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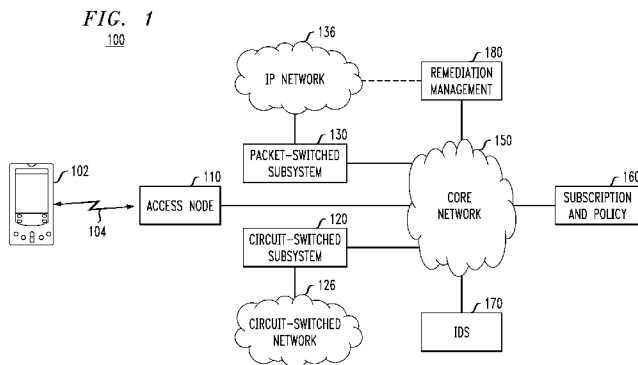
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(54) **Title:** TREATMENT OF MALICIOUS DEVICES IN A MOBILE-COMMUNICATIONS NETWORK



(57) **Abstract:** A method of remotely treating malicious mobile terminals connected to a mobile communications network. In one embodiment, when a malicious mobile terminal is detected by the intrusion-detection services of the network, the network changes the subscriber profile associated with the mobile terminal to operate the latter in a quarantine mode. The packet-switched subsystem of the network then links the quarantined mobile terminal to a remediation manager. The remediation manager remotely treats the mobile terminal, e.g., to repair or reinstall any corrupted software, terminate any active malicious processes, delete or quarantine any malware, and restore the operating system, configuration, and/or memory of the mobile terminal to a clean operational state. After the treatment, the network reverts the subscriber profile back to the initial state and removes the mobile terminal from the quarantine.

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TREATMENT OF MALICIOUS DEVICES IN A MOBILE- COMMUNICATIONS NETWORK

BACKGROUND

5 Field of the Invention

The present invention relates to communication equipment and, more specifically but not exclusively, to equipment for mobile-communications systems/networks.

10 Description of the Related Art

This section introduces aspects that may help facilitate a better understanding of the invention(s). Accordingly, the statements of this section are to be read in this light and are not to be understood as admissions about what is in the prior art or what is not in the prior art.

15 With the advent of mobile broadband, laptops, personal digital assistants, smart phones, and other mobile devices have acquired the capability of communicating with the Internet over mobile-communications networks. Due to this capability, mobile operators have become internet-service providers (ISPs) in addition to functioning in their traditional role of providing cellular voice services. As a result,
20 mobile-communications networks are now exposed to many of the same virtual pathogens, such as viruses, worms, and Trojans, with which the wired ISPs have been dealing for a long time. In addition, 2.5G/3G/4G mobile-communications networks are targeted by pathogen strains that are specifically designed to exploit certain vulnerabilities in the architecture and/or protocols used in wireless networks.

25 The presence of an infected and/or misbehaving mobile device in a mobile-communications network can be detected, e.g., through intrusion-detection services. The term "intrusion detection" generally refers to a process of monitoring relevant events that occur in a network or computer system and analyzing these events for signs of possible anomalies or irregularities, such as actual violations or imminent
30 threats of violation of security policies, use policies, and/or standard security practices. Anomalies and irregularities may have many different causes, such as malware activity, unauthorized access to the system(s) from the Internet, misuse of

privileges by authorized users, and attempts to gain additional privileges without proper authorization.

Malware activity and propagation can be particularly damaging because malware can subject the communication system to a variety of attacks, such as distributed denial of service, overbilling, and spoofed PDP (Packet Data Protocol) context. The impact of a successful attack on a mobile-communications network can be very costly due to one or more of: (1) interrupted voice, data, and/or application service; (2) lost billable time; (3) lost goodwill and increased customer dissatisfaction; (4) increased volume of customer-service calls; and (5) legal ramifications, e.g., stemming from a compromised database of private subscriber information. It is therefore important to timely isolate and treat malicious mobile devices. However, the currently available treatment options are very limited and include, e.g., bringing the implicated device to a service location or a store for an on-site treatment.

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SUMMARY

Disclosed herein are various embodiments of a method of remotely treating malicious mobile terminals connected to a mobile communications network. In one embodiment, when a malicious mobile terminal is detected by the intrusion-detection services of the network, the network changes the subscriber profile associated with the mobile terminal to operate the latter in a quarantine mode. The packet-switched subsystem of the network then links the quarantined mobile terminal to a remediation manager. The remediation manager remotely treats the mobile terminal, e.g., to repair or reinstall any corrupted software, terminate any active malicious processes, delete or quarantine any malware, and restore the operating system, configuration, and/or memory of the mobile terminal to a clean operational state. After the treatment, the network reverts the subscriber profile back to the initial state and removes the mobile terminal from the quarantine.

According to one embodiment, provided is a communication method having the steps of: (A) monitoring packet-based traffic in a mobile-communications network to identify, as a malicious wireless terminal, a wireless terminal that exhibits specified behavior; (B) changing a subscriber profile maintained by the network for

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the wireless terminal to a quarantine state in response to the identification; and (C) allowing the wireless terminal to operate in the quarantine state under the changed subscriber profile.

