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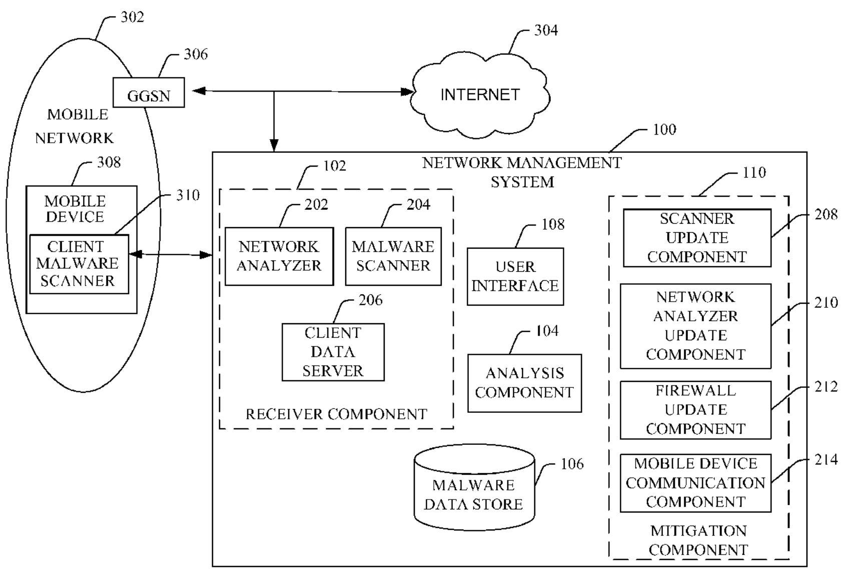

(57) Abstract: A network management system monitors malware within a mobile network. The system comprises a receiver component that obtains data regarding malware in the mobile network. The data is obtained from a first source and a second source, where the first source is of a different type than the second source. The monitoring system also includes an analysis component that generates a malware analysis of the mobile network as a function of the data.

WO 2008/043109 A2

SYSTEM AND METHOD OF REPORTING AND VISUALIZING MALWARE ON MOBILE NETWORKS

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CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application Serial No. 60/828,513 entitled, "System and Method for Reporting and Visualizing Viruses on Mobile Networks", filed on October 6, 2006; and U.S. Provisional Application Serial No. 60/828,500 entitled, "Malware Sample Collection on Mobile Networks", filed on October 6, 2006.

TECHNICAL FIELD

The present invention relates generally to systems, devices, and methods for detecting malware in mobile networks and mobile devices.

BACKGROUND OF THE INVENTION

Most malware, whether worm or virus, share a common characteristic: they tend to spread over time from one device to another device if not contained. The ability to get up-to-date and real-time metrics on mobile networks is critical for quickly developing strategies for containing worm and other virus attacks. There is a need to assimilate statistical information about potential malware on the network and present it to network administrators in a meaningful way so they can quickly take appropriate actions to stop worm and other virus attacks before they have had a chance to widely proliferate.

Client anti-virus applications provide a level of security against malware on mobile phones. However, network operators also need to reinforce the security at the network level to ensure that all handsets are uniformly protected regardless of whether or not the client devices install anti-virus software. Malware-detection systems at the mobile network level have to run so that they will not introduce significant delay to the network traffic. This is because mobile networks transmit voice traffic and introducing even a minor network delay would unacceptably degrade voice quality. Placing a detection system so that network traffic passes directly through the detection system, or "in-line" with the network communication, allows the detection system to scan all data blocks passing through the network. This permits infected data blocks to be blocked before they reach another mobile device. However, such an in-line detection system can introduce unacceptable latency and a corresponding decrease in quality of service to the mobile user.

Currently, once malware has been identified and analyzed, it can be detected using signatures extracted from the malware and cleaned according to its specific ways of spreading and infecting. The more difficult problem is in identifying new malware as early as possible to prevent it from proliferating. Although firewalls are used in the mobile network to limit or forbid suspicious behavior, no existing methods provide a comprehensive security solution towards eliminating all new malware. This is at least in part because the forms and functionalities of new malware are unpredictable. Also, malware can propagate through any number of locations making it impossible to capture all new malware samples at a single location. To effectively combat new malware, new malware samples need to be quickly gathered, identified, and analyzed as soon as they appear on the network so that cleaning schemes using signature schemes or other methods can be implemented before the malware has had a chance to widely proliferate. The sooner a sample of new malware is obtained, the sooner the mobile network can be protected against the new malware and the less damage the malware will ultimately cause.

New malware and malware variants are constantly appearing. Once new malware has been identified, service providers need a way to update mobile devices in the network so that they can remove the new malware from the mobile devices or prevent other mobile devices from becoming infecting. With most malware prevention systems, users manually initiate a process to update their malware prevention system with a server. In the interim, however, their systems remain vulnerable to the new malware. With the growing popularity of smart phones and the potential for greater interaction between mobile phones, there is a need to be able to update mobile devices as soon as new malware is identified.

SUMMARY OF THE INVENTION

The following summary is intended to provide a simple overview as well as to provide a basic understanding of the subject matter described herein. It is not intended to describe or limit the scope of the claimed subject matter. Furthermore, this summary is not intended to describe critical or key elements of the claimed subject matter. Additional aspects and embodiments are described below in the detailed description.

CoreStats

The present invention is a system and method for reporting and visualizing worm and other virus attacks on mobile networks. The system and method provides a comprehensive means for collecting, reporting, and providing visual depictions of information regarding the propagation and effect of worms, viruses and other malware on a network. Malware and virus as used hereafter are meant to encompass a broad definition of malicious or harmful software. Carrier and enterprise network operators and managers use real-time statistics to understand the effects malware has on their networks and the mobile devices connected to their networks. Malware protection system updates are performed on mobile devices in the service provider's network as soon as new malware is detected and identified.

Malware Sample Collection

The present invention is a system and method for obtaining new malware samples once they start spreading within a mobile network, and sending those malware samples to an anti-virus or sample collection center for analysis. Collection agents are distributed within a mobile network at various network locations or sites. The collection agents collect executable programs that are being transferred through various protocols, e.g., Bluetooth and WiFi, using both mobile stations and key communication components in the network, e.g., a GGSN in a GSM network and a PDSN in a CDMA network. The system and method works by collecting data from distributed locations, thereby increasing the likelihood that a new malware sample are captured once it starts spreading.

BRIEF DESCRIPTION OF THE DRAWINGS

The claimed subject matter is described with reference to the accompanying drawings. In the drawings, like reference numbers indicate identical or functionally similar elements. Additionally, the left-most digit(s) of a reference number identifies the drawing in which the reference number first appears.

Fig. 1 is an block diagram of an exemplary network management system in accordance with an aspect of the subject matter described herein.

Fig. 2 is an block diagram of another exemplary network management system in accordance with an aspect of the subject matter described herein.

Fig. 3 is a block diagram of an exemplary deployment of a network management system.

Fig. 4 is a block diagram depicting exemplary the communications between a client mobile device and a network management system in accordance with an aspect of the subject matter described herein.

Fig. 5 is a flowchart illustrating an exemplary method for monitoring and mitigating malware in a mobile network in accordance with an aspect of the subject matter described herein.

Fig. 6 is an exemplary operator display screen of a malware per platform report in accordance with an aspect of the subject matter described herein.

Fig. 7 is an exemplary operator display screen of a malware spreading report in accordance with an aspect of the subject matter described herein.

Fig. 8 is an exemplary operator display screen of a user infection report in accordance with an aspect of the subject matter described herein.

Fig. 9 is an exemplary operator display screen of a sample virus producer report in accordance with an aspect of the subject matter described herein.

Fig. 10 is an exemplary operator display screen of a real time statistics report in accordance with an aspect of the subject matter described herein.

Fig. 11 is an exemplary network diagram illustrating various embodiments of collection agents in a mobile provider's network for collecting suspect data for analysis by the CoreStats Network Management System.

Fig. 12 is a flow chart diagram of an exemplary method utilized by collection agents.

DETAILED DESCRIPTION

CoreStats

Fig. 1 depicts an exemplary network management system **100**, also referred to herein as CoreStats, that provides for reporting and visualizing viruses on mobile networks. As used herein, the term "exemplary" indicates a sample or example. It is not indicative of preference over other aspects or embodiments. The network management system **100** includes a receiver component **102** that obtains or receives malware data for a mobile network (not shown). As used herein, the term "component" refers to hardware, software, firmware or any combination thereof. Malware data includes information related to the presence, spread, or effect of malware on a mobile network. In certain embodiments, the malware data includes a reference to particular devices infected or affected by malware. Such information is advantageous in tracking the spread of malware, as well as, controlling future transmission of malware between client mobile devices (*e.g.*, mobile phones, smart phones, portable digital assistants ("PDAs"), laptops and other mobile electronic devices), also referred to herein as client devices or mobile devices.

In another embodiment, the receiver component **102** obtains malware data from a plurality of sources, such as individual mobile devices, mobile network traffic and/or computer network traffic (*e.g.*, Internet Protocol (IP) packets). Malware data obtained from multiple sources provides a more complete picture of the current state of a mobile network.

Consequently, collection or receipt of information from a variety of sources facilitates the detection and analysis of the spread of malware.

An analysis component **104** receives information from the receiver component **102** regarding the presence, effects and types of malware impacting a mobile network. In an embodiment, the analysis component **104** is able to synthesize malware data received from the plurality of sources to better analyze the nature and effect of malware. In another embodiment, the analysis component **104** generates a malware analysis or report that details and describes instances of malware in the mobile network and the particular mobile devices affected by malware.

A malware data store **106** records malware related information including, but not limited to, malware analysis, reports or processed malware data generated by the analysis component **104**. In another embodiment, the malware data store **106** stores raw information gathered by the receiver component **102**. As used herein, the term "data store" refers to a collection of data (*e.g.*, database, file, cache). In an embodiment, any user specific information is stored in a secure data store to maintain customer privacy.

A user interface **108** utilizes reports and malware analysis generated by the analysis component **104** to provide operators with information regarding malware within the network. In an embodiment, the user interface **108** is implemented as a graphical user interface ("GUI") that renders graphic images that facilitate operator analysis of malware. The user interface **108** can be implemented utilizing a variety of hardware (*e.g.*, a display and input/output devices) and software. In an embodiment, the user interface **108** includes a monitor (*e.g.*, LCD, CRT) that displays malware reports and controllers, such as a keyboard, mouse, trackball, pointer or any other input/output device.

In a further embodiment, CoreStats **100** includes a mitigation component **110** that initiates and takes actions to mitigate or alleviate the impact of malware in a mobile network. The mitigation component **110** gathers information from the receiver component **102** as well as the malware analysis generated by the analysis component **104**. In an embodiment, the mitigation component **110** uses this information to dynamically change the parameters of the scanning algorithms utilized to detect the presence of malware either in network traffic or on individual mobile devices and to modify the malware detection algorithms used to identify malware. Some representative malware algorithms include, but are not limited to, malware signature searches; hash signature searches as described in U.S. Patent Application 11/697,647 "Malware Detection System and Method for Mobile Platforms"; and malware detection in headers and compressed parts of mobile messages as described in U.S. Patent Application 11/697,658 "Malware Detection System and Method for Compressed Data on Mobile Platforms".

CoreStats **100** assists mobile network administrators and operators in stopping malware from spreading by interacting with other network systems. In particular, once CoreStats **100** determines that a mobile station or mobile device is spreading malware, CoreStats **100** allows network administrators and operators to evaluate a range of options to help prevent the further spread of the malicious application to other mobile stations. One way is to associate CoreStats **100** with the mobile network administrator’s firewall so that the administrator can block identified malicious content. Another way is to report alarms upstream to operational support systems or OAM&P (Operations, Administration, Maintenance, and Provisioning) systems used by network service providers to manage mobile networks.

In another embodiment, CoreStats **100** facilitates malware prevention by informing mobile device users and/or taking preventative steps at the mobile device. Once CoreStats **100** identifies an infected user, network administrators or operators send messages to a user to alert them to the problem, force an update of the user's mobile device's anti-virus software and definitions, or even disable the mobile device's data connections altogether.

