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(54) **SYSTEM, DEVICE AND COMPUTER READABLE MEDIUM FOR PROVIDING NETWORKING SERVICES ON A MOBILE DEVICE**

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See application file for complete search history.

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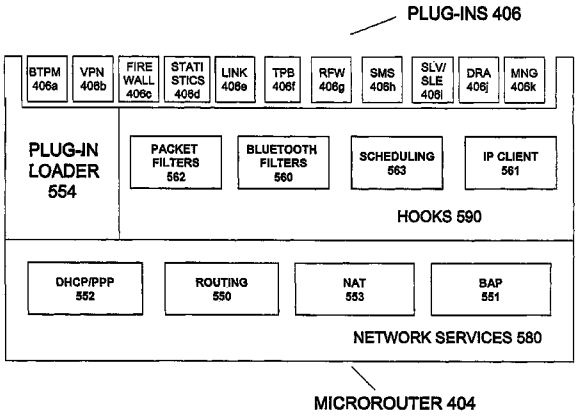
(57) **ABSTRACT**

A system, device and computer readable medium that monitors and reconfigures a LAN by a WAN operator is provided. In an embodiment of the present invention, a telecommunications operator monitors and manages devices and/or applications communicating with a wireless device, such as cellular telephone. In an embodiment of the present invention, a telecommunication operator adds LAN network services to microrouter **404** in a cellular telephone without user intervention. In an embodiment of the present invention, the cellular telephone has a Bluetooth™ processor and transceiver. In an embodiment of the present invention, microrouter **404** includes a Bluetooth™ LAN Access Profile software component, routing software component, PPP server software component and a NAT software component. In an embodiment of the present invention, microrouter **404** includes hooks and interfaces for adding other network services, such as a Bluetooth™ Terminal Pairing Management software component, a VPN software component, Firewall component, Statistics software component, Link Optimization software component, LAN reverse firewall software component, Terminal Flashing software component, SMS software component, SLV and SLE software component and a Device Resources software component.

31 Claims, 6 Drawing Sheets



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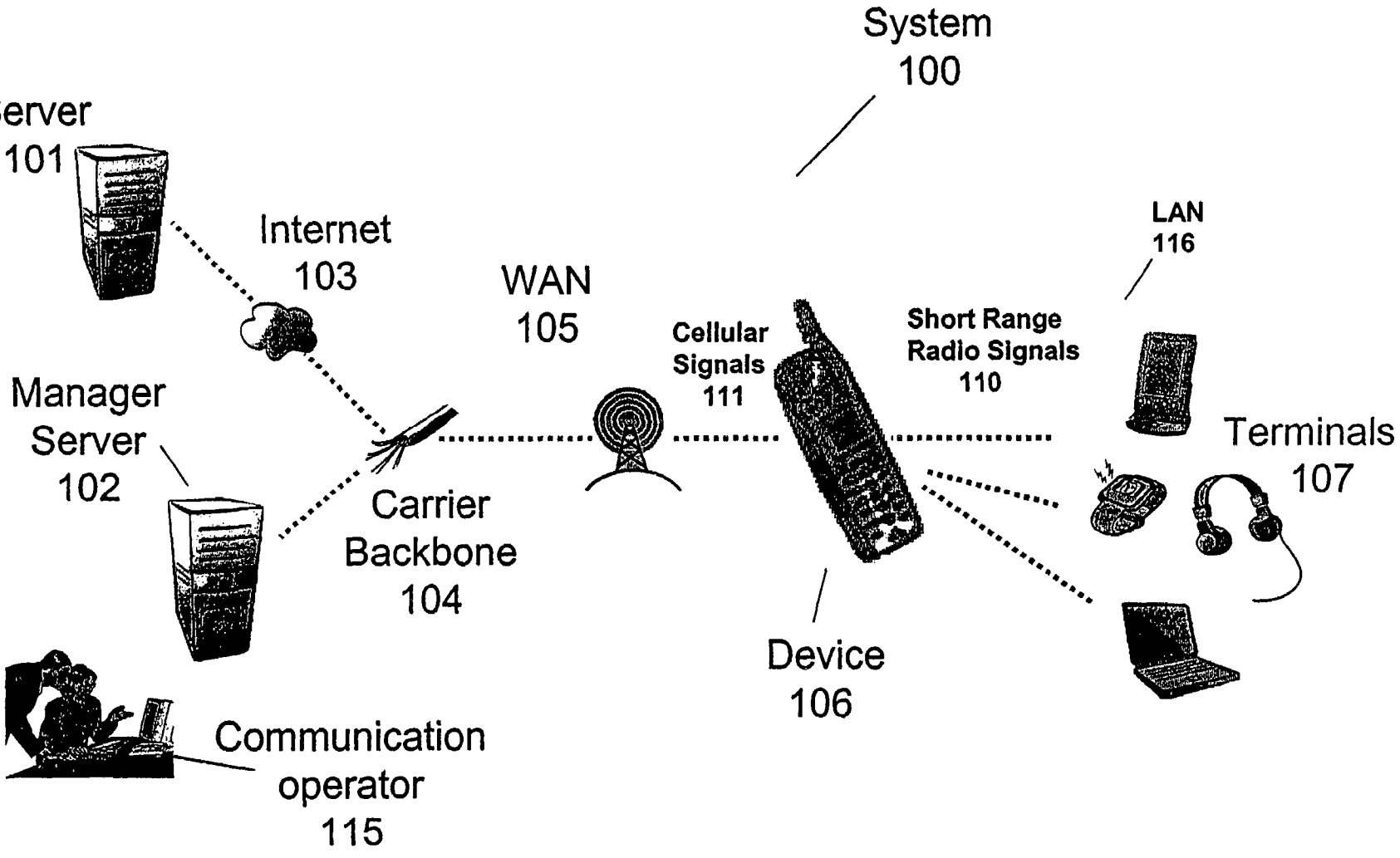
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Radio Signals
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Manager
Server
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Carrier
Backbone
104
Terminals
107
Device
106
Communication
operator
115