According to another embodiment, provided is a mobile-communications network comprising one or more access nodes for wirelessly connecting one or more wireless terminals to the network; a packet-switched subsystem adapted to transport packet-based traffic corresponding to the one or more wireless terminals; an intrusion-detection-services (IDS) unit configured to monitor the packet-based traffic to identify wireless terminals that exhibit specified behavior; a subscription-and-policy unit configured to maintain a plurality of subscriber profiles; and a core network that operatively couples the one or more access nodes, the packet-switched subsystem, the IDS unit, and the subscription-and-policy unit. In response to the IDS unit identifying a wireless terminal that exhibits specified behavior, the subscription-and-policy unit is configured to change a subscriber profile maintained therein for the identified wireless terminal to a quarantine state. The packet-switched subsystem is configured to allow the identified wireless terminal to operate in the quarantine state under the changed subscriber profile.

According to yet another embodiment, provided is a communication method having the steps of: (A) monitoring packet-based traffic in a mobile-communications network to identify, as a malicious wireless terminal, a wireless terminal that exhibits specified behavior; (B) in response to the identification, linking the wireless terminal to a remediation manager; and (C) treating the wireless terminal via the link with the remediation manager to disable a cause of the specified behavior, wherein said cause comprises malware.

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BRIEF DESCRIPTION OF THE DRAWINGS

Other aspects, features, and benefits of various embodiments of the invention will become more fully apparent, by way of example, from the following detailed description and the accompanying drawings, in which:

Fig. 1 shows a block diagram of a representative mobile-communications network in which various embodiments of the invention can be practiced; and

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Fig. 2 shows a flowchart of a communication method that can be used in the mobile-communications network of Fig. 1 according to one embodiment of the invention.

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DETAILED DESCRIPTION

Fig. 1 shows a block diagram of a representative mobile-communications network **100** in which various embodiments of the invention can be practiced. Also shown in Fig. 1 is a mobile terminal **102**, which can be a smart phone, a network-enabled laptop, a personal digital assistant, or any other suitable mobile device.

10 Mobile terminal **102** is able to access, via a wireless link **104**, various services provided by network **100**, but is not considered to be a part of the network. One skilled in the art will appreciate that network **100** can provide services to one or more additional mobile terminals (not explicitly shown in Fig. 1) analogous to mobile terminal **102**.

15 Mobile-communications network **100** is illustratively shown as being interfaced with two external networks, i.e., a circuit-switched network **126** and an IP (Internet Protocol) network **136**. Similar to mobile terminal **102**, networks **126** and **136** are external entities that are not parts of mobile-communications network **100**. One skilled in the art will understand that, in various configurations, mobile-communications network **100** can be interfaced with fewer or more than two external
20 networks. In various embodiments, network **100** can be a UMTS (Universal Mobile Telecommunications System) network, an LTE (Long Term Evolution) network, an EVDO (Evolution-Data Optimized or Evolution-Data only)-enabled network, any of different variants of other 2.5G/3G/4G mobile-communications networks, or any
25 other suitable mobile-communications network.

Mobile-communications network **100** has a core network **150** that serves to operatively interconnect various entities of the network that enable its operation. Note that, for clarity, Fig. 1 shows only those network entities that are relevant to the description of various embodiments of the invention. One skilled in the art will
30 understand that mobile-communications network **100** in general and core network **150** in particular may have additional entities not explicitly shown in Fig. 1.

In terms of the functionality, mobile-communications network **100** can be viewed as comprising two subsystems, e.g., a circuit-switched subsystem **120** and a packet-switched subsystem **130**. Circuit-switched subsystem **120** carries data in a circuit-switched manner, e.g., by establishing a permanent channel for the duration of the call or communication session. Packet-switched subsystem **130** is designed to carry data in packets, which are routed according to their destination and transmitted over a shared transmission medium in an appropriate division-multiplexed manner. Mobile-communications network **100** also has some elements that are shared by both of subsystems **120** and **130**, e.g., as further explained below. In some embodiments of mobile-communications network **100**, e.g., those capable of using Voice over IP (VoIP) for voice services, circuit-switched subsystem **120** is optional.

Circuit-switched subsystem **120** bridges mobile-communications network **100** to circuit-switched network **126**. In various embodiments, circuit-switched network **136** can be an Integrated Services Digital Network (ISDN) or a Public Switched Telephone Network (PSTN). In a representative configuration, circuit-switched subsystem **120** supports one or more of the following exemplary functions: (1) routing voice calls, SMS (Short Message Service) messages, and other circuit-switched data services; (2) setting up and releasing end-to-end circuit-switched connections; (3) handling mobility and hand-over requirements during the call or circuit-switched data session; and (4) billing. For example, in an embodiment in which mobile-communications network **100** is a UMTS network, circuit-switched subsystem **120** comprises one or more mobile switching centers (MSCs) and at least one gateway MSC (G-MSC) at the interface between the circuit-switched subsystem and circuit-switched network **126**.

