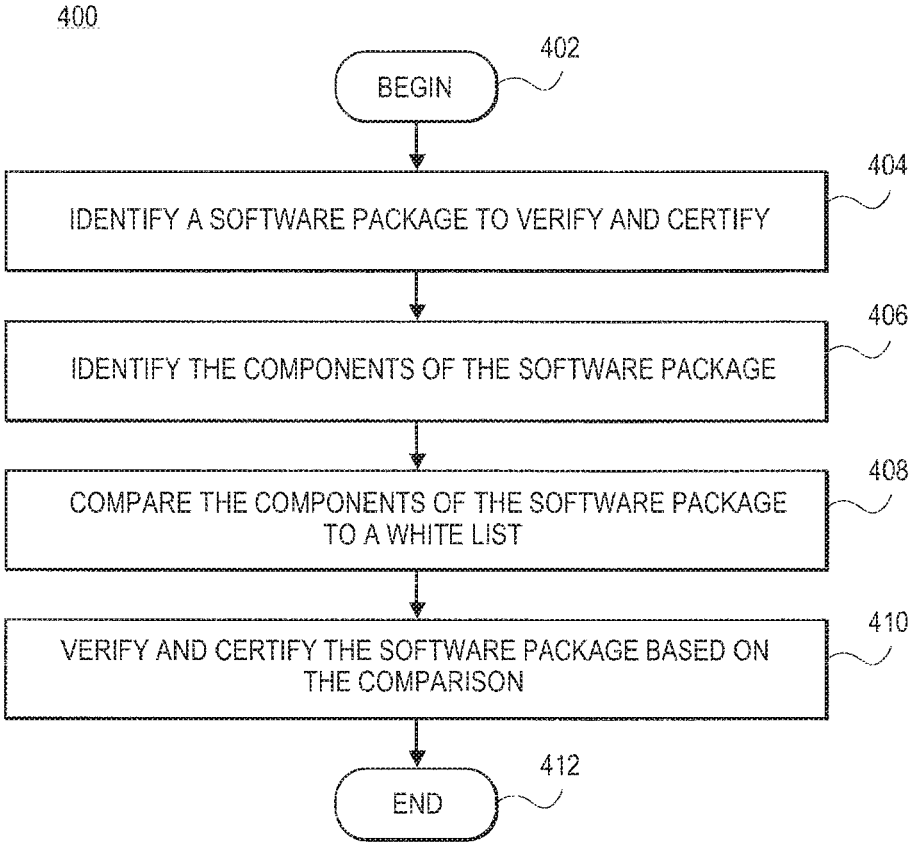
400
BEGIN
402
IDENTIFY A SOFTWARE PACKAGE TO VERIFY AND CERTIFY
404
IDENTIFY THE COMPONENTS OF THE SOFTWARE PACKAGE
406
COMPARE THE COMPONENTS OF THE SOFTWARE PACKAGE TO A WHITE LIST
408
VERIFY AND CERTIFY THE SOFTWARE PACKAGE BASED ON THE COMPARISON
410
END
412

FIG. 4A

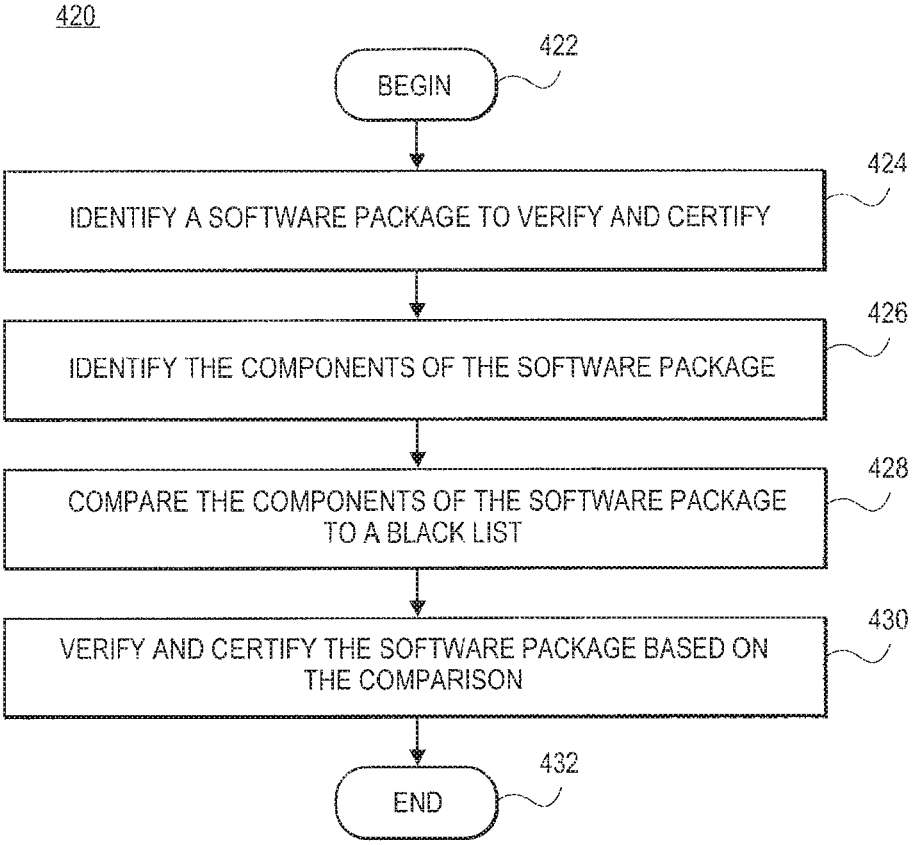
420
BEGIN
422
IDENTIFY A SOFTWARE PACKAGE TO VERIFY AND CERTIFY
424
IDENTIFY THE COMPONENTS OF THE SOFTWARE PACKAGE
426
COMPARE THE COMPONENTS OF THE SOFTWARE PACKAGE TO A BLACK LIST
428
VERIFY AND CERTIFY THE SOFTWARE PACKAGE BASED ON THE COMPARISON
430
END
432