Turning now to **Fig. 2**, a network management system or CoreStats **100** is illustrated in greater detail. In an embodiment, the receiver component **102** includes a network analyzer **202** or packet sniffer that monitors network traffic. The network analyzer **202** can be implemented as software and/or hardware that intercepts and logs traffic passing over a network or a portion of a network. In an embodiment, the network analyzer **202** intercepts communications between the mobile network and a data network (*e.g.*, the Internet). In an alternate embodiment, the network analyzer **202** intercepts data within the mobile network.

Intercepted or "sniffed" data packets are analyzed by a data stream scanner or malware scanner **204** to identify malware present in the data packets and the addresses of the transmitting and/or receiving mobile device. Data is analyzed in real time packet by packet or stored and analyzed non-linearly. In some instances, the data packets may need to be reassembled in the proper order and the contents extracted before analysis can be done.

In a further embodiment, the receiver component **102** includes a client data server **206** that receives reports of viruses or other malware from one or more client mobile devices. Individual mobile devices utilize scanning software to determine when malware is present and transmit malware or infection reports to the mobile network. Some representative malware scanning algorithms for mobile devices include, but are not limited to, malware signature searches; hash signature searches as described in U.S. Patent Application 11/697,647 "Malware Detection System and Method for Mobile Platforms"; malware detection in headers and compressed parts of mobile messages as described in U.S. Patent Application 11/697,658 "Malware Detection System and Method for Compressed Data on Mobile Platforms"; malware modeling as described in U.S. Patent Application 11/697,642 "Malware Modeling Detection System and Method for Mobile Platforms"; malware modeling for limited access devices as described in U.S. Patent Application 11/697,664 "Malware Modeling Detection System and Method for Mobile Platforms"; and non-signature detection methods as described in U.S. Patent Application 11/697,668 "Non-Signature Malware Detection System and Method for Mobile Platforms". The malware reports include malware data, such as information regarding infected files, type, or name of infection. In an embodiment, the malware reports include device specific information such as current device hardware, software and/or an identifier for the infected mobile device (*e.g.*, telephone number).

In certain embodiments, malware data obtained by the network analyzer **202** and client data server **206** includes device-specific information. In particular, reports received by the client data server **206** include data identifying the particular device that detected the malware. The malware data received by the network analyzer **202** is correlated with data from the mobile network to identify the mobile device that transmitted the infected packet or packets. In both cases, the identity of the affected mobile device is determined. Such device specific information is critical in analysis and reaction to the presence of malware within a network.

The analysis component **104** processes or analyzes malware data received *via* the client data server **206**, the malware scanner **204**, and/or any other source. Malware may use a variety of techniques to spread and may even be designed to avoid detection. Monitoring a plurality of sources increases the likelihood of early detection of malware, before infection becomes widespread. In addition, use of data from multiple sources, as well as, historical data retrieved from the malware data store **106**, increases accuracy of the malware analysis. The resulting malware analysis is stored in a malware data store **106** and/or presented to operators *via* the user interface **108**.

The mitigation component **110** can take a variety of actions to lessen impact of malware present in the mobile network and/or to prevent introduction of additional malware. For example, the mitigation component **110** can include a scanner update component **208** that updates or reconfigures the malware scanner **204** to improve detection of malware. For example, when a new malware variant is discovered, the scanner update component **208** allows the malware scanner **204** to begin scanning for the new malware variant. In an embodiment, the user interface **108** presents operators with update options or suggestions. The operator utilizes the user interface **108** to control update of the malware scanner **204** *via* the scanner update component **208**. In another embodiment, the scanner update component **208** automatically reconfigures the malware scanner **204** based at least in part upon malware analysis by the analysis component **104**.

In another embodiment, the mitigation component **110** includes a network analyzer update component **210**. The network analyzer update component **210** reconfigures or modifies the network analyzer **202** to control which data packets are intercepted or selected by the network analyzer **202** for further analysis by the malware scanner **204**. Due to time and processing power constraints, analysis of all data packets by the network analyzer **202** may not be feasible. Accordingly, the network analyzer **202** selects a subset of the data packets for further analysis. The network analyzer **202** identifies certain packets for further evaluation based upon indicia of malware infection based on the various malware detection algorithms employed. For example, if a pattern of malware infection is identified as occurring in mobile devices after suspect mobile applications are downloaded from a specific internet site, the network analyzer **202** can be set to trigger capture of data from that site for further analysis. Suspect mobile devices thought to be infected with malware are also targeted to not only help stop the further spread of malware, but also provide network administrators additional information about how certain malware variants are spreading, so that the new ways of combating the spread of different malware variants can be developed. The network analyzer **202** also reassembles data packets and/or extracts contents when required. The network analyzer update component **210** updates indicia used to identify data packets for further analysis and increase the likelihood that infected packets are selected. In an embodiment, the user interface **108** presents operators with network analyzer **202** update options or suggestions. An operator directs update of the network analyzer **202** using the user interface **108**. Alternatively, the network management system **100** automatically triggers the network analyzer update component **210** based at least in part upon analysis of received malware data.

In still another embodiment, the mitigation component **110** includes a firewall update component **212** capable of updating or reconfiguring one or more firewalls (not shown) to prevent the spread of malware. As discussed in greater detail below, mobile networks frequently exchange data packets with data networks such as the Internet. Typically, a firewall is installed between the mobile network and the data network to prevent spread of malware between the networks. As malware infected identified sites or malware infected mobile devices are identified, the firewall is updated to prevent transmission of infected data packets between the networks. In the case of major worldwide virus or malware outbreaks, a firewall can quickly disrupt the flow of data between the mobile network and the Internet except for those sites specifically enabled or used by network administrators. In an embodiment, the user interface **108** presents operators with firewall update options or suggestions. An operator directs update of the firewall using the user interface **108**. In another embodiment, the firewall update component **212** automatically updates the firewall, based at least in part upon analysis of malware data.

In a further embodiment, the mitigation component **110** includes a mobile device communication component **214** that directs updates of malware scanners maintained on individual mobile devices. As described in further detail below, mobile devices include client malware scanners that detect malware or infection of the mobile device. These individual mobile device malware scanners can be updated to enhance detection of malware. In an embodiment, the mobile device communication component **214** identifies or prioritizes particular mobile devices for update. The mobile device communication component **214** transmits the updated malware scanner directions to the mobile network or particular mobile devices for installation. The update are based at least in part upon the analysis of malware within the mobile network, and are targeted to those mobile devices most susceptible to attack, for instance, heavy Internet data users. In another embodiment, an operator directs update of mobile devices through a user interface **108**.

In still a further embodiment, the mobile device communication component **214** helps stop the spread of malware using a Hybrid Intrusion Prevention System (HIPS). In HIPS, the client device has software installed which controls the access of downloaded applications.

Whenever CoreStats **100** detects possible malicious activity, the mobile device communication component **214** sends a message to the client device, which in turn issues a warning to the user before executing the downloaded application or asks the user permission to delete the downloaded application. HIPS allows the network analyzer **202** and malware scanner **204** and analysis component **104** additional time to thoroughly scan a downloaded application while not becoming unnecessarily intrusive to the user or delaying the download of the application.

Referring now to **Fig. 3**, an exemplary deployment of a sample CoreStats system **100** in a network environment is depicted. Fig. 3 illustrates a deployment of CoreStats **100** between the edge of a mobile network **302** and the Internet **304**, although it can also be deployed effectively at various other points in the mobile network **302** depending upon the network topology and desired coverage. The network analyzer **202** monitors and evaluates all traffic going from the mobile network **302** to the public data networks (*e.g.*, the Internet **304**) and vice-versa. The network analyzer **202** can intercept packets on either side of a firewall (not shown).

In an embodiment, CoreStats **100** monitors a mobile network (or operator's network) **302** by monitoring or packet sniffing IP packets passing from the Gateway General Packet Radio Service ("GPRS") Support Node or Gateway GPRS Support Node ("GGSN") **306** and the Internet **304**. In an embodiment, CoreStats **100** is deployed between the edge of the mobile network **302** and the Internet **304**. The GGSN **306** links the access dependent Radio Access Network (RAN), shown on the figure as the mobile network **302**, to the access independent Internet **304**. RAN comprises the entire radio/wireless network with a variety of protocols for data transfer (*e.g.*, CDMA ,GPRS, 802.11). The GGSN **306** acts as a gateway between the mobile network **302** and the Internet **304**, converting access-specific packet data to IP packets and vice-versa. As discussed above, the intercepted packets are processed by the malware scanner **204** and the resulting malware data is provided to the analysis component **104.**

In another embodiment, CoreStats **100** receives communications from mobile client devices (also referred to as mobile devices or client devices) **308**. In certain embodiments, mobile client devices **308** include a client malware scanner **310** capable of detecting malware on mobile client devices **308**. Once malware is detected, the client malware scanner **310** generates an infection report **404** that provides malware data to the receiver component **102** of the CoreStats system **100**. The malware data can be used to reconfigure the malware detection algorithms for malware in the network malware scanner **204** and client malware scanners **310**.

Turning now to **Fig. 4**, a block diagram depicting communication between CoreStats **100** and a mobile device **308** is illustrated. In one embodiment, upon detecting malware, a mobile device **308** generates or updates an internal log file (or log file) **402**, recording malware information. The internal log file **402** can be plain text containing the name of the infected file and the name of the malware that infected the file as a semi-colon delimited text file. An exemplary entry in the log file is recorded as follows:

"C:\CinBell_Viruses.zip - Cabir.D(sis); C:\CinBell_Viruses\3d_oidi500.sis-Cabir.D(sis); C:\CinBell_Viruses\autoexecdaemon.SIS - Cabir.gen(app);".

In a further embodiment, the client malware scanner **310** generates an infection report **404** that contains information about the detected malware and transmits the infection report **404** to the client data server **206** of CoreStats **100**. Report generation transmission is automatically triggered (pushed) upon detection of malware or based upon a periodic fixed time interval. Alternatively, infection reports **404** are maintained in the client device internal log file **402** until queried (pulled) by CoreStats **100**. In yet another embodiment, infection reports **404** are delivered to CoreStats **100** using some combination of pulling and pushing. Infection reports **404** are transmitted, for example, using hypertext transfer protocol (http), file transfer protocol (ftp), or any packet data transmission method as would be generally known in the art.

Infection reports **404** typically comprise information such as, but not limited to, detailed virus/threat vector information and mobile device related information, including type of mobile device **308**, operating system, software and versions, and user information and mobile device **308** identifier. In an exemplary embodiment, the infection report **404** contains product identification that identifies the client malware scanner **310** software. For example, product identification includes, but is not limited to, a product identifier, major version identifier, minor version identifier and also a patch version as follows: "productid + majorversion + minorversion + patchversion." The infection report **404** can also include the infected filename and a unique identifier for the infected application, the name of the malware infection and the date and time of the infection. In addition, the infection report **404** can include mobile device **308** information, such as the identification of the mobile phone (*e.g.*, phone number), firmware of the particular mobile device **308** (*e.g.*, operating system information) and the software version of the mobile device **308**.

Referring once again to **Fig. 4**, in certain embodiments, transmission of an infection report **404** sent from the mobile device **308** to CoreStats **100** triggers transmission of an acknowledgement **406** from CoreStats **100** to the mobile device **308**. Receipt of the acknowledgement **406** triggers the mobile device **308** to delete the existing infection report **404** maintained in the internal log file **402.** When the mobile device **308** next detects a virus, the mobile device **308** creates a new infection report **404**. In an embodiment, the mobile device **308** continues to send the infection report **404** until an acknowledgement **406** is received from CoreStats **100**, ensuring that the infection report **404** is received. This embodiment provides a primitive datagram delivery acknowledgement mechanism for simple protocols such as User Datagram Protocol (UDP). Deleting the infection report **404** after receipt of an acknowledgement **406** is advantageous in that CoreStats **100** is less likely to receive duplicated information about old virus infections from mobile devices **308**. Infection reports from CoreStats **404** are transmitted only for current infections. In addition, mobile devices **308** are less burdened memory-wise since they need to retain infection reports **404** locally for a relatively small duration of time. This is particularly advantageous since many mobile devices **308** have limited memory resources. Similarly, simple protocols stacks such as UDP are relatively easy to implement and require small internal state machines, further simplifying the design of malware scanning applications for mobile devices **308**.