Packet-switched subsystem **130** bridges mobile-communications network **100** to IP network **136** (e.g., the Internet) and is configured to control, according to a specified policy, the packet-transmission-based data service(s) offered by the mobile-communications network to mobile terminal **102**. In a representative configuration, packet-switched subsystem **130** supports one or more of the following exemplary functions: (1) routing data packets; (2) mobility management; (3) session management; (4) interaction between certain entities of mobile-communications network **100**; and (5) billing. For example, when mobile terminal **102** attaches to

packet-switched subsystem **130**, the packet-switched subsystem generates and updates mobility-management information to track the location of the mobile terminal, which enables the mobile-communications network to properly route and deliver the data packets directed to the mobile terminal, e.g., from IP network **136**. Packet-switched subsystem **130** also handles the inter-working between mobile-communications network **100** and IP network **136**, and can be considered as a rather sophisticated routing entity. Packet-switched subsystem **130** manages data sessions, e.g., by providing the required quality of service (QoS) and handling the PDP contexts. Using core network **150**, packet-switched subsystem **130** is able to communicate with other entities of mobile-communications network **100**, including those in circuit-switched subsystem **120**. Packet-switched subsystem **130** assists in generating the billing records for mobile terminal **102**, e.g., by monitoring and recording the volume of data transmissions to and from the mobile terminal. In an embodiment in which mobile-communications network **100** is a UMTS network, packet-switched subsystem **130** comprises at least one Serving GPRS Support Node (SGSN) and at least one Gateway GPRS Support Node (GGSN), where GPRS stands for General Packet Radio Service.

Mobile terminal **102** interfaces with mobile-communications network **100** via an access node **110**, the functionality of which can be used by both circuit-switched subsystem **120** and packet-switched subsystem **130**. In addition to the access node **110** shown in Fig. 1, mobile-communications network **100** typically has a plurality of additional access nodes **110** (not explicitly shown in Fig. 1). In a representative embodiment, access node **110** includes a base-station transceiver (not explicitly shown) that maintains wireless link **104** with mobile terminal **102**. Access node **110** further includes a radio controller (not explicitly shown) that controls the base-station transceiver. The radio controller typically performs radio-resource management and certain mobility-management functions. The radio controller is also the point at which data encryption/decryption may be performed to protect the data, e.g., from eavesdropping. In an embodiment in which mobile-communications network **100** is a UMTS network, access node **110** is part of the UTRAN (UMTS Terrestrial Radio Access Network) and comprises at least one Node B and at least one Radio Network Controller (RNC).

Mobile-communications network **100** further includes a subscription-and-policy unit **160**, an intrusion-detection-services (IDS) unit **170**, and a remediation-management unit **180**, all connected to core network **150**. Subscription-and-policy unit **160** stores and manages the subscription and policy information corresponding to individual users (subscriber profiles) and, when appropriate or necessary, supplies the relevant information from the subscriber profiles to appropriate entities of mobile-communications network **100**. For example, all traffic corresponding to mobile terminal **102** is handled by the corresponding entities of mobile-communications network **100** based on and in compliance with the information and policies specific to that mobile terminal, as specified by subscription-and-policy unit **160**. IDS unit **170** monitors and analyzes the network traffic and signaling data to detect anomalies and irregularities and identify infected or misbehaving mobile terminals. Remediation-management unit **180** performs remote treatment of and software updates for the identified mobile terminals. Note that, in a representative embodiment, remediation-management unit **180** is directly connected to both core network **150** and IP network **136**, as indicated in Fig. 1. Additional description of the functionality of subscription-and-policy unit **160**, IDS unit **170**, and remediation-management unit **180** is given below in reference to Fig. 2.

Fig. 2 shows a flowchart of a communication method **200** that can be used in mobile-communications network **100** according to one embodiment of the invention. Method **200** is described in reference to both Figs. 1 and 2. The description assumes that mobile terminal **102** is a malicious (e.g., malware-infected) device that has gained access to mobile-communications network **100** through access node **110** and attempts to perform illegal actions, e.g., actions that violate security policies, security practices, and/or use policies.

At step **202** of method **200**, IDS unit **170** determines that mobile terminal **102** is a malicious device. To make this determination, IDS unit **170** monitors data packets that are transported through packet-switched subsystem **130** between the corresponding access nodes (such as access node **110**) and IP network **136**. In a representative configuration, IDS unit **170** has a communication link with a gateway node (e.g., GGSN, not explicitly shown) of packet-switched subsystem **130** established over core network **150**. Using this communication link, the gateway node