FIG. 4B

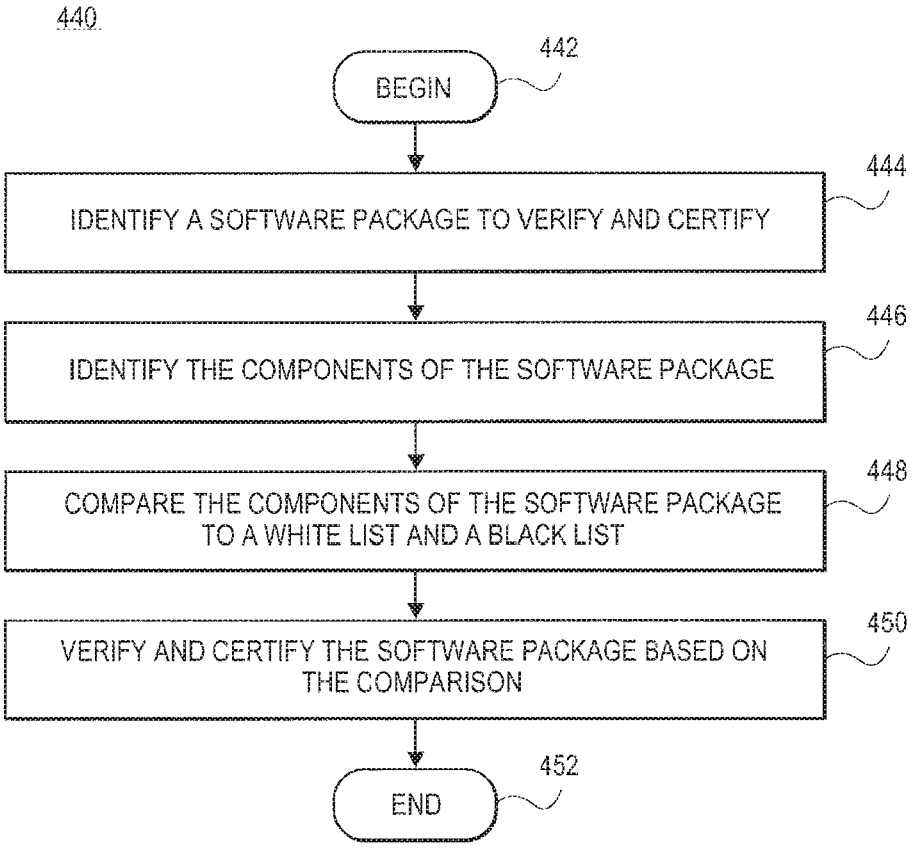
440
BEGIN
442
IDENTIFY A SOFTWARE PACKAGE TO VERIFY AND CERTIFY
444
IDENTIFY THE COMPONENTS OF THE SOFTWARE PACKAGE
446
COMPARE THE COMPONENTS OF THE SOFTWARE PACKAGE TO A WHITE LIST AND A BLACK LIST
448
VERIFY AND CERTIFY THE SOFTWARE PACKAGE BASED ON THE COMPARISON
450
END
452

FIG. 4C

DETECTION OF MALICIOUS SOFTWARE PACKAGES

RELATED APPLICATIONS

This application is a continuation of application Ser. No. 12/898,876, filed Oct. 6, 2010, now U.S. Pat. No. 9,792,429, entitled "Detection of Malicious Software Packages," which is incorporated herein by reference herein.

TECHNICAL FIELD

This invention relates generally to computer software installation for computing systems.

DESCRIPTION OF THE RELATED ART

Today, a person using a computing system has a variety of avenues for obtaining software and installing the software on the computing system, such as purchasing physical media and downloading the software over a network. When downloading the software over a network, the person can acquire and install the software using a software package delivery system. The software package delivery system typically consists of a software repository which stores and maintains various software packages. The software packages typically consist of software stored in an archive format that includes data for installing the software.

The software repository, typically, stores software packages from different types of developers, such as software development companies or individual developers. Because the software packages originate from different developers, there currently exist no process by which software packages are certified as trusted and secure. Additionally, because of the flexibility of software packages, individuals can repackage a software package to include additional components. Because an individual can introduce new components into the software package without the benefit of trusted verification, the individual could possibly add exploitable code, bugs, malicious code, or files to the software package. Accordingly, the software repositories and the users of the repositories lack the ability to identify a known exploitable, malicious software package or trust that a software package is believed to be secure.

BRIEF DESCRIPTION OF THE DRAWINGS

Various features of the embodiments can be more fully appreciated, as the same become better understood with reference to the following detailed description of the embodiments when considered in connection with the accompanying figures, in which:

FIGS. **1**A and **1**B illustrate examples of a software package delivery system including a security tool, in which various embodiments of the present teachings can be practiced;

FIG. **2** illustrates an example of a black list according to various embodiments;

FIG. **3** illustrates an exemplary hardware configuration for a computing system capable of executing the security tool, according to various embodiments;

FIG. **4**A illustrates a flowchart of an exemplary process for verifying and certifying a software package is secure utilizing a white list, according to various embodiments;

FIG. **4**B illustrates a flowchart of an exemplary process for verifying and certifying a software package is secure utilizing a black list, according to various embodiments; and

FIG. **4**C illustrates a flowchart of an exemplary process for verifying and certifying a software package is secure utilizing a white list and a black list, according to various embodiments.