Fig. 1

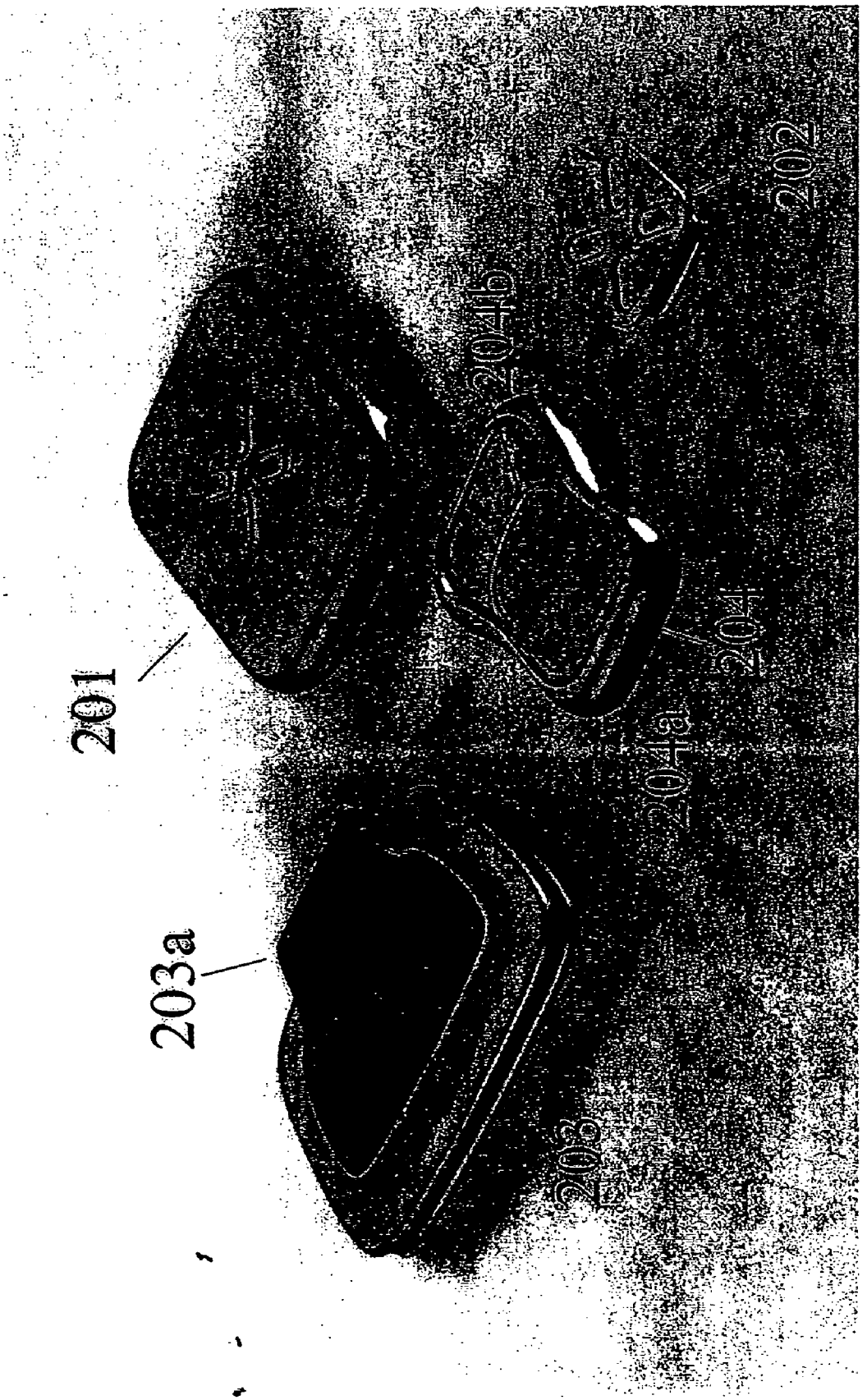

Fig. 2

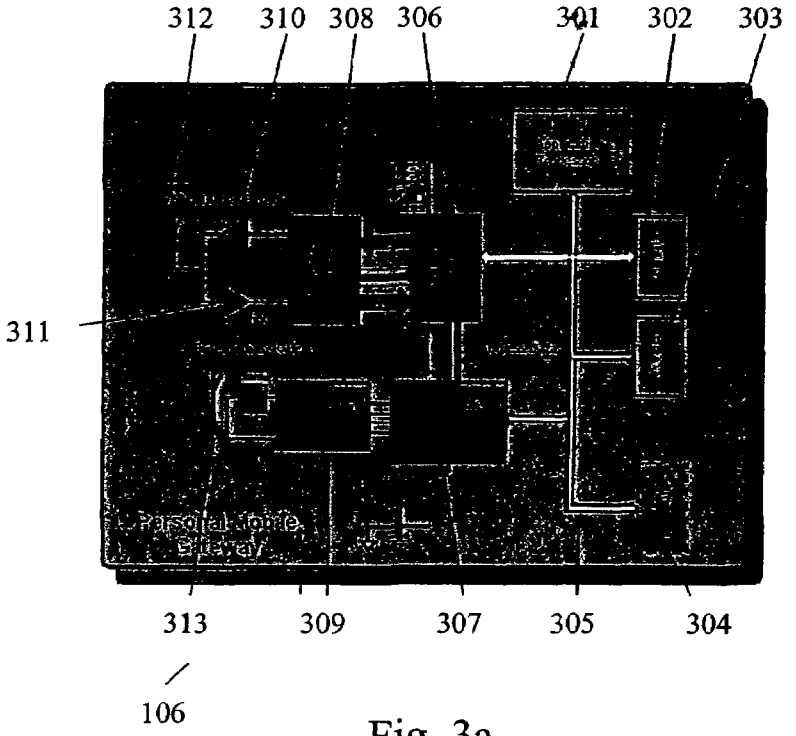
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Fig. 3a

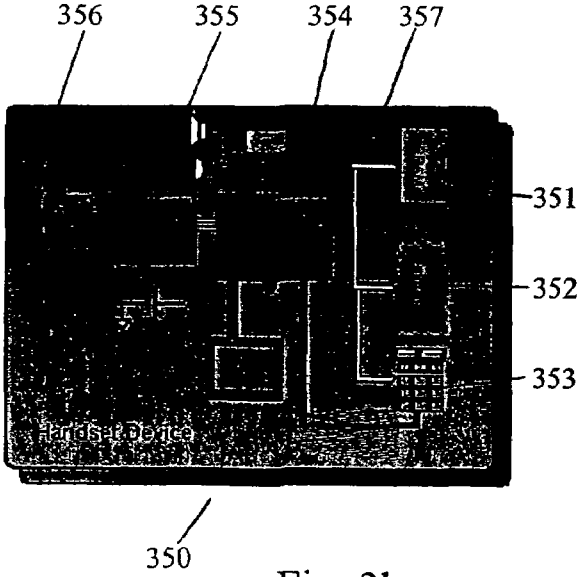
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Fig. 3b