supplies and IDS unit **170** receives all relevant or requested packet-traffic information. IDS unit **170** analyzes the received packet-traffic information using any suitable IDS technique(s), e.g., those based on distinct counting of port numbers, IP addresses, or any selected packet-header attributes and/or on deep packet inspection (DPI). Based on the analysis, IDS unit **170** can detect common behaviors of malicious processes, such as port scanning, PDP-context spoofing, command-and-control activity in the form of peer-to-peer or fast-flux actions, vulnerability probing to or from an end-point, pseudo-random scanning for infected systems, DNS MX record searching, SMTP hosting, and spam broadcasting to SMTP servers, where DNS, MX, and SMTP stand for Domain Name System, Mail Exchanger, and Simple Mail Transfer Protocol, respectively. If the analysis implicates mobile terminal **102** as a host of a malicious process, then IDS unit **170** identifies mobile terminal **102** as a malicious device. Representative intrusion-detection techniques that can be adapted for use in IDS unit **170** are disclosed, e.g., in U.S. Patent Nos. 7,701,945, 7,640,585, 7,565,693, 7,496,962, and 7,295,831, all of which are incorporated herein by reference in their entirety.

At step **204**, IDS unit **170** sends one or more messages to subscription-and-policy unit **160** and remediation-management unit **180** to alert them that mobile terminal **102** has been identified as a malicious device. It is important that the message(s) sent to remediation-management unit **180** identify mobile terminal **102** by one or more of its non-IP identifiers, such as the IMSI (International Mobile Subscriber Identity).

At step **206**, in response to the message(s) received at step **204**, subscription-and-policy unit **160** changes the subscriber profile associated with mobile terminal **102** to a specified quarantine state. The change affects the type and/or level of services provided by mobile-communications network **100** to mobile terminal **102** and is designed to isolate the mobile terminal and effectively shut down its illegal activities. More specifically, one or more of the following changes can be implemented to effect a quarantine state: (1) reduce the maximum data-transmission rate available to the mobile terminal on the default bearer to a relatively low preset value; (2) redirect all traffic corresponding to the mobile terminal through a special dedicated portal, server, or router; (3) change the source IP address for the mobile

terminal to one selected from a reserved subnet and optionally make the new IP address static; (4) add filters to limit the external domain(s) that the mobile terminal can access; and (5) modify firewall settings corresponding to the mobile terminal.

At step **208**, subscription-and-policy unit **160** instructs the appropriate entities
5 of packet-switched subsystem **130** to apply the changes made at step **206** to the packet-based data traffic corresponding to mobile terminal **102**. Depending on the particular embodiment of mobile-communications network **100**, the execution of step **208** may include multiple messages exchanged between several pertinent entities of packet-switched subsystem **130**.

10 For example, Figure 5.4.2.1-1: Bearer Modification Procedure with Bearer QoS Update, in technical specification 3GPP TS 23.401 V9.4.0 (2010-03) published by the 3rd Generation Partnership Project (3GPP), shows an exemplary flow of messages that can be used at step **208** to rate-limit mobile terminal **102** in an embodiment in which mobile-communications network **100** is an LTE network.
15 Briefly, this flow comprises a total of at least twelve messages transmitted between (1) the PCRF (Policy and Charging Rules Function) and the PDN (Packet Data Network) gateway; (2) the PDN gateway and the serving gateway; (3) the serving gateway and the MME (Mobility Management Entity); (4) the MME and the enhanced Node B (eNodeB) entity; and (5) the eNodeB entity and the user equipment
20 (UE, e.g., mobile terminal **102**). For additional details on the individual messages of this flow, the reader is referred to technical specification 3GPP TS 23.401 V9.4.0 (2010-03), which is incorporated herein by reference in its entirety. Note that, in this embodiment, the PCRF is a sub-unit of subscription-and-policy unit **160**; the PDN gateway, the serving gateway, and the MME are parts of packet-switched subsystem
25 **130**; and the eNodeB entity is a component of access node **110**.

As another example, in an embodiment in which mobile-communications network **100** is a UMTS network, step **208** comprises the HSS (Home Subscriber Server) sending a cancel-location command to the SGSN (Serving GPRS Support Node). Executing this command, the SGSN terminates any ongoing packet-based
30 data sessions for mobile terminal **102**. Note that any ongoing circuit-switched sessions (e.g., phone calls) that are being handled for mobile terminal **102** by circuit-switched subsystem **120** can remain mostly unaffected (e.g., uninterrupted). The HSS

also updates, based on the changes made at step **206**, the APN (Access Point Name) and subscriber-profile information with the SGSN. When mobile terminal **102** tries to reattach to packet-switched subsystem **130**, the new APN and subscriber-profile information are in effect, thereby changing the type and/or level of services provided by mobile-communications network **100** to mobile terminal **102** to those specified at step **206**. Note that, in this embodiment, the HSS is a subunit of subscription-and-policy unit **160**, and the SGSN is a part of packet-switched subsystem **130**.