Turning once again to **Fig. 3**, one function of the CoreStats system **100** is information gathering. CoreStats obtains information regarding malware form a plurality of sources, including individual mobile device, network traffic analysis and data traffic analysis. In certain embodiments, CoreStats **100** includes a malware data store **106** to store the information gathered by CoreStats **100**. In an embodiment, user specific information is stored in a secure data store to maintain customer privacy.

In an exemplary embodiment, the malware data store **106** maintains information obtained based upon network traffic analysis, including, but not limited to, Internet protocol (IP) address of the network level packet analyzer and the time at which the packet was detected. The malware data store **106** maintains records regarding the infected data, such as virus name, infected file name, infected file size, infected packet size and infected packet number. The malware data store **106** also maintains packet source related information, such as the source IP, source port and even source identifier (*e.g.*, phone number). Moreover, destination information such as destination IP address, destination port and destination phone number can be recorded for analysis and reporting. The malware data store **106** can also maintain a record of the particular protocol name used for transmission of the packet.

In another embodiment, the malware data store **106** maintains malware analyses, such as reports generated by the analysis component **104**. The reports or malware analyses generated by the analysis component **104** is maintained for use in further analysis, presentation to an operator *via* a user interface **108** or use in mitigation of malware effects on a mobile network **302**. The malware data store **106** is maintained locally within CoreStats or may be remotely located.

In certain embodiments, the analysis component **104** analyzes and correlates malware data obtained by the receiver component **102** and/or maintained by the malware data store **106**. In particular, the analysis component **104** correlates data obtained from a variety of sources (*e.g.*, network traffic, data network traffic and individual mobile devices **308**). One function of CoreStats **100** is to assist mobile network administrators and operators to monitor threats to the mobile network **302** thereby identifying the mobile network's **302** vulnerability to malware. Early detection of the vulnerability helps them take better preventative measures. CoreStats **100** reports the spreading pattern of malware using collected information from individual mobile devices **308** as well as the network traffic. On the mobile network **302**, malware can spread over using short range transmission protocols (*e.g.*, Bluetooth, Infrared), long range or standard network protocols (*e.g.*, TCP/IP, Messaging) or a combination of short and long range protocols. Hence, in order to facilitate reports of infections and spreading patterns of malware across the mobile network **302**, CoreStats **100** uses information regarding the infections found in mobile devices **308** as well as those malware found in the network traffic by the network analyzer **202** and malware scanner **204**. In particular, CoreStats **100** can generate spreading statistics of long range malware, such as malware that spreads using the mobile network **302** via TCP/IP, Messaging, and/or other protocols. Furthermore, CoreStats **100** can generate spreading statistics of short range malware, such as malware that spreads over Bluetooth, memory cards, or other means without being transported across the mobile network **302**.

One feature of CoreStats **100** is the ability to present data to operators showing correlation between infections found in the mobile device **308** and those found in the network traffic. Operators can draw useful conclusions based on this and other correlations. For example, if a larger number of infections are found on mobile devices **308** compared to the number of infections found on the mobile network traffic, it is likely that short range protocols are more prominent than long range protocols in spreading a particular kind of malware through the mobile network **302**. Accordingly, efforts to prevent further spread of the malware may be focused on short range protocols.

In certain embodiments, the CoreStats system **100** is able to provide operators with detailed information regarding malware activities in a mobile network **302**. In an embodiment, the CoreStats system **100** provides information relating to the density, distribution, geography, type, *etc.* of infected mobile devices **308** in the mobile network **302**. In another embodiment, CoreStats **100** provides information relating to the infected network traffic itself, such as malware identification, traffic patterns and topologies, and the like. In yet another embodiment, CoreStats **100** computes vulnerability of particular mobile devices **308** based on acquired heuristic data about infected mobile devices **308**, protocols used, type of malware and the like.

In still another embodiment, CoreStats **100** determines vulnerability of a mobile network **302** to certain kinds of malware.

With reference to **Fig. 5**, a flowchart depicting a methodology **500** associated with malware monitoring, detection and mitigation is illustrated. For simplicity, the flowchart is depicted as a series of steps or acts. However, the methodology **500** is not limited by the number or order of steps depicted in the flowchart and described herein. For example, not all steps may be necessary; the steps may be reordered, or performed concurrently.

Turning now to **Fig. 5**, a flowchart depicting an exemplary methodology **500** for mobile network management is illustrated. At reference number **502** malware data is obtained. In an embodiment, malware data is obtained from a plurality of sources, such as individual mobile devices **308**, mobile network traffic and a computer network. In another embodiment, malware data includes information that specifies a particular mobile device or devices **308** affected by malware. For example, the malware data can include an identifier for the mobile device **308** reporting the malware or an identifier for the mobile device **308** sending and/or receiving a data packet containing malware.

At reference number **504**, the malware data is analyzed and/or correlated. An analysis component **104** generates a malware analysis and/or statistics describing malware activity as well as other pertinent network statistics useful in quantifying relative levels of malware activity. In an embodiment, historical malware data is retrieved from a malware data store **106** utilized in the analysis. In particular, changes in malware activity levels or types and spread of malware over time is examined. In another embodiment, analysis also includes examination of spreading patterns and possible prediction of future spreading of malware. The obtained malware data as well as malware analyses (*e.g.*, statistical information and predictions) are recorded in a malware data store **106** at reference number **506**.

At reference number **508** a determination is made as to whether to generate output, such as a report or alert. The determination can be based in whole or in part upon the malware data obtained from various sources. For example, if analysis indicates high levels of malware activity or significant impact on mobile network **302** performance, the determination is made to generate a report and alert or notify network administrators. Alternatively, reports are triggered periodically or upon operator request. In particular, operators can request particular reports *via* a user interface **108.**

If the determination is made to generate output, one or more reports or alerts are generated at reference number **510**. Such reports can include information for presentation for an operator, stored for later use, or used in determining appropriate mitigation. If no reports are to be generated, or after generation is complete, the process continues at reference number **512**, where a determination is made as to whether to take action to mitigate the effects of malware on the mobile network. If no action is to be taken, the process terminates. If mitigating actions are to be taken, the process continues at reference number **514**.

Mitigating actions include preventative steps to avoid or inhibit spreading and/or effects of malware in the mobile network **302**. In an embodiment, mitigating actions include update of a network analyzer and or malware scanner to capture and identify additional types of malware. In still other embodiments, a mitigation component **110** notifies a mobile device **308** user, force an update of mobile device **308** software, or even disable the mobile device's **308** data connections.

Referring now to **Figs. 6–10**, exemplary user interface displays are illustrated. As discussed above, CoreStats **100** also performs report generating functions. The analysis component **104** uses both stored and real-time information, including network traffic and individual user information, to generate statistics and dynamic graphs depicting malware activity and network statistics necessary to quantify relative levels of malware activity. For example, the analysis component **104** generates malware analyses, which can be presented by a user interface **108** as straightforward visual reports to alert managers and operators as to which platforms are infected with the most viruses, which viruses are spreading the fastest, the most recently infected mobile devices **308**, and which infected mobile devices **308** are spreading the most viruses.

Referring to now to **Fig. 6**, a sample malware per platform report **600** is illustrated. The malware per platform report **600** illustrates which platforms are infected with the most malware. The sample malware per platform report **600** comprises option selections **602** for generating a report regarding a selectable interval of time in the past **604** or the most current period of time **606**. The report **600** is presented on a display screen **610,** as shown. Alternatively, reports **600** are exported **608** to a data structure. For example, reports **600** are output to semi-colon delimited text files. When presented on a display screen **610,** the data is presented any number of ways including, for example, a graphical representation **612** of the number of viruses per platform.

Fig. 7 illustrates a sample malware spreading report **700.** The sample malware spreading report **700** indicates which malware are spreading the fastest throughout the mobile network **302**. The sample malware spreading report **700** comprises option selections **702** for generating a report regarding a selectable interval of time in the past **704** or the most current period of time **706**. The report **700** is presented on a screen **710** or exported **708** to a data structure. For example, the report **700** is output to a semi-colon delimited text file. When presented on a display screen **710,** the data is presented any number of ways including, for example, a graphical representation **712** of the number of instances of each virus detected in the mobile network **302**.

Referring now to **Fig. 8**, a sample user infection report **800** is illustrated. The sample user infection report **800** shows recently infected users. In an embodiment, the sample user infection report **800** comprises option selections **802** for generating a report **800** regarding a selectable interval of time in the past **804** or the most current period of time **806**. The report **800** is presented on a display screen **810** or is exported **808** to a data structure. For example, the report **800** is exported to a semi-colon delimited text file. When presented on a display screen **810,** the data is presented any number of ways including, for example, a text list **812** of which platforms are infected by which viruses.

Fig. 9 depicts a sample virus producer report **900.** The virus producer report **900** shows which users are responsible for spreading the most malware. The virus producer report **900** comprises option selections **902** for generating a report regarding a selectable interval of time in the past **904** or the most current period of time **906**. The report **900** is presented on a display screen **910** or exported **908** to a data structure. For example, the report **900** is exported to a semi-colon delimited text file. When presented on a display screen **910,** the data is presented any number of ways including, for example, a text list **912** of which platforms are infected by, and therefore likely to be, spreading the most viruses.

Referring now to **Fig. 10**, an exemplary real time statistics report **1000** is illustrated. The real time statistics report **1000** indicates which components of a mobile network **302** are indicating the presence of malware. In an embodiment, a display of the real time statistics reports **1000** has a configurable dashboard **1002.** In another embodiment, the dashboard provides metrics on mobile device malware **1004**, malware detected during scanning of MMS messages **1006**, malware detected as traffic arriving from the Internet through a gateway **1008**, or malware detected in the wireless network **1010**.

In other embodiments, the analysis component **104** generates additional reports, including the growth of individual viruses over time, infected subscriber information, dynamic virus threat level assessment and loss of operator revenue due to malware traffic. A simple calculation of the loss of operator revenue is based on the following function: Revenue Lost = (Amount of virus traffic) * (Revenue per Byte of data transfer). Other functions and metrics for loss of system performance, bandwidth utilization, capacity degradation, and other metrics can be formed by one of ordinary skill in the art.

CoreStats **100** typically operates as a stand-alone system with some associated virus scanning modules running independently in user mobile devices **308** to aid in reporting and visualizing viruses on mobile networks **302**, monitoring the current status of virus infections on a mobile network **302**, evaluating the potential threat posed by a new or spreading virus, and providing the tools necessary to evaluate the challenge and initiate corrective actions. CoreStats **100** also integrates with other operational support systems, reporting alarms upstream to typical OAM&P (Operations, Administration, Maintenance, and Provisioning) systems used by network service providers to manage their mobile networks **302**. In other embodiments, CoreStats **100** is an application that operates inside the mobile network **302**, at the edge of the mobile network **302**, inside a GGSN **306**, or in a combination of locations. As one familiar in the art would appreciate, these are merely exemplary embodiments of the invention for illustration purposes only, and are not intended to limit the invention to any particular configuration or topology.

CoreStats **100** can be implemented using a general purpose computer. More particularly, a general purpose computer including a processor, memory and a system bus that couples the processor and memory can be used to implement CoreStats **100**. The processor can be a microprocessor, microcontroller, or central processor unit (CPU) chip and printed circuit board (PCB). Any suitable bus architecture can be utilized to connect the processor and memory. System memory can include static memory such as erasable programmable read only memory (EPROM), electronically erasable programmable read only memory (EEPROM), flash or bubble memory, as well as volatile memory, such as random access memory (RAM). In addition, the system can include storage media, such as hard disk drive, tape drive, optical disk drive or any other suitable media.

The system can also include various input devices, including a keyboard, mouse stylus, and the like, connected to the processor through the system bus. In addition, the system can include output devices, such as monitors, on which the operators can view the generated reports. Additionally, the system can be connected *via* a network interface to various communications networks (*e.g.*, local area network (LAN) or wide area network (WAN)).