DETAILED DESCRIPTION OF EMBODIMENTS

For simplicity and illustrative purposes, the principles of the present teachings are described by referring mainly to exemplary embodiments thereof. However, one of ordinary skill in the art would readily recognize that the same principles are equally applicable to, and can be implemented in, all types of information and systems, and that any such variations do not depart from the true spirit and scope of the present teachings. Moreover, in the following detailed description, references are made to the accompanying figures, which illustrate specific embodiments. Electrical, mechanical, logical and structural changes may be made to the embodiments without departing from the spirit and scope of the present teachings. The following detailed description is, therefore, not to be taken in a limiting sense and the scope of the present teachings is defined by the appended claims and their equivalents.

Embodiments of the present teachings relate to systems and methods for verifying the security of software packages. According to embodiments, a software repository offering a software package or a computing system downloading a software package can utilize a security tool to verify the security of the software package. The security tool can be configured to check and to verify the security of software packages utilizing a black list of components. To check the security, the security tool can be configured to compare the components of the software package to the black list. The components of the software package can include the archival files (e.g. jar/egg files) contained in the software package. The security tool can be configured to compare the base archival file (package) and/or any archival sub-files (sub-packages) contained in the base archival file to the black list. A black list can include a list of archival files that are known to be insecure, such as known insecure packages/subpackages referenced in a Common Vulnerabilities and Exposures (CVE) list. The black list can include a hash of the archival files and details of the archival files that are insecure, such as name of the archival file, version of the archival file, size of the archival file, etc.

According to embodiments, to check the security of a software package, the security tool can be configured to examine the software package to identify the components of the software package, e.g. the base archival file (package) and/or any archival sub-files (sub-packages). Once the components are identified, the security tool can be configured to compare the components to the black list. The security tool can compare hashed versions of the identified components to hashed versions of the known insecure components included in the black list. The security tool can be configured to verify the security of the software package based on the comparison. The security tool can verify that the software package is insecure if an identified component of the software package is found in the black list.

By utilizing the security tool, a software repository and/or a user can verify that a software packages is secure and does not pose a danger to computing system due to malicious code, at the time of scanning. As such, the software repository can ensure, at that time, that the software packages offered are safe, and a user retrieving a software package can ensure that the software packages downloaded will not damage or compromise their computing systems.

FIG. **1**A illustrates a software package delivery system **100**, according to various embodiments of the present teachings. While FIG. **1**A illustrates various components that can be included in the software package delivery system **100**, one skilled in the art will realize that additional components can be added or existing components can be removed.

As illustrated in FIG. **1**A, the software package delivery system **100** can be designed to allow a computing system **102** to communicate with a software repository **104** via one or more networks **106**. The computing system **102** can communicate with the software repository **104** in order to obtain and install software packages **108**. The software repository **104** can be implemented as any type of open-source or proprietary software repository, which can store the software packages **108** and provide the software packages **108** to the computing system **102**. For example, the software repository **104** can be implemented as a Yum repository, Debian™ repository, or any other type of conventional software repository.

As described herein, the software packages **108** can include one or more software programs or software program updates that are packaged together in a format that allows a software package manger or software package installer to install the software programs or updates, contained in the software packages **108**. The software programs included in the software packages **108** can be any type of software programs such as operating systems (OS), application programs, and the like or updates to these software programs. The software packages **108** can also include metadata that describes the software packages, such as the name of the software package, the software programs included in the package, epoch, version and release of the software packages, architecture for which the software package was built, description of the purpose of the software packages, etc. The software packages **108** can also include metadata that aids in the installation of the software programs contained in the software packages, such as checksums, format of the checksums, and a list of dependencies of the software packages. The checksums verify the integrity of the files of the software packages **108**, e.g. that the files of the software packages are complete and correct. The list of dependencies can describe the relationship of the software programs or software program updates contained in the software packages **108** and any other software programs, file, software libraries, etc. required by the software packages.

The software repository **104** can store the software packages **108** in any type of open-source or proprietary format depending on the type of the software repository. For example, the software packages **108** can be in conventional formats such as RPM format for a Yum repository, .deb format for a Debian™ repository, or other conventional archival formats such as .jar .zip, tar.gz, and the like.

The software package delivery system **100** can also include one or more software repository mirrors **110**, coupled to the one or more networks **106**. The software repository mirrors **110** can be configured to maintain copies of the software packages **108** offered by the software repository **104**. The software repository mirrors **110** can be configured to backup the software repository **104**. For example, the software repository mirrors **110** can provide the software packages **108** to the computing system **102**, in the event that the software repository **104** is unavailable or the software repository **104** is experiencing high traffic.

The software repository **104** and the software repository mirrors **110** can be supported by any type of computing systems capable of storing the software packages, capable of communicating with the one or more networks **106** and capable of running a repository application for cooperating with a software package manager or software package installer in order to deliver the software packages **108**. For example, the software repository **104** and the software repository mirrors **110** can be supported by conventional computing systems or other devices such as such as servers, personal computers, laptop computers, network-enabled media devices, networked stations, etc. As such, the computing systems supporting the software repository **104** and the software repository mirrors **110** can include conventional hardware such as processors, memory, computer readable storage media and devices (CD, DVD, hard drive, portable storage memory, etc.), network devices, and the like.