At step **210**, packet-switched subsystem **130** assigns a new IP address to mobile terminal **102**, e.g., from a dedicated subnet, and connects the mobile terminal to remediation-management unit **180**, e.g., via IP network **136**. In one embodiment, packet-switched subsystem **130** is configured to route data packets with source IP addresses from the dedicated subnet so that the packets are directed to remediation-management unit **180** regardless of the actual destination IP address specified in the packet's header. Since, at step **204**, mobile terminal **102** was identified to remediation-management unit **180** as a malicious device, the remediation-management unit expects the mobile terminal to link up for treatment. Note that, even if not all of the packet-based data traffic is directed from mobile terminal **102** to remediation-management unit **180**, the rate limiting and other configuration changes implemented at steps **206** and **208** severely curtail the ability of the mobile terminal to continue to perform illegal actions. At the same time, the ability of mobile terminal **102** to send and receive packet-based data traffic enables remediation-management unit **180** to remotely treat the mobile terminal.

At step **212**, remediation-management unit **180** remotely treats mobile terminal **102** using the connection established at step **210**. The treatment procedure may include but is not limited to any of the following: (1) downloading remediation software to mobile terminal **102**; (2) initiating memory and system scans at the mobile terminal to detect corrupted software, malware, and/or active malicious processes; (3) repairing or reinstalling the detected corrupted software; (4) terminating the active malicious processes; (5) deleting or quarantining the detected malware; (6) restoring the system and memory of the mobile terminal to a "clean" operational state; and (7) notifying the user about the treatment.

At step **214**, remediation-management unit **180** notifies subscription-and-policy unit **160** and, optionally, IDS unit **170** about the results of the treatment procedure performed at step **212**. If the treatment was successful, then subscription-and-policy unit **160** reverts the subscriber profile associated with mobile terminal **102** back to the initial state (i.e., the state prior to step **206**) or to a specified default state.

At step **216**, subscription-and-policy unit **160** instructs the appropriate entities of packet-switched subsystem **130** to apply the changes made at step **214** to the packet-switched data traffic corresponding to mobile terminal **102**. The execution of step **216** is analogous to the execution of step **208**, which is illustrated by the examples above. After the changes are effected, packet-switched subsystem **130** resumes normal operation with respect to mobile terminal **102**.

As used in this specification, the term “malware,” short for malicious software, refers to the software designed to infiltrate the operating or file system of a “smart” device without an informed consent of the owner. In the computer arts, this term is generally used to designate a variety of forms of hostile, intrusive, or annoying program code. Software is considered to be malware based on the perceived intent of the creator rather than on any specific features. Malware includes computer viruses, worms, Trojan horses, spyware, dishonest adware, crimeware, most rootkits, and other malicious and unwanted programs. In law, malware is sometimes referred to as a computer contaminant, e.g., as codified in several U. S. states, such as California and West Virginia. Malware should be distinguished from defective software, that is, software that has a legitimate purpose but contains harmful bugs. A malicious process is an instance of malware-program code that is being executed by the operating system of the host device.

While this invention has been described with reference to illustrative embodiments, this description is not intended to be construed in a limiting sense. For example, in certain embodiments, a malicious mobile terminal can be treated by the remediation manager without changes to the subscription and policy information corresponding to the terminal. Various modifications of the described embodiments, as well as other embodiments of the invention, which are apparent to persons skilled in the art to which the invention pertains are deemed to lie within the principle and scope of the invention as expressed in the following claims. The described

embodiments are to be considered in all respects as only illustrative and not restrictive. In particular, the scope of the invention is indicated by the appended claims rather than by the description and figures herein. All changes that come within the meaning and range of equivalency of the claims are to be embraced within their scope.

The present invention can be embodied in the form of methods and apparatuses for practicing those methods. The present invention can also be embodied in the form of program code embodied in tangible media, such as magnetic recording media, optical recording media, solid state memory, floppy diskettes, CD-ROMs, hard drives, or any other non-transitory machine-readable storage medium, wherein, when the program code is loaded into and executed by a machine, such as a network server, the machine becomes an apparatus for practicing the invention. When implemented on a general-purpose processor, the program code segments combine with the processor to provide a unique device that operates analogously to specific logic circuits.

The description and drawings merely illustrate the principles of the invention. It will thus be appreciated that those of ordinary skill in the art will be able to devise various arrangements that, although not explicitly described or shown herein, embody the principles of the invention and are included within its spirit and scope. Furthermore, all examples recited herein are principally intended expressly to be only for pedagogical purposes to aid the reader in understanding the principles of the invention and the concepts contributed by the inventor(s) to furthering the art, and are to be construed as being without limitation to such specifically recited examples and conditions. Moreover, all statements herein reciting principles, aspects, and embodiments of the invention, as well as specific examples thereof, are intended to encompass equivalents thereof.

It should be appreciated by those of ordinary skill in the art that any block diagrams herein represent conceptual views of illustrative circuitry embodying the principles of the invention. Similarly, it will be appreciated that any flow charts, flow diagrams, state transition diagrams, pseudo code, and the like represent various processes which may be substantially represented in computer readable medium and

so executed by a computer or processor, whether or not such computer or processor is explicitly shown.

The use of figure numbers and/or figure reference labels in the claims is intended to identify one or more possible embodiments of the claimed subject matter in order to facilitate the interpretation of the claims. Such use is not to be construed as necessarily limiting the scope of those claims to the embodiments shown in the corresponding figures.