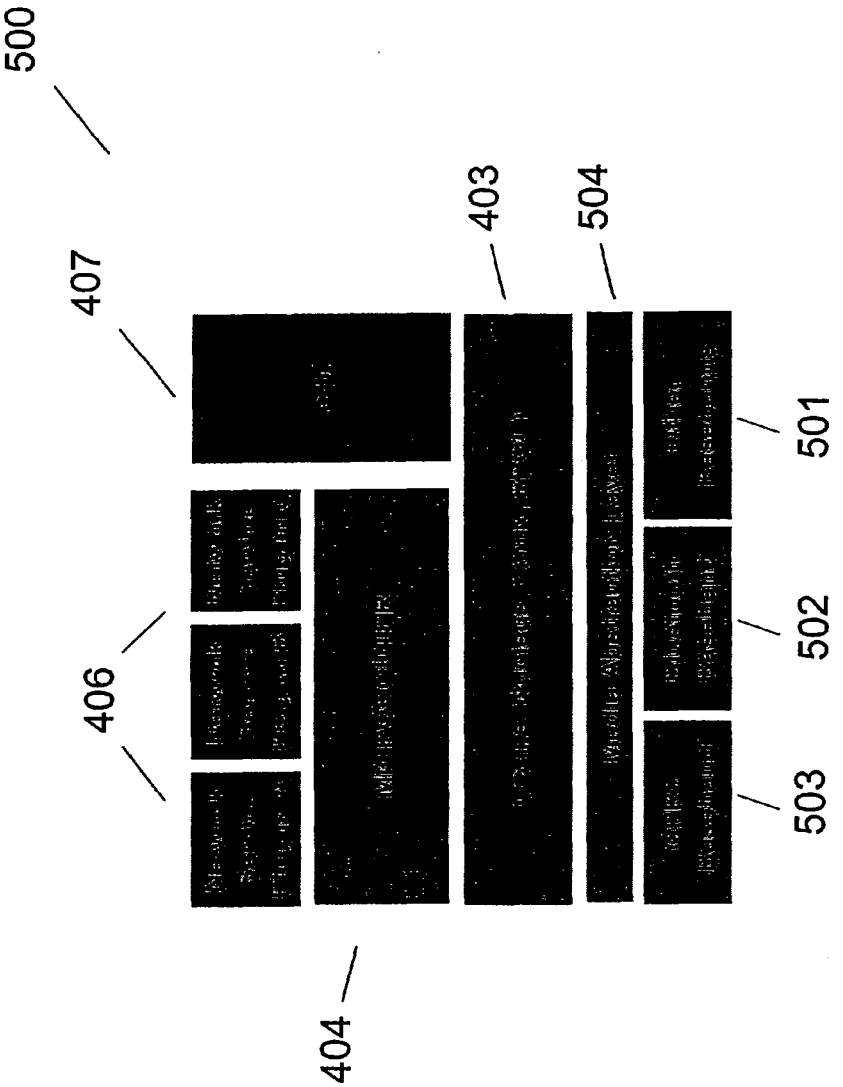
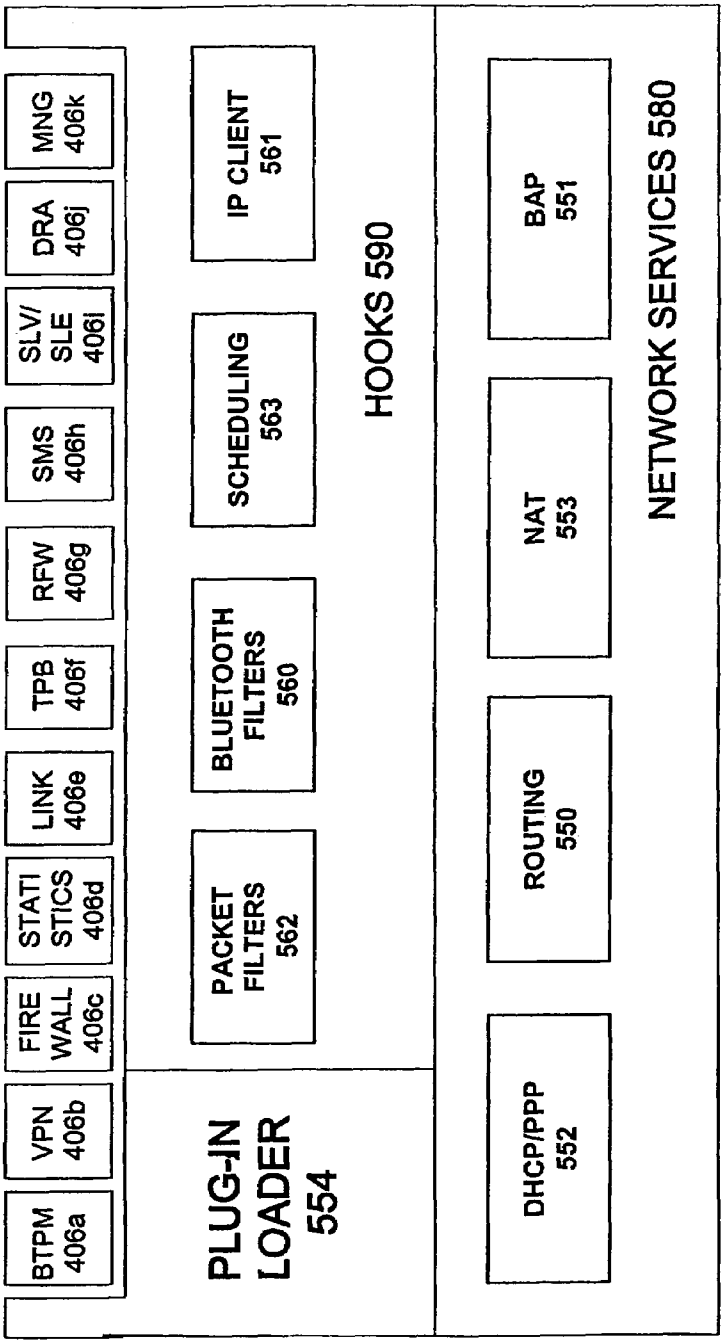