The one or more networks **106** can be or include the Internet, or other public or private networks. The one or more networks **106** can be or include wired, wireless, optical, and other network connections. One skilled in the art will realize that the one or more networks **106** can be any type of network, utilizing any type of communication protocol, to connect computing systems.

The computing system **102** can be any type of conventional computing system or other device such as such as servers, personal computers, laptop computers, network-enabled media devices, networked stations, etc. As such, the computing system **102** can include conventional hardware such as processors, memory, computer readable storage media and devices (CD, DVD, hard drive, portable storage memory, etc.), network devices, and the like.

In order to communicate with the software repository **104** or the software repository mirrors **110**, the computing system **102** can include a software package manager **112**. The software package manager **112** can be configured to cooperate with the software repository **104** or the software repository mirrors **110** to perform various actions associated with the software packages. For example, the software package manager **112** can be configured to retrieve one or more of the software packages **108**, maintained by the software repository **104** and configured to install the software packages **108** on the computing system **102**. Likewise, the software package manager **112** can be configured to retrieve updates to the software packages **108**, already installed on the computing system **102**, and install the updates on the computing system **102**.

The software package manager **112** can be configured to cooperate with manager tools **114** to perform actions related to the software packages. For example, the manager tools **114** can be configured to install and update particular application programs, files, or software libraries maintained by the software repository **104**. As such, the manager tools **114** can be configured to provide a request to the software package manager **112** to perform the installation or update.

The software package manager **112** can be configured to allow a user of the computing system **102** to request the various actions associated with installing and updating software packages. To achieve this, the software package manager **112** can be configured to provide command line interfaces and/or graphical user interfaces (GUIs) that allow the user to direct the software package manager **112** to perform the actions. For example, the software package manager **112** can provide GUIs that display the software packages, such as new software packages and software package updates, available in the software repositories and that allow the user to select the action to be performed related to the software packages. Likewise, in order to perform the various actions, the software package manager **112** can be configured to communicate with the software repository **104** or the software repository mirrors **110** and retrieve data from the

software repositories. For example, when providing the GUIs to a user of the computing system **102**, the software package manager **112** can retrieve a list of the software packages **108** from the software repository **104**. Likewise, for example, when installing or updating a particular software package, the software package manager **112** can retrieve the particular software package updates and any other data associated with the particular software package.

When performing the various actions, the software package manager **112** can be configured to utilize the metadata associated with the software packages **108** in order to perform the actions. For example, when installing a particular software package or updating a particular software package, the software package manager **112** can access the metadata associated with the particular software package in order to properly install or update the software package on the computing system **102**. For instance, the software package manager **112** can utilize the checksums and the list of dependencies in the metadata in order to identify and verify the software programs, files, and software libraries that are affected. Additionally, when performing the various actions, the software package manager **112** can be configured to store the metadata in a database **116**.

The software package manager **112** can be any application program that is capable of executing on the computing system **102** to perform the actions described above. For example, the software package manager **112** can be any type of conventional open-source or proprietary package manager such as Yum package manager, Debian™ package manager, and the like. The software package manager **112** can be stored on computer readable storage devices or media (CD, DVD, hard drive, portable storage memory, etc.) of the computing system **102** and executed by the computing system **102**.

As described above, the software packages **108** maintained by the software repository **104** can be provided to the software repository **104** from a variety of sources. The software packages **108** can be created and provided by software development companies. Likewise, the software packages **108** can be created and provided by individual developers and users. Because the software packages **108** originate from a variety of sources, the software repository **104** may not be able to verify or certify that the software packages **108** are secure and do not contain malicious files or code. For example, if one of the software packages **108** is provided by an individual, the software repository **104** may not know or trust the individual and, accordingly, cannot verify that the software package is secure based on its relationship with the individual.

In embodiments, to verify and certify that the software packages **108** are secure, the software repository **104** can include a security tool **118**. The security tool **118** can be configured to examine the software packages **108** and compare the components of the software packages **108** to a white list **120** of known secure components and to a black list **122** of known insecure components. The security tool **118** can be implemented as an application program that is capable of executing on the computing systems supporting the software repository **104** to perform the processes as described herein. As such, the security tool **118** can be configured to include the necessary logic, commands, instructions, and protocols in order to perform the methods and processes described herein. Likewise, the security tool **118** can be implemented as a portion of another application program, such as the software repository applications. In either case, the security tool **118** can be stored on computer readable storage devices or media (CD, DVD, hard drive, portable storage memory, etc.) of the computing systems supporting the software repository **104** and can be executed by the computing systems supporting the software repository **104**.

In embodiments, to check and verify the security of the software packages **108**, the security tool **118** can be configured to examine the software packages **108** to identify the components of the software packages **108**. The components, identified by the security tool **118**, can include the archival files (jar/egg files) contained in the software package, such as rpm files, .zip files, tar.gz, .jar, etc. The components can include the base archival file (package) and/or any archival sub-files (sub-packages) contained in the base archival file. The security tool **118** can be configured examine the archival files of the software packages **108** and/or decompose the archival files to identify the archival sub-files. For example, a particular software package **108** can include a base RPM file which contains several tar.gz sub-files. In this example, the security tool **118** can be configured to identify, as components, the base RPM file and/or the several tar.gz sub-files. To achieve this, the security tool **118** can be configured to include the necessary logic, commands, instructions, and protocols to access the archival format of the software packages **108** and to decompose the software packages **108**.