Although the elements in the following method claims, if any, are recited in a particular sequence with corresponding labeling, unless the claim recitations otherwise imply a particular sequence for implementing some or all of those elements, those elements are not necessarily intended to be limited to being implemented in that particular sequence.

Unless explicitly stated otherwise, each numerical value and range should be interpreted as being approximate as if the word "about" or "approximately" preceded the value or range.

Reference herein to "one embodiment" or "an embodiment" means that a particular feature, structure, or characteristic described in connection with the embodiment can be included in at least one embodiment of the invention. The appearances of the phrase "in one embodiment" in various places in the specification are not necessarily all referring to the same embodiment, nor are separate or alternative embodiments necessarily mutually exclusive of other embodiments. The same applies to the term "implementation."

Also for purposes of this description, the terms "couple," "coupling," "coupled," "connect," "connecting," or "connected" refer to any manner known in the art or later developed in which energy is allowed to be transferred between two or more elements, and the interposition of one or more additional elements is contemplated, although not required. Conversely, the terms "directly coupled," "directly connected," etc., imply the absence of such additional elements.

As used herein in reference to an element and a standard, the term compatible means that the element communicates with other elements in a manner wholly or partially specified by the standard, and would be recognized by other elements as sufficiently capable of communicating with the other elements in the manner

specified by the standard. The compatible element does not need to operate internally in a manner specified by the standard.

The embodiments covered by the claims in this application are limited to embodiments that (1) are enabled by this specification and (2) correspond to statutory
5 subject matter. Non-enabled embodiments and embodiments that correspond to non-statutory subject matter are explicitly disclaimed even if they formally fall within the scope of the claims.

CLAIMS

What is claimed is:

1. A communication method, comprising:

(A) monitoring packet-based traffic in a mobile-communications network to
5 identify, as a malicious wireless terminal, a wireless terminal that exhibits specified
behavior;

(B) changing a subscriber profile maintained by the network for the wireless
terminal to a quarantine state in response to the identification; and

(C) allowing the wireless terminal to operate in the quarantine state under the
10 changed subscriber profile.

2. The method of claim 1, further comprising:

(D) treating the wireless terminal via a link with a remediation manager to disable
a cause of the specified behavior, wherein said cause comprises malware.
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3. The method of claim 2, wherein step (D) comprises one or more of:

(D1) downloading remediation software from the remediation manager to the
wireless terminal;

(D2) initiating a memory and/or system scan at the wireless terminal using
20 remediation software;

(D3) repairing or reinstalling any corrupted software detected by the scan;

(D4) terminating any active malicious processes detected by the scan;

(D5) deleting or quarantining any malware detected by the scan; and

(D6) restoring the system and/or the memory of the wireless terminal to a
25 specified operational state.

4. The method of claim 2, further comprising:

after performing step (D), changing the subscriber profile from the quarantine
state to a specified operational state; and
30

configuring a packet-switched subsystem of the network to link the wireless
terminal and the remediation manager via an IP network that is external to the mobile-
communications network.

5. The method of claim 1, wherein:

step (A) comprises applying an intrusion-detection technique to detect network manifestations of a malicious process, wherein:

5 the wireless terminal is a host device for the malicious process; and
 the network manifestations caused by the malicious process indicate existence of the specified behavior; and

step (B) comprises one or more of:

10 (B1) reducing a maximum data-transmission rate available to the identified malicious wireless terminal;

 (B2) changing a source IP address for the identified malicious wireless terminal to one selected from a reserved subnet;

 (B3) making the source IP address static;

15 (B4) specifying a filter configuration that limits external domains accessible to the identified malicious wireless terminal via a packet-switched subsystem of the network; and

 (B5) modifying one or more firewall settings corresponding to the identified malicious wireless terminal to restrict the terminal's access to other networks connected to the mobile-communications network.

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6. The method of claim 1, further comprising:

reserving a subnet of IP addresses for assignment exclusively to malicious wireless terminals;

25 assigning one of the reserved IP addresses to the identified malicious wireless terminal; and

 configuring a packet-switched subsystem of the network to route data packets with source IP addresses from the reserved subnet to a remediation manager regardless of actual destination IP addresses specified for said data packets.

30

7. The method of claim 1, further comprising:

after performing step (B), configuring a packet-switched subsystem of the network to redirect all packet-based traffic corresponding to the wireless terminal via a

specified path, wherein the specified path funnels the packet-based traffic corresponding to the wireless terminal to a dedicated portal or server that is configured for remotely treating the wireless terminal to remove a cause of the specified behavior; and

5 prior to performing step (C), terminating any ongoing packet-based sessions corresponding to the wireless terminal without dropping an ongoing phone call on the wireless terminal.