Fig. 4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SLV/ SLE 406i
DRA 406j
MNG 406k
PLUG-IN LOADER 554
PACKET FILTERS 562
BLUETOOTH FILTERS 560
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NAT 553
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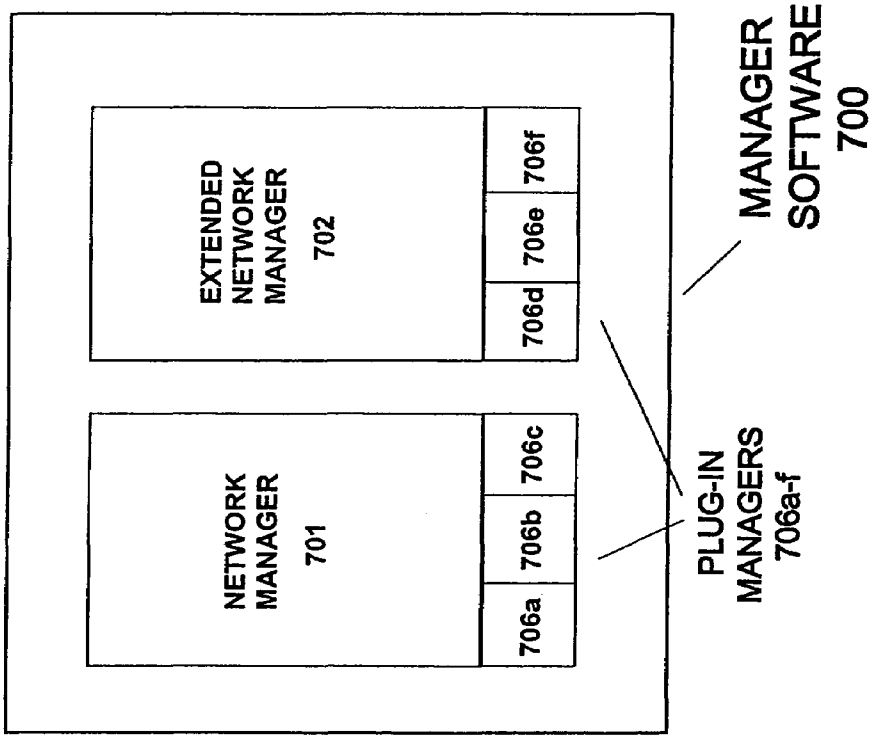
MICROROUTER 404

Fig. 5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EXTENDED NETWORK MANAGER 702
NETWORK MANAGER 701
706a
706b
706c
706d
706e
706f
PLUG-IN MANAGERS 706a-f

Fig. 6

SYSTEM, DEVICE AND COMPUTER READABLE MEDIUM FOR PROVIDING NETWORKING SERVICES ON A MOBILE DEVICE

FIELD OF THE INVENTION

This invention relates generally to networks.