Once the components have been identified, the security tool **118** can be configured to compare the identified components to the white list **120** and/or to the black list **122**. The black list **122** can include a list of components (packages and sub-packages) that are known to be insecure. For example, the black list **122** can include known archival files that have been identified as malicious, such as archival files that have been referenced in a CVE list. The white list **120** can include a list of components that are known to be secure. For example, the white list **120** can include components that are known to be secure because the components are developed and produced by trusted developers, the components have been previously tested and verified as secure, the components have been included in software packages that have been verified as being secure, and the like.

In order to match the components of the software packages to the white list **120** or black list **122**, the white list **120** and the black list **122** can include hashed versions of the components of the software packages that are known to be secure or insecure. The the white list **120** and the black list **122** can include hashed versions of the base archival file (package) and/or hashed versions of the archival sub-files (sub-packages). The hashed versions of the components of the software packages **108** can be generated using any algorithm, procedure, or function to convert the components of the software packages an/or the complete software packages to a fixed size. For example, the hashed versions of the components can be created using any type of known hashing algorithm, such as SHA (secure hash algorithm) **512**, SHA 384, SHA 256, SHA 224. The security tool **118** can utilize the hashed versions of the components in order to uniquely identify the known insecure and secure components (archival files), and to easily and quickly compare the known insecure and secure components to other software packages. Additionally, both the white list **120** and the black list **122** can include details of the components that are secure and insecure, such as names of the components (name of the archival files), versions of the components (version of the archival files), sizes of the components (size of the archival files), etc.

FIG. **2** illustrates an example of the black list **122**. As illustrated, the black list **122** can be formatted as a table **200** with columns **205** and rows **210** that include the details of

known insecure components (archival files), such as a name of the component (e.g. file name), a version of the component, a size of the component, vendor of the component, etc. Additionally, the black list **122** can include hashed versions of the components (archival files). As illustrated, the black list **122** can include the length of the hash value, e.g. **512**, and the hash value. Additionally, as illustrated, the black list **122** can include a reference to a CVE list, which identifies further details of the insecure component, and the name of the entity, company, corporation, that created or maintains the CVE list. While FIG. **2** illustrates exemplary details that can be included the black list **122**, one skilled in the art will realize that the black list **122** can include any details relevant to the components of software packages. One skilled in the art will also realize that the white list **120** can include similar information as illustrated in FIG. **2**.

In embodiments, the security tool **118** can be configured to verify the security of the software packages **108** by comparing the identified components to the white list **120** and/or to the black list **122**. In particular, the security tool **118** can be configured to compare hashed versions of the archival files of the software packages **108** to hashed versions of archival files in the white list **120** and/or in the black list **122** to find a match. To achieve this, the security tool **118** can be configured to include the necessary logic, commands, instructions, and protocols to generate hashed versions of the base archival file (package) and/or the archival sub-files (sub-packages) using hashing algorithms, such as SHA 512, SHA 384, SHA 256, SHA 224.

When verifying the security of the software packages **108**, the security tool **118** can be configured to base the verification and certification on a comparison to the white list **120**, a comparison to the black list **122**, or a comparison to both. If the security tool **118** utilizes the black list **122**, the security tool **118** can verify that a software package **108** is insecure if none of the identified components (archival files) of the software package **108** match known insecure components (archival files) contained in the black list **122**.

If the security tool **118** utilizes the white list **120**, the security tool **118** can verify that a software packages **108** is secure if all the identified components of the software package **108** match known secure components contained in the white list **120**. If the security tool **118** utilizes both the white list **120** and the black list **122**, the security tool **118** can verify that a software package **108** is secure if identified components of the software package **108**, which do not match known secure components contained in the white list **120**, do not match any of the known insecure components contained in the black list **122**.

In embodiments, the security tool **118** can be configured to check and verify the security of the software packages **108** at any time once the software packages **108** is received at the software repository **104**. The security tool **118** can be configured to check the security of the software packages **108** as the software packages are initially received by the software repository **104**. For example, upon receipt of a new software package **124** from a developer, the security tool **118** can run a security check on the new software package **124**. For example, an administrator can instruct the security tool **118** to run a security check or can instruct the security tool **118** to automatically run a security check. If the new software package **124** is verified as being secure, the software package **124** can be added to the software packages **108** offered by the software repository **104**. If the new software package **124** is determined to be insecure, the software package **124** can be prevented from being added to the software packages **108**.

Likewise, the security tool **118** can be configured to check the security of the software packages **108** as they are requested by the computing system **102**. For example, the computing system **102** can request to download and install the software package **124**. Prior to installing the software package **124**, the security tool **118** can run a security check on the software package **124**. For example, an administrator can instruct the security tool **118** to run a security check or can instruct the security tool **118** to automatically run a security check. If the software package **124** is determined to be secure, the software package **124** can be installed on the computing system **102**. If the software package **124** is determined to be insecure, the software package **124** can be prevented from being installed on the computing system **102**, and the computing system **102** can be notified of the insecurity, for example, be notified of the name, version, and a reference to a CVE list for further details of the insecure component maintained in the white list **120** and/or black list **122**.

Additionally, the security tool **118** can be configured to allow a user to specify a particular software packages **108** to verify. To achieve this, the security tool **118** can be configured to include the necessary logic, commands, instructions, and protocols to generate command line interfaces and/or GUIs that allow a user to specify a software package **108** to verify and certify.

In embodiments, the security tool **118** can be configured to generate and update the white list **120** and the black list **122**. For example, the security tool **118** can communicate with trusted developers, security companies and consultants, and the like to identify known secure and insecure components to include in or removed from the white list **120** and the black list **122**. To achieve this, the security tool **118** can be configured to include the necessary logic, commands, instructions, and protocols to communicate with the trusted developers, security companies and consultants and the like via the one or more networks **106**. Likewise, the security tool **118** can be configured to allow a user of the software repository **104** to enter components to be included in or removed from the white list **120** and the black list **122**. To achieve this, the security tool **118** can be configured to generate the command line interfaces and/or GUIs that allow a user to enter components to be included in or removed from the white list **120** and the black list **122**.