8. A mobile-communications network, comprising:

10 one or more access nodes for wirelessly connecting one or more wireless terminals to the network;

a packet-switched subsystem adapted to transport packet-based traffic corresponding to the one or more wireless terminals;

15 an intrusion-detection-services (IDS) unit configured to monitor the packet-based traffic to identify wireless terminals that exhibit specified behavior;

a subscription-and-policy unit configured to maintain a plurality of subscriber profiles; and

a core network that operatively couples the one or more access nodes, the packet-switched subsystem, the IDS unit, and the subscription-and-policy unit, wherein:

20 in response to the IDS unit identifying a wireless terminal that exhibits specified behavior, the subscription-and-policy unit is configured to change a subscriber profile maintained therein for the identified wireless terminal to a quarantine state; and

25 the packet-switched subsystem is configured to allow the identified wireless terminal to operate in the quarantine state under the changed subscriber profile.

9. The mobile-communications network of claim 9, further comprising:

30 a remediation manager configured to remotely treat the identified wireless terminal, via a link supported by the packet-switched subsystem, to remove a cause of the specified behavior; and

a circuit-switched subsystem operatively coupled to the core network, wherein:

the packet-switched subsystem is configured to terminate any ongoing packet-based sessions corresponding to the identified wireless terminal; and

the circuit-switched subsystem is configured to carry, without dropping, an ongoing phone call for the identified wireless terminal while said ongoing packet-based sessions are being terminated.

10. A communication method, comprising:

(A) monitoring packet-based traffic in a mobile-communications network to identify, as a malicious wireless terminal, a wireless terminal that exhibits specified behavior;

(B) in response to the identification, linking the wireless terminal to a remediation manager; and

(C) treating the wireless terminal via the link with the remediation manager to disable a cause of the specified behavior, wherein said cause comprises malware.