Malware Sample Collection System

Referring now to the network diagram depicted in Fig. 11, a malware sample collection system **1100** is shown for obtaining samples of executable code that are spreading within a mobile network **302** and sending those samples to a sample collection center **1112** for analysis. In particular, collection agents, or Honeypots, **1102** are distributed within a mobile network **302** at various network locations or sites to collect executable programs being monitored by a protocol handler, e.g., Bluetooth **1114a** and WiFi **1114b**, (each being a type of protocol handler **1114**), using both mobile stations and key communication components in the network, e.g., a

GGSN in a GSM network and a PDSN in a CDMA network. The system **1100** collects the samples containing executable code from distributed locations, thereby increasing the likelihood that a new malware sample is captured once it starts spreading.

In operation, malware infected devices, such as Bluetooth devices **1106** and WiFi devices **1104** send connection attempts via a Bluetooth protocolo handler **1114a** or a Wi-Fi protocol handler **1114b** respectively. A collection agent **1102** accepts the incoming call attempts from the malware infected devices **1104**, **1106** and forwards any transferred executables to a sample collection center **1112** of a network management system **100**, such as CoreStats **100,** using the provider's mobile network **302**. Calls from the collection agent **1102** may be switched through the provider's mobile network **302** using a wireless data connection **1108e**. Alternatively, the a collection agent **1102** may send information to the sample collection center **1112** across a Public Switched Telephone Network, or PSTN (not shown).

In another embodiment, an Internet enabled mobile device **308** attempting to download an executable from a remote server typically uses TCP/IP and the Web to facilitate the download. The IP packets **1108d** from the Internet enabled mobile device **308** are switched at a switching center **1110**, typically an MSC or MTSO, to a Gateway **306**, which is typically a GGSN (Gateway GPRS Support Node) or PDSN (Packet Data Serving Node), that routes the IP packets **1108d** to the Internet **304**. In this embodiment, the IP sniffer, or network analyser **202**, functions as a collection agent **1102** of the present invention and monitors the connection between the Internet **304** and the Gateway **306**, forwarding all sampled executables to the sample collection center **1112**.

Collection Agents

A collection agent **1102**, **202** is a device which is placed at various points in the mobile network **302** in order to collect samples being transmitted over the network executables, wherein a sample is transmitted data containing executable code. The type of collection agent **1102**, **202** and the protocols monitored by the protocol handlers **1114a, 1114b** are dependent not only upon the anticipated data loads and protocols being transmitted, but also on the mechanism used by the malware to accomplish its tasks, if known. The use of two types of collection agents, e.g., honeypots **1102** and network sniffers or analyzers **202**, provides a network service provider the best opportunity for early detection of malicious applications before they have had a chance to proliferate widely across a service provider's mobile network **302**.

Honeypots: Honeypots, collection agent **1102,** are typically stand-alone devices that have open network ports for unobtrusively accepting messages that are broadcast or specifically sent to them from malware infected mobile devices **1104**, **1106**. A typical feature of many malicious applications is that they attempt to forward copies of themselves automatically to other networked devices **308**, thereby allowing themselves to spread through the mobile network **302** like a virus. It is possible for malicious applications to copy themselves to nearby mobile devices **308** using ad hoc or similar point-to-point type networks, instead of across the much larger service provider's mobile network **302**. This makes it difficult, if not impossible, for the service provider to detect malware because the malware may not be transmitting across the service provider's mobile network **302**. A person with a malware infected mobile device **1104**, **1106** may during the course of single day come into range of tens, if not hundreds, of other mobile devices **308**, possibly infecting many of them. In such cases, the malware may be discovered only at a later date when much of the damage has already been done. Therefore, honeypots **1102** allow earlier detection of malicious applications by virtue of the fact that they are not in the core of the service provider's mobile network **302**, as a network analyzer **202** collection agent would be, but rather are spread strategically in the periphery.

Honeypots **1102** can be configured with a Bluetooth protocol handler **1114a** and a Wi-Fi protocol handler **1114b**. Bluetooth enabled honeypots **1102** are mobile devices **308** or laptops that are placed in areas where there is typically a lot of wireless communication. The aim is to capture Bluetooth broadcast messages **1108b** containing malicious executables sent from other nearby Bluetooth enabled, malware infected mobile devices **308**. Target areas include airports, restaurants, downtown areas, and public parks. Wi-Fi enabled honeypots **1102** are mobile devices **308** or laptops that are placed in areas where there is a possibility of hacking and illegal access taking place. The aim is to allow illegal access of the honeypot collection agent **1102** in order to capture the malicious executable files sent using the Wi-Fi protocol **1108a** from malware infected mobile devices **1104**. Target areas include banks and stock exchanges.

Because such honeypot collection agents **1102** can be installed in locations outside of the provider's mobile network **302**, calls from such collection agents **1102** may be switched across the Public Switched Telephone Network, or PSTN (not shown). Preferably such collection agents **1102** are switched through the provider's mobile network **302**, when possible, as shown by wireless data connection **1108e,** to reduce potential calling costs with other service providers.

In different embodiments, honeypot collection agents **1102** use a number of communication interfaces to connect to a sample collection center **1112** of a network management system **100**. For example, such communication interfaces may include placing calls over telephony interfaces such as POTS lines or Plain Old telephone Service, ISDN, or other bearer channel technologies, or using data communication networks such as legacy serial or packet-based networks, TCP/IP, xDSL, and fiber-based technologies. Additionally, such collection agents **1102** use wireless interfaces including, but not limited to, WiFi, IEEE 802.11 or more generically 802.x wireless interfaces.

Network Sniffers: Network analyzer **202** collection agents that monitor the service provider's mobile network **302** for transmission of malware applications are strategically placed in a service provider's mobile network **302** to intercept all, or nearly all, applications and forward them to a sample collection center **1112** of a network management system **100** for analysis. Network sniffers or analyzers **202** collection agents are capable of monitoring Internet traffic for downloads of executable applications by mobile devices **308**.

For applications being downloaded from remote servers using TCP/IP and the Internet **304**, computers and servers act as IP sniffers, or network analyzers **202** to intercept and collect executable applications found within the normal flow of network traffic to and from the Internet. TCP/IP sniffers are generally placed behind GGSN or PDSN nodes, or Gateways **306**, ensuring that all the traffic flowing between the Internet **304** and the Internet enabled mobile devices **308** on the service provider's mobile network **302** are constantly monitored for malware applications.

Design and Operation of Collection Agents

Referring now to the flow chart diagram depicted in Fig. 12, a collection agent **1102, 202** monitors **1202** a protocol via a protocol handler **1114a, 1114b** for data samples that contain executable code. If a sample does not contain executable code, the collection agent **1102, 202** discards the sample.

If at reference number **1202**, the collection agent **1102, 202** determines that a sample contains executable code, the collection agent **1102, 202** accepts and stores **1204** the executables, and the proceeds to reference number **1206** to check the executable and determine if the executable is for a mobile device **308**. If the collection agent **1102, 202** determines that the executable code of the sample is not targeted for a mobile device **308**, the collection agent **1102, 202** disgards the executable.

Proceeding to reference number **1208**, the collection agent **1102, 202** determines if it is configured to collect only malware infected executables and if it is, the collection agent **1102, 202** proceeds to reference number **1210** wherein it first scans **1210** the executable for malware . If the executable sample does not contain maleware, the collection agent **1102, 202** discards the sample. If the executable sample does contain malware, the collection agent **1102, 202** proceeds to reference number **1212** to determine if the executable has been previously seen and sent to the sample collection center **1112**. Returning to reference number **1208**, if the collection agent **1102, 202** is not configured to collect only malware, the collection agent **1102, 202** skips the scanning **1210** operation and continues directly to reference number **1212**.

At reference number **1212, if** the executable has been seen previously by the collection agent **1102, 202**, the collection agent **1102, 202** notifies **1216** the sample collection center **1112** that the malware is being seen and identified again. If the executable has been seen previously by the collection agent **1102, 202,** the collection agent **1102, 202** sends **1214** the sample executable to the sample collection center **100** for further analysis and reporting, such as discussed above with CoreStats **100**.

Collection agents **1102**, **202** have the following general functionalities: monitoring **1202** a specific protocol via a protocol handler **1114a, 1114b** for data samples having executable content; accepting **1204** such samples having executable content that are transferred through the protocol; checking **1206** if the executable is specifically for mobile devices **308** by looking at the executable file format, if it is not specifically for mobile devices **308**, then ignoring the executable; and, sending **1214** the entire executable using a secure network connection (e.g., https) or a wireless data connection **1108e** to the sample collection center **1112**, such as CoreStats **100** discussed above. Alternatively, a collection agent **1102**, **202** selectively forwards executables after checking **1206** to see if the executable is for a mobile device **308**. In this embodiment of the invention, the collection agent **1102**, **202** checks to see if it is configured **1208** to collect only malware infected applications and if it is, then it first scans **1210** the executable for malware and only proceeds if malware is detected. Next, the collection agent **1102**, **202** proceeds to determine **1212** if that executable has already been sent to the malware collection center. If a collection agent **1102**, **202** determines **1212** that the executable has already been sent to the sample collection center **1112**, the collection agent **1102, 202** only notifies **1216** the sample collection center **1112** of the new occurrence of the executable. Alternatively, collection agent **1102**, **202** notifies **1216** the sample collection center **1112** of the number of times it has seen the executable. If this is a new executable however, it sends **1214** the executable to the sample collection center **1112** for analysis and reporting.

The design, both hardware and software, of a collection agent **1102**, **202** depends on its location in the service provider's mobile network **302**. A honeypot collection agent **1102** for receiving Bluetooth **1108b** communications via a Bluetooth protocol handler **1114a** and Wi-Fi **1108a** communications via a WiFi protocol handler **1114b** contains devices with Bluetooth and/or Wi-Fi receivers. Typically, a collection agent **1102** maintains an open Bluetooth **1108b** or Wi-Fi **1108a** port at all times. The honeypot collection agent **1102** accepts all incoming mobile executables transferred to it on Bluetooth **1108b** or Wi-Fi **1108a**. The honeypot collection agent **1102** then automatically sends the executable file to a sample collection center **1112** server, such as in CoreStats **100**, through a secure connection (e.g., https) or a wireless data connection **1108e**. A Bluetooth enabled honeypot collection agent **1102** is placed in crowded areas like airports, coffee shops, and restaurants since Bluetooth is a short range protocol. Wi-Fi enabled honeypot collection agents **1102** have somewhat more extended ranges, but are similarly placed in airports, coffee shops, and restaurants, but are also placed in places where wireless security may be an issue such as office buildings, banks and stock exchanges.

An IP sniffer, or network analyser **202** collection agent is typically placed at the point of connection between a gateway **306** and the Internet **304**. Mobile devices **308** access and download applications from remote servers on the Internet **304** through a gateway **306** called a Gateway GPRS Support Node (GGSN) or Packet Data Serving Node (PDSN). To obtain all executables arriving from the Internet **304**, the IP sniffer, or network analyser **202** collection agent is placed behind the GGSN (or PDSN) and monitors the connection to the Internet **304**. This collects all mobile executables downloaded from the Internet **304** and forwards them to a sample collection center **1112** of a network management system, e.g., CoreStats **100**. Since the data is accessed at the network level, packets may be out of order when collected. The IP sniffer, or network analyser **202** collection agent re-assembles the data in the correct order before forwarding the entire executable file to the sample collection center **1112**.

The collection agent **1102**, **202** can be implemented using a general purpose computer. More particularly, a general purpose computer including a processor, memory and a system bus that couples the processor and memory can be used to implement the collection agent **1102**, **202**. The processor can be a microprocessor, microcontroller, or central processor unit (CPU) chip and printed circuit board (PCB). Any suitable bus architecture can be utilized to connect the processor and memory. Computer system memory can include static memory such as erasable programmable read only memory (EPROM), electronically erasable programmable read only memory (EEPROM), flash or bubble memory, as well as volatile memory, such as random access memory (RAM). In addition, the computer system can include storage media, such as hard disk drive, tape drive, optical disk drive or any other suitable media. In an alternate embodiment, the collection agent **1102**, **202** is integrated with a mobile device **308** or any suitable network equipment in the service provider's mobile network **302**. In an alternate embodiment, the collection agent **1102**, **202** is one or more processes running on a mobile device **308** or any of the service provider's mobile network **302** equipment.