In embodiments, the security tool **118** can be configured to allow other users, such as a user of the computing system **102**, to request that components be added to the white list **120** and/or the black list **122** via the one or more networks **106**. To achieve this, the security tool **118** can be configured to generate network-based command line interfaces and/or GUIs that allow a user to enter components to be added to the white list **120** and/or the black list **122** via the one or more networks **106**. For example, the security tool **118** can be configured to generate and provide a web page that allows the users to enter components to be added to the white list **120** and/or the black list **122** utilizing a web browser application program executing on the computing system **102**. When the other users request that components be added to the white list **120** and/or the black list **122**, the security tool **118** can be configured to verify that the component should be added to the white list **120** and/or the black list **122**. For example, the security tool **118** can be configured to allow the administrator of the software repository to verify the component to be added. Likewise, the security tool **118** can be configured to contact other trusted entities, such as trusted software developers or security companies or con-

sultants to verify that the requested component should be added to the white list **120** and/or the black list **122**.

As described above, the security tool **118** can be stored and executed on the computing systems of the software repository **104** so that the software repository **104** can ensure the software packages **108** maintained and offered by the software repository **104** are safe. FIG. **113** illustrates another example of the software package delivery system **100** in which the security tool **118** can be stored and executed on the computing system **102**, according to various embodiments of the present teachings. While FIG. **1**B illustrates various components that can be included in the software package delivery system **100**, one skilled in the art will realize that additional components can be added or existing components can be removed.

As illustrated in FIG. **1**B, the security tool **118** can be stored and executed on the computing system **102**. In this embodiment, the security tool **118** can be configured to allow the computing system **102** to check the security of software packages **108** prior to installing the software packages **108** on the computing system **102**. When checking the security, the security tool **118** can check and verify the security of the software packages **108** as described above in FIG. **1**A.

The security tool **118** can be configured to check the security of each software package **108** to be installed on the computing system **102**. For example, an user can instruct the security tool **118** to run a security check or can instruct the security tool **118** to automatically run a security check. To achieve this, the security tool **118** can be configured to include the necessary logic, commands, instructions, and protocols to communicate with the software package manager **112** in order to identify and check the software packages **108** that are being installed on the computing system **102**. Likewise, the security tool **118** can be configured to allow a user of the computing system **102** to select the software packages **108** to check. To achieve this, the security tool **118** can be configured to include the necessary logic, commands, instructions, and protocols to generate command line interfaces and/or GUIs that allow the user to select the software packages **108** to check.

In embodiments, the security tool **118** can be configured to retrieve and/or update the white list **120** and/or the black list **122**. For example, the security tool **118** can communicate with an update service, via the one or more networks **106**, to retrieve and/or update the white list **120** and/or the black list **122**. To achieve this, the security tool **118** can be configured to include the necessary logic, commands, instructions, and protocols to communicate with the update, service via the one or more networks **106**. Likewise, as described above, the security tool **118** can be configured to allow the user of the computing system **102** to requests that components be added to the white list **120** and/or the black list **122** via the one or more networks **106**. To achieve this, the security tool **118** can be configured to generate network-based command line interfaces and/or GUIs that allow a user to enter components to be added to the white list **120** and/or the black list **122** via the one or more networks **106**. For example, the security tool **118** can be configured to generate and provide a web page that allows the users to request that components be added to the white list **120** and/or the black list **122** utilizing a web browser application program executing on the computing system **102**. Once the software repository has verified the requested components, the security tool **118** can be configured to update the white list **120** and/or the black list **122** as maintained on the computing system **102**.

In embodiments, as described in FIG. **1**B, the security tool **118** can be implemented as an application program that is capable of executing on the computing system **102** to perform the processes as described herein. As such, the security tool **118** can be configured to include the necessary logic, commands, instructions, and protocols in order to perform the methods and processes described herein. Likewise, the security tool **118** can be implemented as a portion of another application program, such as the software package manager **112** and/or the manager tools **114**. In either case, the security tool **118** can be stored on computer readable storage devices or media (CD, DVD, hard drive, portable storage memory, etc.) of the computing system **102** and can be executed by the computing system **102**.

FIG. **3** illustrates an exemplary diagram of hardware and other resources that can be incorporated in a computing system **300**, such as the computing system **102**, computing systems supporting the software repository **104**, or computing systems supporting the software repository mirrors **110**, and configured to store and execute the security tool **118**, according to embodiments. In embodiments as shown, the computing system **300** can comprise a processor **302** communicating with a memory **304**, such as electronic random access memory, operating under control of or in conjunction with a operating system (OS) **306**. The OS **306** can be, for example, a distribution of the Linux™ operating system, such as Red Hat™. Enterprise Linux, Fedora, etc., the Unix™ operating system, or other open-source or proprietary operating system or platform. The processor **302** also communicates with one or more computer readable storage devices or media **308**, such as hard drives, optical storage, and the like, for maintaining the OS **306** and the security tool **118**. The processor **302** further communicates with network interface **310**, such as an Ethernet or wireless data connection, which in turn communicates with one or more networks **106**, such as the Internet or other public or private networks.

The processor **302** also communicates with the security tool **118** to execute the logic of the security tool **118** and to allow performance of the processes as described herein. Other configurations of the computing system **300**, associated network connections, and other hardware and software resources are possible.