FIG. 1
100

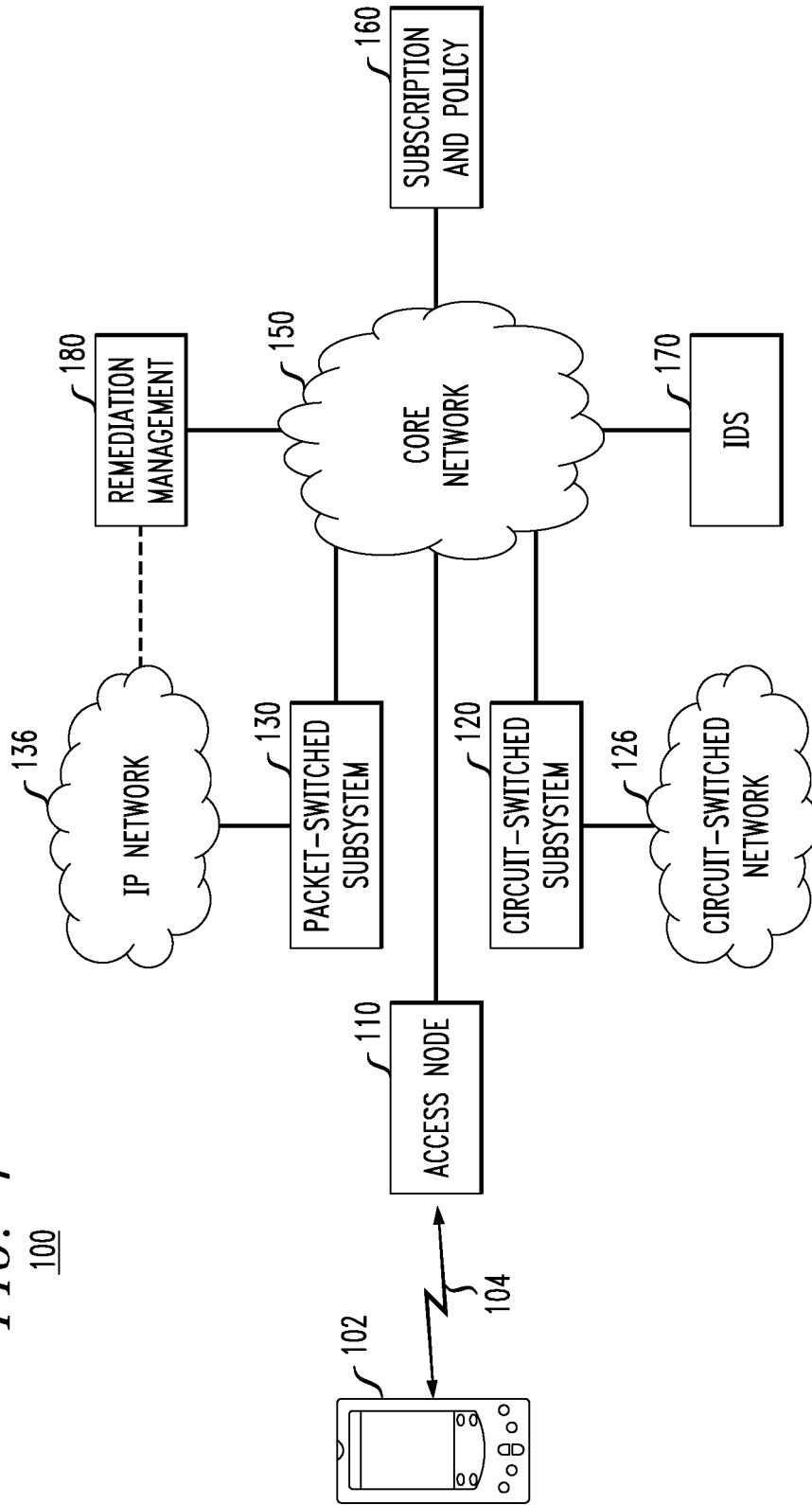
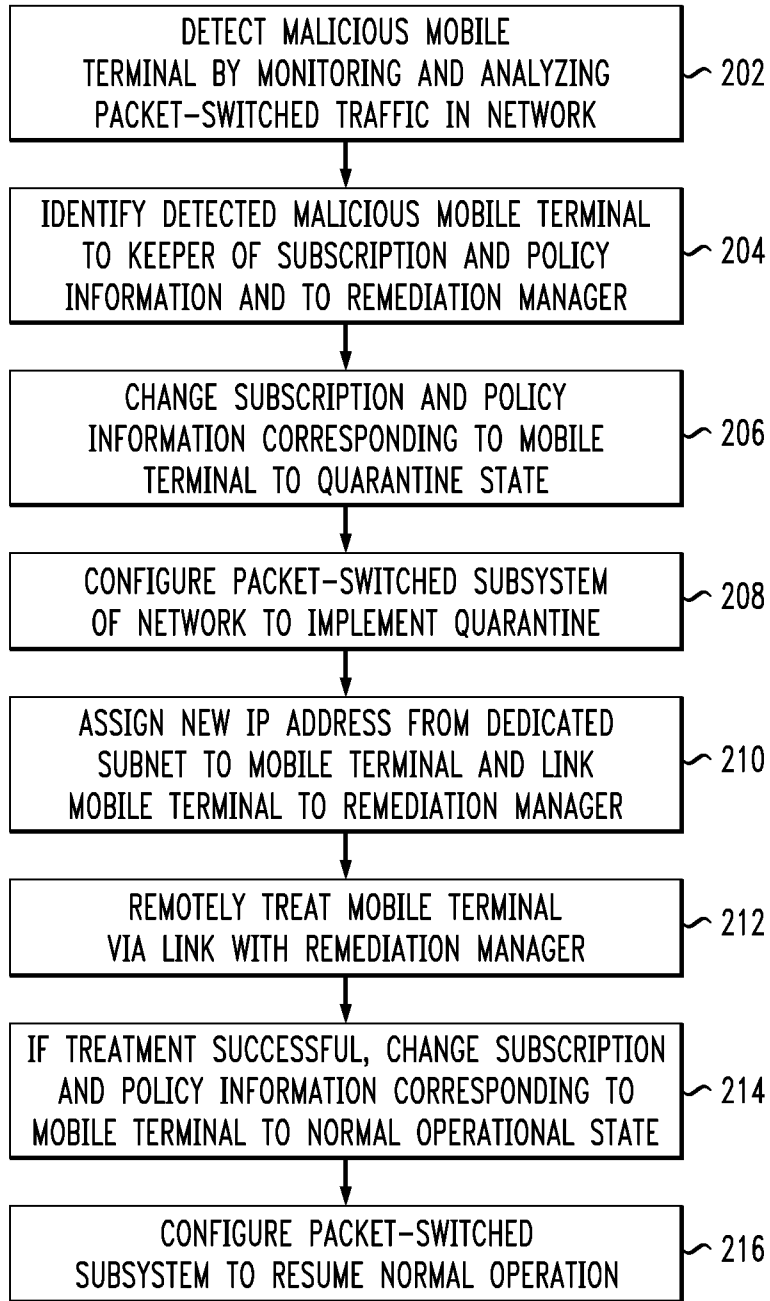


FIG. 2

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INTERNATIONAL SEARCH REPORT

International application No PCT/US2011/039251

A. CLASSIFICATION OF SUBJECT MATTER INV. H04W12/12 H04L29/06 ADD.		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) H04W H04L G06F		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal, COMPENDEX, INSPEC, WPI Data		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2007/006312 A1 (LI CHANGHONG [FI] ET AL) 4 January 2007 (2007-01-04) paragraphs [0015], [0017], [0020], [0022] - [0029] figures 1-5 -----	1-10
X	WO 2006/126089 A1 (NOKIA CORP [FI]; MONONEN RISTO [FI]) 30 November 2006 (2006-11-30) page 14, lines 10-12 page 15, line 8 - page 17, line 23 page 18, line 15 - page 19, line 15 figures 1-4 -----	1-10
X	US 2006/276173 A1 (SREY LENA [US] ET AL) 7 December 2006 (2006-12-07) paragraphs [0022], [0024], [0026], [0031] - [0033], [0035], [0038] figures 1-9 -----	1-10
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
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28 July 2011	04/08/2011	
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2011/039251

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