The above exemplary embodiment describes a system and method to collect potential malware applications from distributed locations throughout a service provider's mobile network **302**, increasing the likelihood that new malware samples are captured once they start spreading. Early detection of malware allows preventative measures to be taken sooner, potentially preventing or at least reducing any damage the malware will ultimately cause.

Conclusion

While various embodiments have been described above, it should be understood that the embodiments have been presented by way of example only, and not limitation. It will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the subject matter described herein and defined in the appended claims. Thus, 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.

What is claimed is:

1. A system that monitors malware within a mobile network, comprising:

a receiver component that obtains data regarding the malware in the mobile network, said data is obtained from a first source and a second source, said first source is of a different type than said second source; and

an analysis component that generates a malware analysis of the mobile network as a function of said data.

2. The system of claim 1, said first source and said second source are each selected from the group consisting of: a mobile phone, a malware collection agent, a BlueTooth enabled mobile device, a WiFi enabled mobile device, an IEEE 802.x enabled mobile device, a network traffic analyzer, a firewall, a network switch, a network router, a gateway, a network management system, and an OAM&P network management system.

3. The system of claim 1, said first source is at least one mobile device and said second source is a network traffic analyzer.

4. The system of claim 1, further comprising a mitigation component that mitigates an effect of the malware based at least in part upon said malware analysis.

5. The system of claim 4, said mitigation component takes a preventative action, said preventative action is selected from the group consisting of: generation of an alert for transmission to a mobile device, direction of update of scanner software of said mobile device, and disablement of a data connection of said mobile device.

6. The system of claim 1, further comprising:

a network analyzer component that obtains a data packet; and

a malware scanner that evaluates said data packet and generates said data.

7. The system of claim 1, further comprising a client data server that obtains said data from a mobile device within the mobile network.

8. The system of claim 1, said data includes mobile device specific information.

9. The system of claim 1, said malware analysis includes a spreading pattern based upon correlation of said data from said first source and said second source.

10. The system of claim 1, further comprising a communication component that provides an update to a malware scanning algorithm at said first source.

11. A method of monitoring a mobile network, comprising:

obtaining a malware data from which mobile device identity information is derived; and

processing said malware data to produce a malware analysis that facilitates operator comprehension of a malware on the mobile network.

12. The method of claim 11, further comprising:

receiving said malware data from a mobile device; and

transmitting an acknowledgement of receipt of said malware data, said mobile device deletes said malware data based upon said acknowledgement.

13. The method of claim 11, said obtaining further comprising receiving said malware data from a first source and a second source, said first source is of a different type than said second source and said first source and said second source are each selected from the group consisting of: a mobile phone, a malware collection agent, a BlueTooth enabled mobile device, a WiFi enabled mobile device, an IEEE 802.x enabled mobile device, a network traffic analyzer, a firewall, a network switch, a network router, a gateway, a network management system, and an OAM&P network management system.

14. The method of claim 11, further comprising mitigating effects of said malware.

15. The method of claim 14, said mitigating further comprises updating a firewall associated with the mobile network based at least in part on said malware analysis.

16. The method of claim 14, said mitigating further comprises directing a network analyzer to intercept data packets for malware scanning based at least in part on said malware analysis.

17. The method of claim 14, said mitigating further comprises updating a network malware scanning algorithm based at least in part on said malware analysis.

18. The method of claim 14, said mitigating further comprises updating a malware scanning algorithm of a mobile device based at least in part on said malware analysis.

19. A system that facilitates mitigation of malware in a mobile network, comprising:

means for scanning data to obtain first malware data obtained from a first source and second malware data obtained from a second source, said first source is of a different type than said second source; and

means for generating a malware analysis based at least in part upon said first malware data and said second malware data.

20. The system of claim 19, said first source and said second source are each selected from the group consisting of: a mobile phone, a malware collection agent, a BlueTooth enabled mobile device, a WiFi enabled mobile device, an IEEE 802.x enabled mobile device, a network traffic analyzer, a firewall, a network switch, a network router, a gateway, a network management system, and an OAM&P network management system.

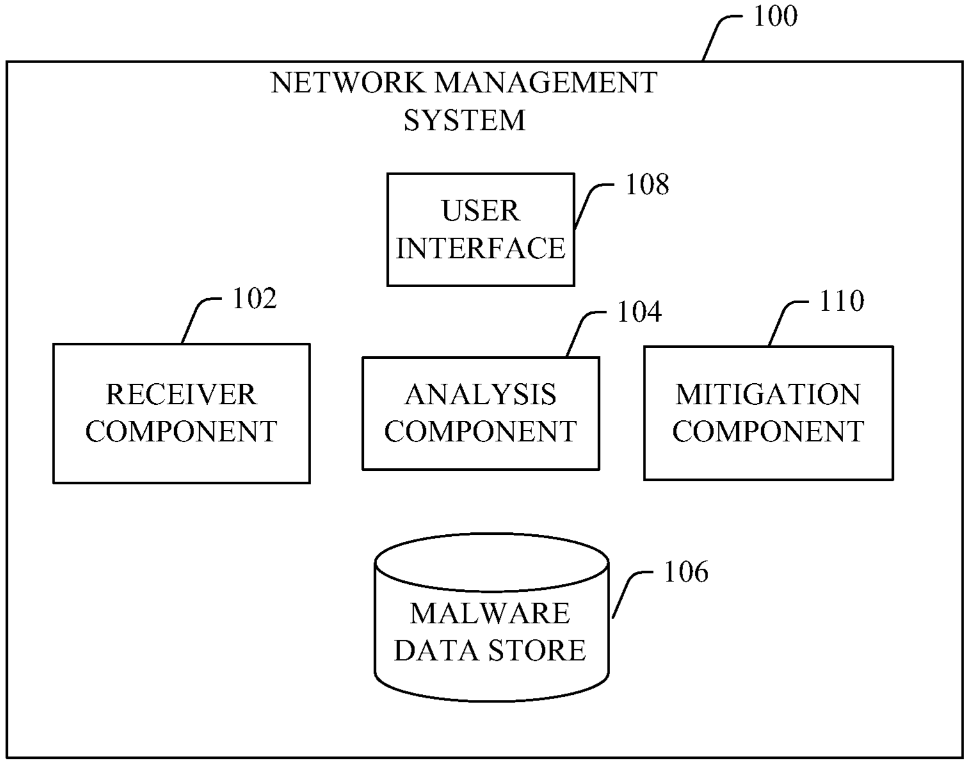

100
NETWORK MANAGEMENT SYSTEM
USER INTERFACE
108
102
RECEIVER COMPONENT
104
ANALYSIS COMPONENT
110
MITIGATION COMPONENT
MALWARE DATA STORE
106

FIG. 1

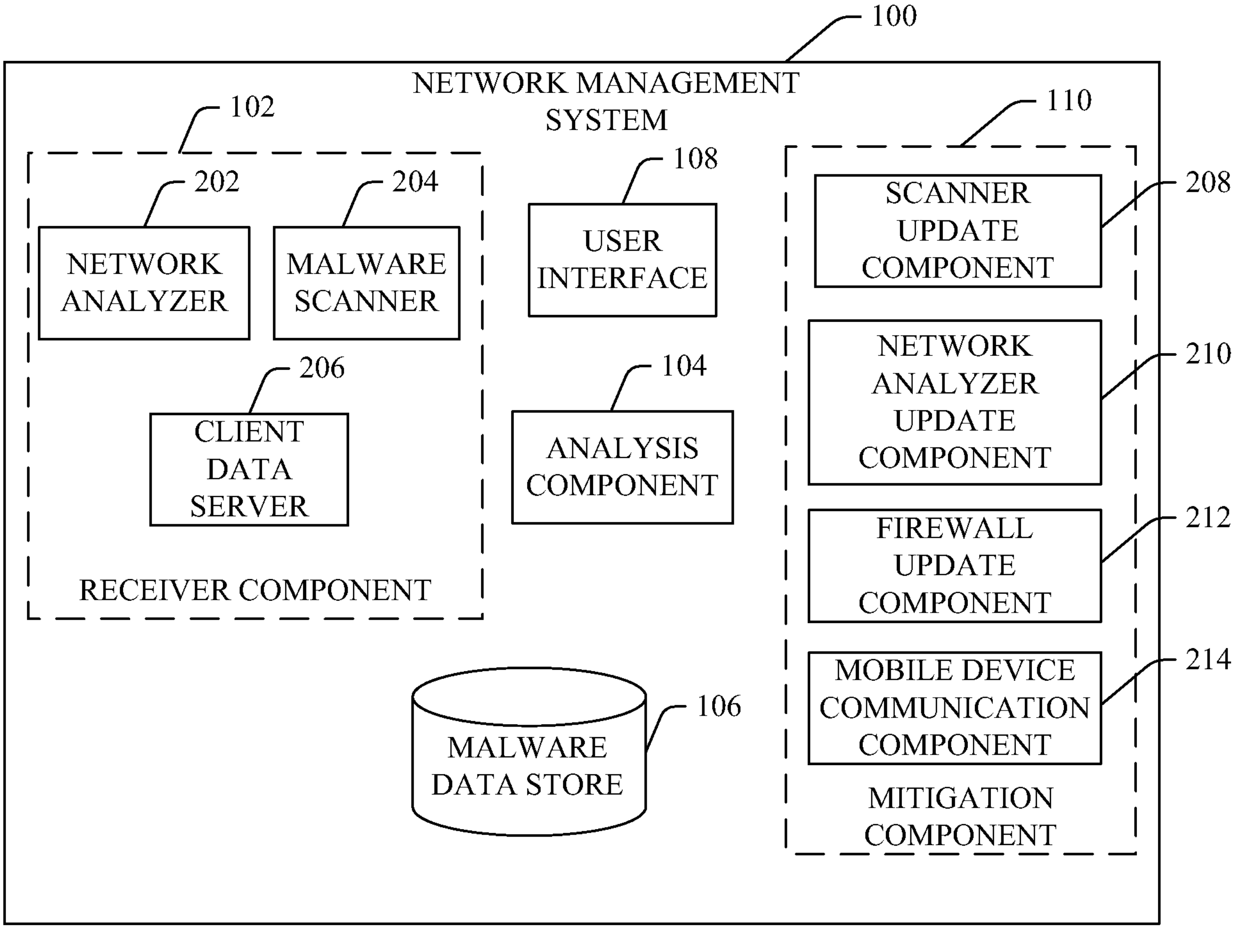
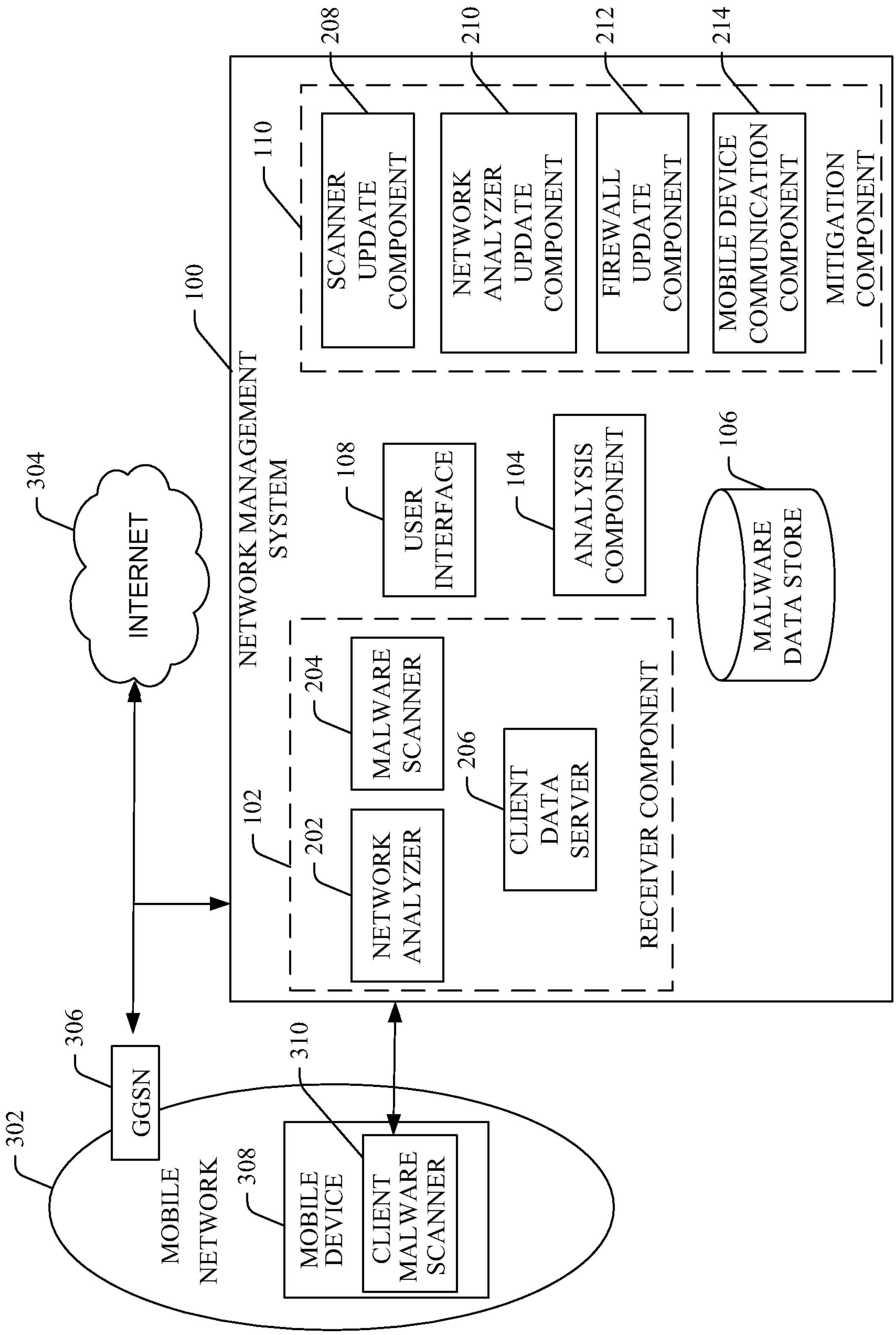