While FIG. **3** illustrates the computing system **300** as a standalone system including a combination of hardware and software, the computing system **300** can include multiple systems operating in cooperation. As described above, the security tool **118** can be implemented as an application program capable of being executed by the computing system **300**, as illustrated, or other conventional computer platforms. Likewise, the security tool **118** can also be implemented as a software module or program module capable of being incorporated in other software applications and programs, such as the OS **306** of the computing system **300**, the software package manager **112**, the manager tools **114**, and/or combined in a single application or program. In any example, the security tool **118** can be implemented in any type of programming language. When implemented as an application program, application module, or program code, the security tool **118** can be stored in a computer readable storage medium, such as the storage **308**, accessible by the computing system **300**. Likewise, during execution, a copy of the security tool **118** can be stored in the memory **304**.

FIG. **4**A illustrates a flow diagram for a process **400** of verifying and certifying a software package is secure utilizing a white list, according to embodiments of the present teachings. In **402**, the process can begin. In **404**, the security tool **118** can identify a software package **108** to verify and

certify. For example, the security tool **118** can verify and certify a software package **108** is secure when the software package **108** is added to the software repository **104** or when the software package **108** is requested by the computing system **102**. Additionally, the security tool **118**, which is executing on the computing system **102**, can verify and certify a software package **108** at the time of install, or a user of the computing system **102** can select the software package **108** to verify and certify.

In **406**, the security tool **118** can identify the components of the software package **108**. For example, the security tool **118** can decompose the software package **108** into its components (archival files).

In **408**, the security tool **118** can compare the identified components of the software package **108** to a white list **120**. For example, the security tool **118** can compare hashed versions of the identified components to hashed versions of the known secure components in the white list **120** in order to find a match.

In **410**, the security tool **118** can verify and certify the software package **108** based on the results of the comparison. For example, the security tool **118** can verify that a software packages **108** is secure if all the identified components of the software package **108** match known secure components contained in the white list **120**. The security tool **118** can then take other actions based on the verification such notifying an administrator or user of the results.

In **412**, the process can end, repeat, or return to any point.

FIG. **4**B illustrates a flow diagram for a process **420** of verifying and certifying a software package is secure utilizing a black list, according to embodiments of the present teachings. In **422**, the process can begin. In **424**, the security tool **118** can identify a software package **108** to verify and certify. For example, the security tool **118** can verify and certify a software package **108** is secure when the software package **108** is added to the software repository **104** or when the software package **108** is requested by the computing system **102**. Additionally, the security tool **118**, which is executing on the computing system **102**, can verify and certify a software package **108** at the time of install, or a user of the computing system **102** can select the software package **108** to verify and certify.

In **426**, the security tool **118** can identify the components of the software package **108**. For example, the security tool **118** can identify the base archival file (package) can decompose the software package **108** to identify any archival sub-files (sub-packages).

In **428**, the security tool **118** can compare the identified components of the software package **108** to a black list **122**. For example, the security tool **118** can compare hashed versions of the identified components (archival files) to hashed version of known insecure components (archival files) in the black list **122** in order to find a match.

In **430**, the security tool **118** can verify and certify the software package **108** based on the results of the comparison. For example, the security tool **118** can verify that the software package **108** is insecure if any of the identified components of the software package **108** match known insecure components contained in the black list **122**. The security tool **118** can then take other actions based on the verification such as notifying an administrator or user of the insecurity. The notification can include the details of the known insecure component such as name of the archival file and a reference to a CVE list with further details.

In **432**, the process can end, repeat, or return to any point.

FIG. **4**C illustrates a flow diagram for a process **440** of verifying and certifying a software package is secure utilizing a white list and a black list, according to embodiments of the present teachings. In **442**, the process can begin. In **444**, the security tool **118** can identify a software package **108** to verify and certify. For example, the security tool **118** can verify and certify a software package **108** is secure when the software package **108** is added to the software repository **104** or when the software package **108** is requested by the computing system **102**. Additionally, the security tool **118**, which is executing on the computing system **102**, can verify and certify a software package **108** at the time of install, or a user of the computing system **102** can select the software package **108** to verify and certify.

In **446**, the security tool **118** can identify the components of the software package **108**. For example, the security tool **118** can decompose the software package **108** into its components.

In **448**, the security tool **118** can compare the identified components of the software package **108** to a white list **120** and a black list **122**. The security tool **118** can compare hashed versions of the identified components of the software package **108** to the hashed versions of known secure components in the white list **120**. If an identified component is not found in the white list **120**, the security tool **118** can compare the hashed version of each identified component, not found in the white list **120**, to the hashed versions of known insecure components in the black list **122** in order to find a match.

In **450**, the security tool **118** can verify and certify the software package **108** based on the results of the comparison. For example, the security tool **118** can verify that a software package **108** is secure if identified components of the software package **108**, which do not match known secure components contained hi the white list **120**, also do not match any of the known insecure components contained in the black list **122**. The security tool **118** can then take other actions based on the verification such as notifying an administrator or user of the results.

In **452**, the process can end, repeat, or return to any point.

Certain embodiments can be performed as a computer application program. The application program can exist in a variety of forms both active and inactive. For example, the application program can exist as software program(s) comprised of program instructions in source code, object code, executable code or other formats. Any of the above can be embodied on a computer readable medium, which include computer readable storage devices and media, and signals, in compressed or uncompressed form. Exemplary computer readable storage devices and media include conventional computer system RAM (random access memory), ROM (read-only memory), EPROM (erasable, programmable ROM), EEPROM (electrically erasable, programmable ROM), and magnetic or optical disks or tapes. Exemplary computer readable signals, whether modulated using a carrier or not, are signals that a computer system hosting or running the present teachings can be configured to access, including signals downloaded through the Internet or other networks. Concrete examples of the foregoing include distribution of executable software of the computer application program on a CD-ROM or via Internet download.