100
NETWORK MANAGEMENT SYSTEM
102
202
NETWORK ANALYZER
204
MALWARE SCANNER
206
CLIENT DATA SERVER
RECEIVER COMPONENT
108
USER INTERFACE
104
ANALYSIS COMPONENT
106
MALWARE DATA STORE
110
208
SCANNER UPDATE COMPONENT
210
NETWORK ANALYZER UPDATE COMPONENT
212
FIREWALL UPDATE COMPONENT
214
MOBILE DEVICE COMMUNICATION COMPONENT
MITIGATION COMPONENT

FIG. 2



100
NETWORK MANAGEMENT SYSTEM
102
RECEIVER COMPONENT
202
NETWORK ANALYZER
204
MALWARE SCANNER
206
CLIENT DATA SERVER
108
USER INTERFACE
104
ANALYSIS COMPONENT
106
MALWARE DATA STORE
110
MITIGATION COMPONENT
208
SCANNER UPDATE COMPONENT
210
NETWORK ANALYZER UPDATE COMPONENT
212
FIREWALL UPDATE COMPONENT
214
MOBILE DEVICE COMMUNICATION COMPONENT
304
INTERNET
306
GGSN
302
MOBILE NETWORK
308
MOBILE DEVICE
310
CLIENT MALWARE SCANNER

FIG. 3

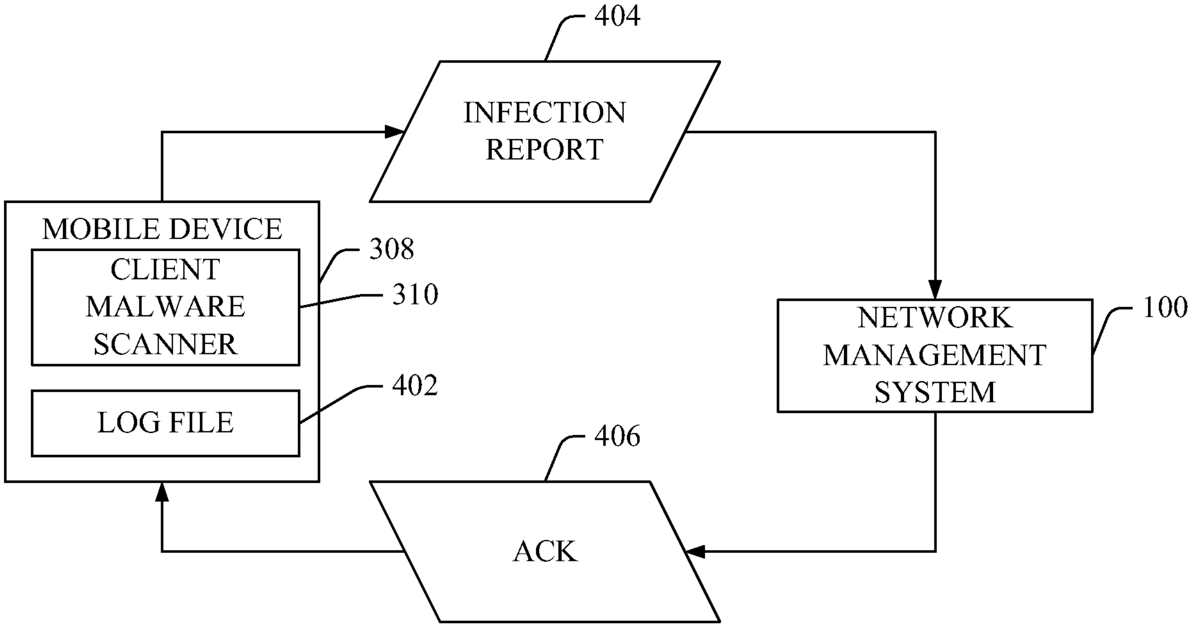

404
INFECTION REPORT
MOBILE DEVICE
CLIENT MALWARE SCANNER
308
310
LOG FILE
402
NETWORK MANAGEMENT SYSTEM
100
406
ACK

FIG. 4

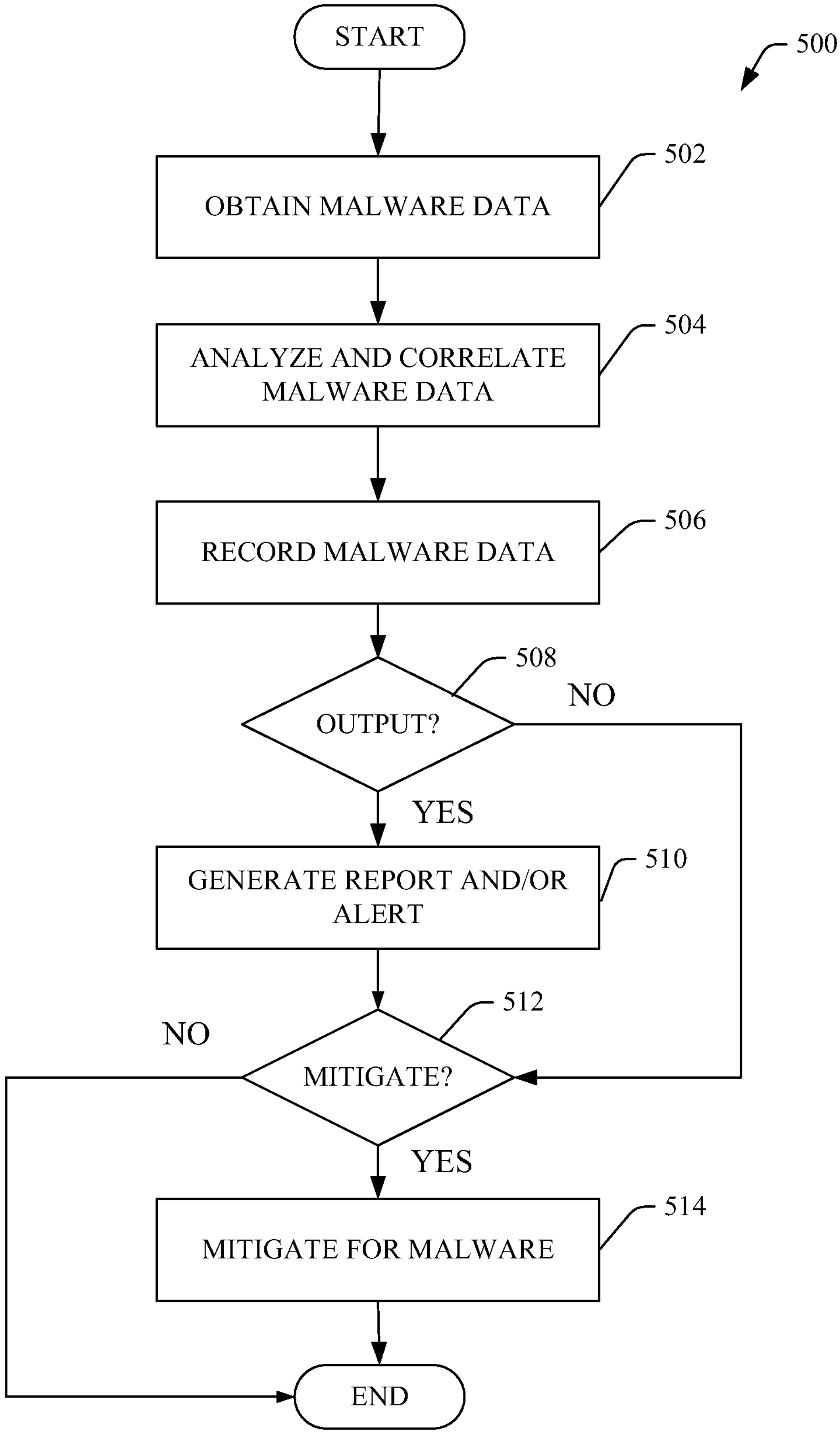

START
500
OBTAIN MALWARE DATA
502
ANALYZE AND CORRELATE MALWARE DATA
504
RECORD MALWARE DATA
506
OUTPUT?
508
NO
YES
GENERATE REPORT AND/OR ALERT
510
MITIGATE?
512
NO
YES
MITIGATE FOR MALWARE
514
END

FIG. 5

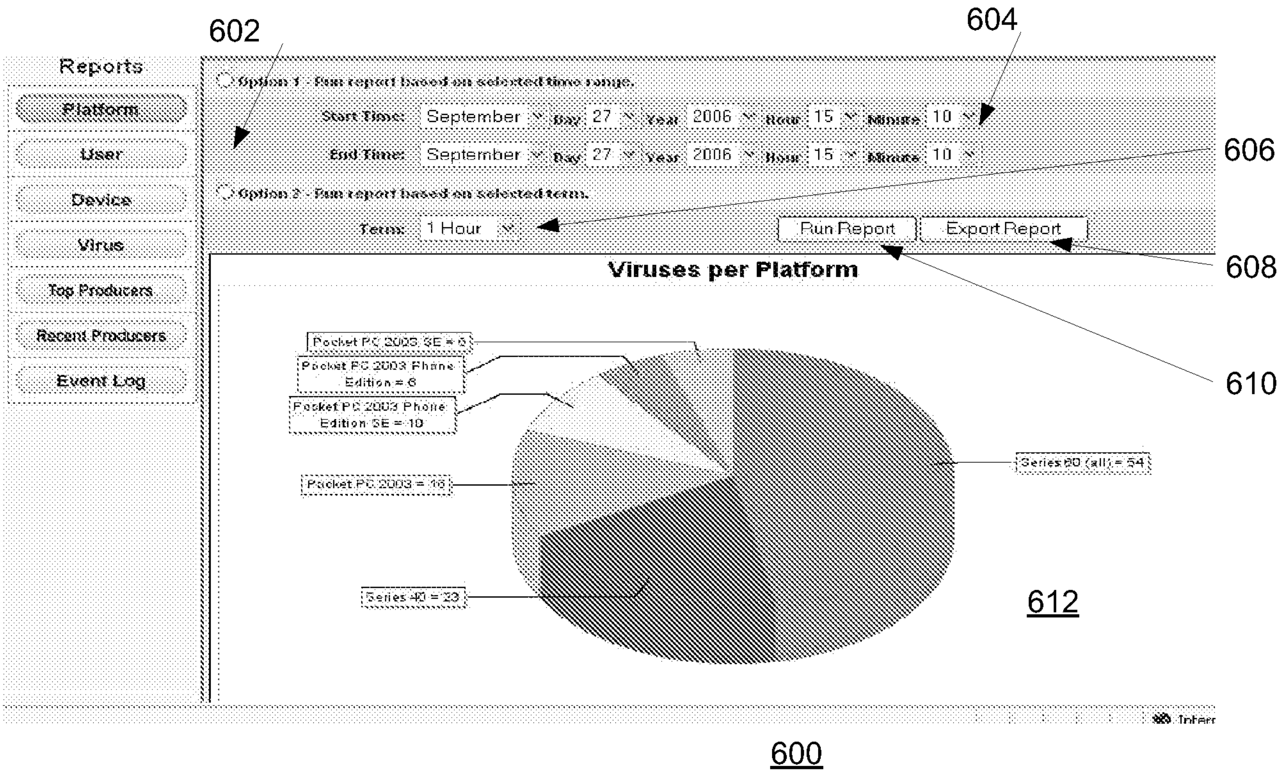

602
604
606
608
610
612
600
Reports
Platform
User
Device
Virus
Top Producers
Recent Producers
Event Log
Option 1 - Run report based on selected time range.
Start Time: September Day 27 Year 2006 Hour 15 Minute 10
End Time: September Day 27 Year 2006 Hour 15 Minute 10
Option 2 - Run report based on selected term.
Term: 1 Hour
Run Report
Export Report
Viruses per Platform
Pocket PC 2003 SE = 6
Pocket PC 2003 Phone Edition = 6
Pocket PC 2003 Phone Edition SE = 10
Pocket PC 2003 = 18
Series 40 = 23
Series 60 (all) = 54

FIG. 6

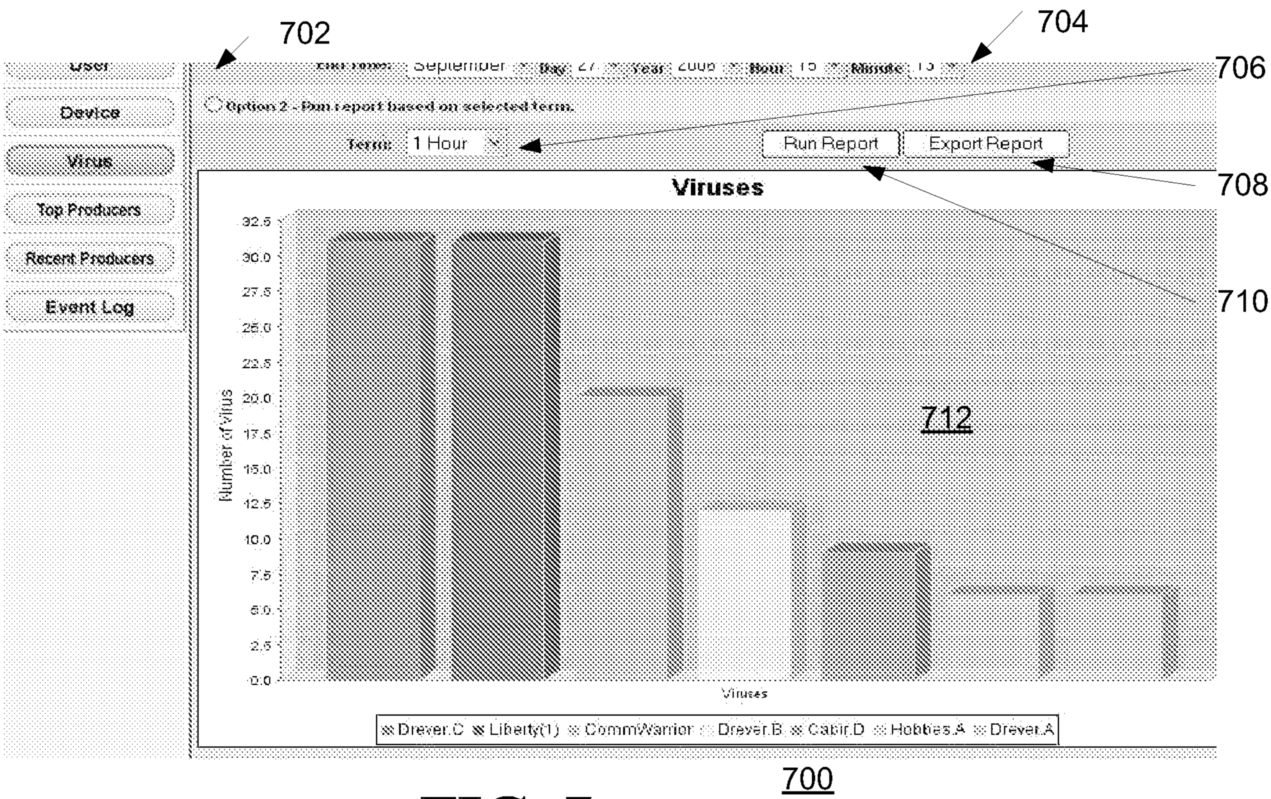

702
704
706
708
710
712
700
User
Device
Virus
Top Producers
Recent Producers
Event Log
Option 2 - Run report based on selected term.
Term: 1 Hour
Run Report
Export Report
Viruses
Number of Virus
32.5
30.0
27.5
25.0
22.5
20.0
17.5
15.0
12.5
10.0
7.5
5.0
2.5
0.0
Viruses
Drever.C Liberty(1) CommWarrior Drever.B Cabir.D Hobbes.A Drever.A

FIG. 7

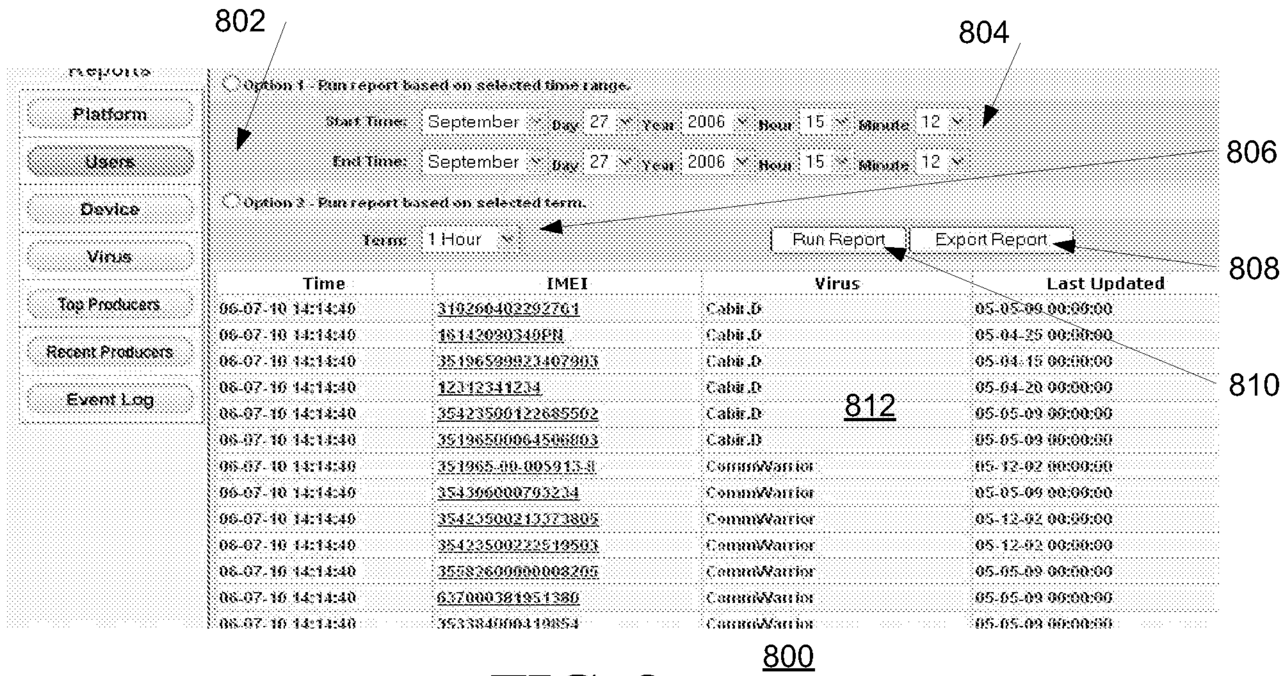

802
804
806
808
810
812
800
Platform
Users
Device
Virus
Top Producers
Recent Producers
Event Log
Run Report
Export Report
Time
IMEI
Virus
Last Updated

FIG. 8

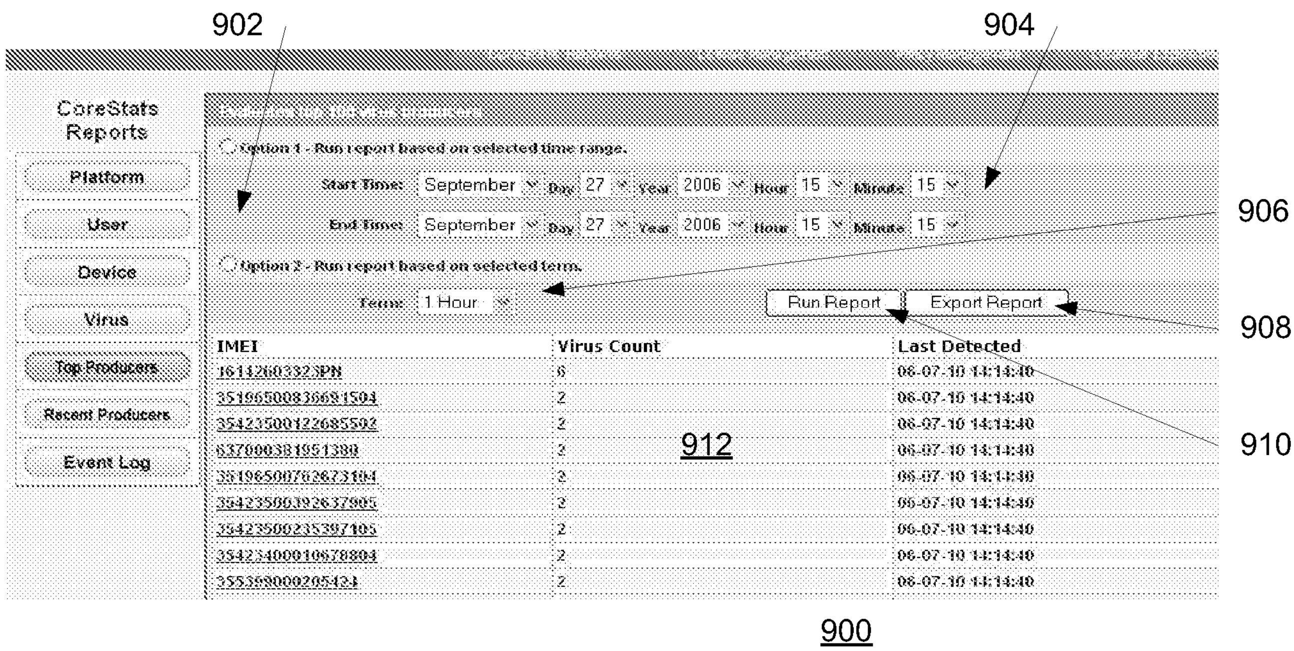

902
904
906
908
910
912
900
CoreStats Reports
Platform
User
Device
Virus
Top Producers
Recent Producers
Event Log
Run Report
Export Report
IMEI
Virus Count
Last Detected