While the teachings have been described with reference to the exemplary embodiments thereof, those skilled in the art will be able to make various modifications to the described embodiments without departing from the true spirit and scope. The terms and descriptions used herein are set forth by way of illustration only and are not meant as limitations. In particular, although the method has been described by examples, the steps of the method may be performed in a

different order than illustrated or simultaneously. Furthermore, to the extent that the terms "including", "includes", "having", "has", "with", or variants thereof are used in either the detailed description and the claims, such terms are intended to be inclusive in a manner similar to the term "comprising." As used herein, the term "one or more of" with respect to a listing of items such as, for example, A and B, means A alone, B alone, or A and B. Those skilled in the art will recognize that these and other variations are possible within the spirit and scope as defined in the following claims and their equivalents.

What is claimed is:

1. A method comprising:

identifying, by a processor executing a security tool, a plurality of components contained in a software package comprising one of a java archive (JAR) file, an Android application package, a docker image, a container file, or a virtual machine image;

comparing, by the processor, the plurality of components contained in the software package to a list of known components;

classifying, by the processor, the software package as insecure when at least one of the plurality of compared components matches an insecure component on the list of known components, or as secure when each of the plurality of compared components matches a corresponding secure component on the list of known components;

preventing, by the processor executing the security tool, addition of the software package to a software repository when the software package is classified as insecure; and

in response to the at least one of the plurality of compared components matching the insecure component, providing, by the processor executing the security tool, an interface to enable a user to request the at least one of the plurality of compared components of the software package be added as a secure component on the list of known components.

2. The method of claim **1**, wherein comparing the plurality of components comprises comparing a hashed version of the plurality of components contained in the software package to hashed versions of insecure components on the list of known components.

3. The method of claim **1**, wherein the software package is a new software package added to the software repository.

4. The method of claim **1**, wherein the plurality of components contained in the software package comprises an archival file contained in the software package.

5. The method of claim **1**, wherein the software package comprises a container file and wherein the software repository comprises a container repository.

6. The method of claim **1**, wherein the software package comprises a virtual machine image and wherein the software repository comprises a virtual machine repository.

7. The method of claim **1**, wherein the software package comprises a docker image file and wherein the software repository comprises one of a docker registry and a docker repository.

8. The method of claim **1** further comprising, allowing, by the processor, addition of the software package to the software repository when the software package is classified as secure.

9. A non-transitory computer readable medium comprising instructions to cause a processor to:

identify, by the processor executing a security tool, a plurality of components contained in a software package comprising one of a Java archive (JAR) file, an Android application package, a docker image, a container file, or a virtual machine image;

compare, by the processor, the plurality of components contained in the software package to a list of known components;

classify, by the processor, the software package as insecure when at least one of the plurality of compared components matches an insecure component on the list of known components, or as secure when each of the plurality of compared components matches a corresponding secure component on the list of known components;

prevent, by the processor executing the security tool, addition of the software package to a software repository when the software package is classified as insecure; and

in response to the at least one of the plurality of compared components matching the insecure component, provide, by the processor executing the security tool, an interface to enable a user to request the at least one of the plurality of compared components of the software package be added as a secure component on the list of known components.

10. The non-transitory computer readable medium of claim **9**, wherein to compare the plurality of components comprises the processor to compare a hashed version of the plurality of components contained in the software package to hashed versions of insecure components on the list of known components.

11. The non-transitory computer readable medium of claim **9**, wherein the plurality of components contained in the software package comprise an archival file contained in the software package.

12. The non-transitory computer readable medium of claim **9**, wherein the software package comprises a container file and wherein the software repository comprises a container repository.

13. The non-transitory computer readable medium of claim **9**, wherein the software package comprises a virtual machine image and wherein the software repository comprises a virtual machine repository.

14. The non-transitory computer readable medium of claim **9**, wherein the software package comprises a docker image file and wherein the software repository comprises one of a docker registry and a docker repository.

15. An apparatus comprising:

a memory to contain instructions; and

a processor, operatively coupled to the memory, to execute a security tool, the processor to:

identify plurality of components contained in a software package comprising one of a Java archive (JAR) file, an Android application package, a docker image, a container file, or a virtual machine image;

compare the plurality of components contained in the software package to a list of known components;

classify the software package as insecure in response to at least one of the plurality of compared components matching an insecure component on the list of known components, or as secure when each of the plurality of compared components matches a corresponding secure component on the list of known components;

prevent addition of the software package to a software repository when the software package is classified as insecure; and

in response to the at least one of the plurality of compared components matching the insecure component, provide

an interface to enable a user to request the at least one of the plurality of compared components of the software package be added as a secure component on the list of known components.

16. The apparatus of claim **15**, wherein the plurality of components contained in the software package comprises an archival file contained in the software package.

17. The apparatus of claim **15**, wherein the software package comprises a container file and wherein the software repository comprises a container repository.

18. The apparatus of claim **15**, wherein the software package comprises a virtual machine image and wherein the software repository comprises a virtual machine repository.

19. The apparatus of claim **15**, wherein the software package comprises a docker image file and wherein the software repository comprises one of a docker registry and a docker repository.

20. The apparatus of claim **15**, the processor further to, allow addition of the software package to the software repository when the software package is classified as secure.

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