FIG. 9

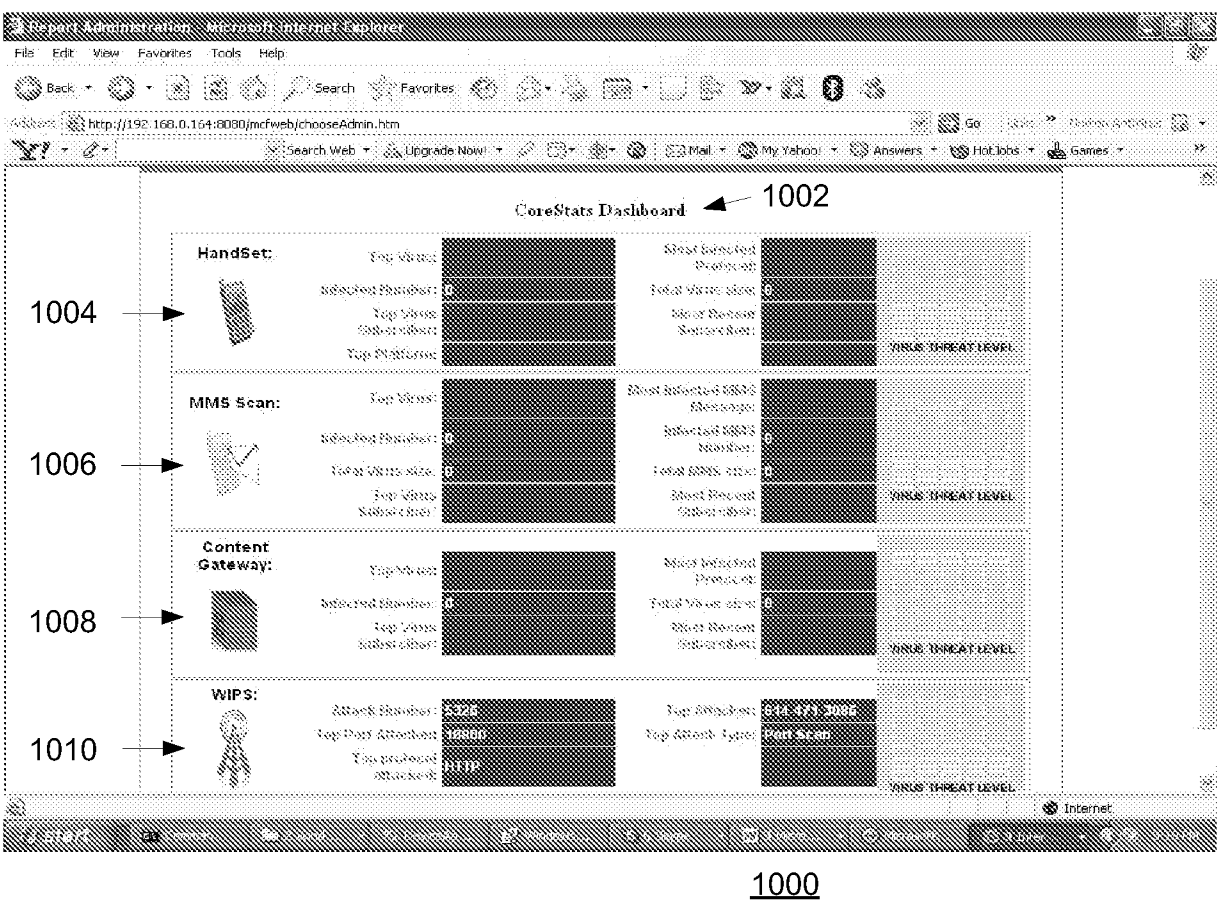

CoreStats Dashboard
1002
HandSet:
1004
MMS Scan:
1006
Content Gateway:
1008
WIPS:
1010
VIRUS THREAT LEVEL
Port Scan
HTTP
1000

FIG. 10

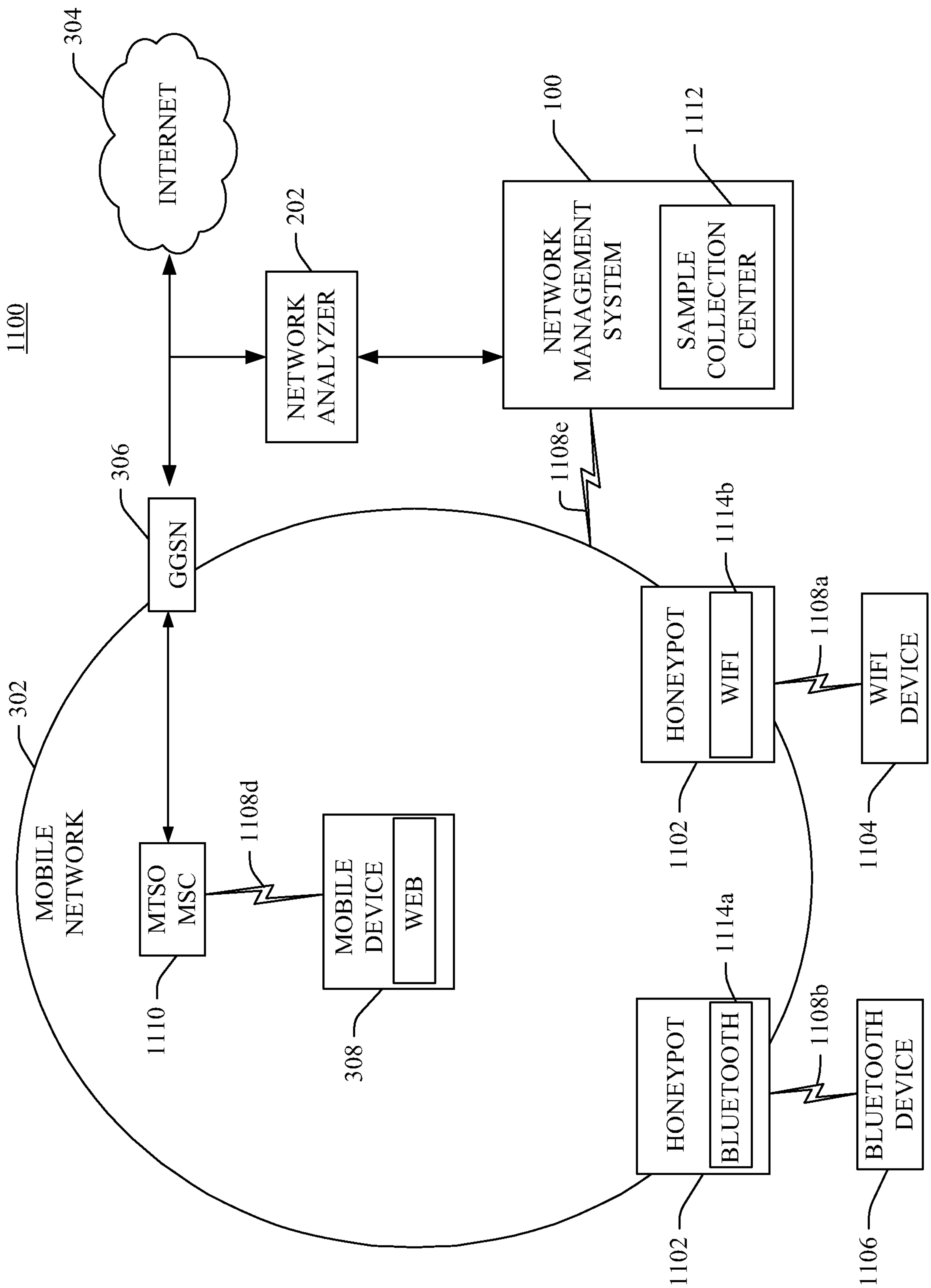

1100
304
INTERNET
202
NETWORK ANALYZER
100
NETWORK MANAGEMENT SYSTEM
1112
SAMPLE COLLECTION CENTER
306
GGSN
1108e
302
MOBILE NETWORK
MTSO MSC
1110
1108d
MOBILE DEVICE
WEB
308
HONEYPOT
WIFI
1114b
1108a
WIFI DEVICE
1102
1104
HONEYPOT
BLUETOOTH
1114a
1108b
BLUETOOTH DEVICE
1102
1106

FIG. 11

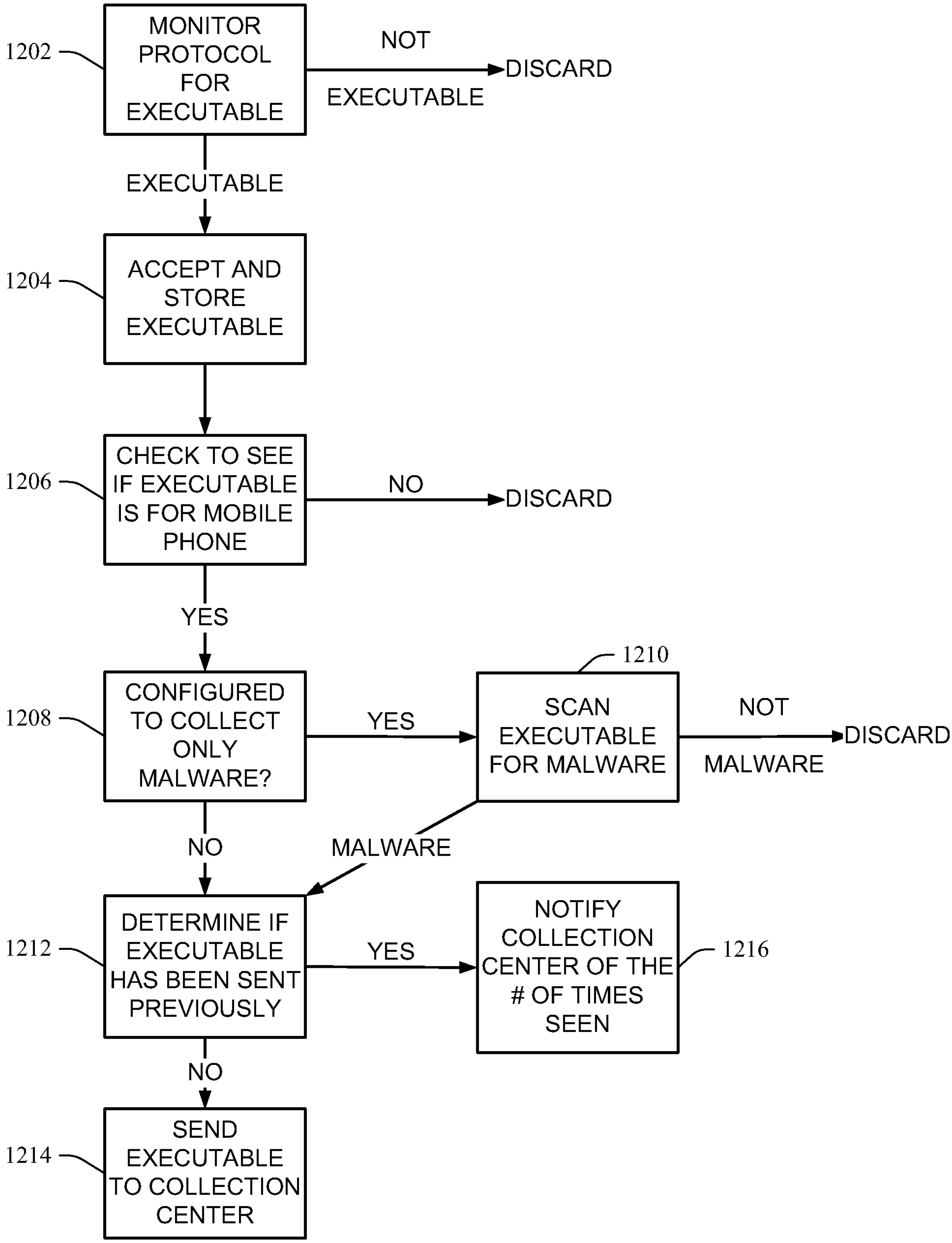

1202
MONITOR PROTOCOL FOR EXECUTABLE
NOT EXECUTABLE
DISCARD
EXECUTABLE
1204
ACCEPT AND STORE EXECUTABLE
1206
CHECK TO SEE IF EXECUTABLE IS FOR MOBILE PHONE
NO
DISCARD
YES
1208
CONFIGURED TO COLLECT ONLY MALWARE?
YES
1210
SCAN EXECUTABLE FOR MALWARE
NOT MALWARE
DISCARD
NO
MALWARE
1212
DETERMINE IF EXECUTABLE HAS BEEN SENT PREVIOUSLY
YES
NOTIFY COLLECTION CENTER OF THE # OF TIMES SEEN
1216
NO
1214
SEND EXECUTABLE TO COLLECTION CENTER

FIG. 12