BACKGROUND OF THE INVENTION

Managing and monitoring networks, such as wide area networks ("WANs") and local area networks ("LANs"), is a very important function.

An operator of a network needs to monitor network configuration and operation in order to maximize usage and accessibility of network services. An operator can use such information in reconfiguring a network or adding network service. A network operator also desires flexibility in easily adding network services without requiring user intervention. Often, a user does not have the technical ability or desire to reconfigure or add network services.

A user of a network is generally interested in particular applications that provide specific results, such as an application for retrieving an address from a database. Typically, a user of a network is not interested in network configuration and adding network services as long as the user's applications are providing results in a timely manner.

A wireless communication device, such as a cellular telephone, is typically a node of a WAN or communication network managed by a telecommunication operator. As described above, the user of a cellular telephone is typically not interested in a particular network configuration as long as particular applications are providing the desired results. However, the cellular telephone may also be a part of a LAN or network for communicating with other user devices, such as a laptop or Personal Digital Assistant ("PDA"). For example, Bluetooth™ technology (www.Bluetooth.com) provides wireless communications between devices. These other LAN devices may have applications that access the WAN; yet, a telecommunication operator has no visibility as to statistics on usage profiles of particular LAN devices and/or applications. The cellular telephone acts as a wall to prevent the telecommunication operator from monitoring or managing LAN devices and/or applications. Moreover, the telecommunication operator cannot easily add network services to the LAN without user intervention.

Therefore, it is desirable to provide a system, device and computer readable medium that allows a network operator to manage and monitor usage profiles of devices and applications on a LAN. It is further desirable to provide a system that allows a network operator to easily reconfigure or add network services to a LAN without user intervention. LAN devices then may be able to share information and services. In particular, it is desirable to provide a system that monitors usage profiles of devices and/or applications communicating with a cellular telephone.

SUMMARY OF THE INVENTION

A hand-held device for providing communication between a wide area network and a wireless local area network is provided according to an embodiment of the present invention. The device comprises a storage device coupled to a processor. The storage device stores a router software component for transferring a packet between the wide area network and the wireless local area network.

According to an embodiment of the present invention, the packet is an Internet Protocol ("IP") packet.

According to an embodiment of the present invention, the wide area network includes a plurality of public IP addresses and the wireless local area network includes a plurality of private IP addresses. The router software component translates the first IP address in the plurality of public IP addresses to a second IP address in the plurality of private IP addresses.

According to another embodiment of the present invention, the device includes a Bluetooth™ processor and a 2.4 GHZ transceiver.

According to still another embodiment of the present invention, the wide area network is the Internet, cellular network, corporate network and/or private IP network.

According to another embodiment of the present invention, the wireless local area network is a Bluetooth™ wireless local area network and/or an 802.11 wireless local area network.

According to another embodiment of the present invention, the router software component includes a network address translator ("NAT") software component for translating between a first wide area network address and a first local area network address.

According to another embodiment of the present invention, the router software component includes a network address port translation ("NAPT") software component for translating between a first wide area network address and a first local area network address.

According to an embodiment of the present invention, the router software component includes a local routing software component for routing the IP packet between a first wireless device in the wireless local area network and a second wireless device in the wireless local area network.

According to an embodiment of the present invention, the router software component includes an interface for adding a first network service software component for providing a network service to the wireless local area network.

According to still another embodiment of the present invention, the first network service software component is loaded into the storage device from a managing processing device in the wide area network.

According to another embodiment of the present invention, the first network service software component is loaded into the storage device during manufacturing of the hand-held device.

According to another embodiment of the present invention, the first network service software component is a pairing management software component for determining whether a first wireless device is coupled to the wireless local area network.

According to another embodiment of the present invention, the first network service software component is a virtual private network software component for establishing a secure link.

According to another embodiment of the present invention, the first network service software component is a firewall software component.

According to an embodiment of the present invention, the first network service software component is a statistics software component for collecting usage information of the wireless local area network.

According to an embodiment of the present invention, the statistics software component collects usage information of a wireless device in the wireless local area network.

According to an embodiment of the present invention, the statistics software component collects usage information

from an application software component in a wireless device in the wireless local area network.

According to an embodiment of the present invention, the first network service software component includes a link optimization software component for converting the IP packet from a first wireless device in the wireless local area network to an optimized cellular protocol packet transferred to a processing device in the wide area network.

According to an embodiment of the present invention, the first network service software component includes a reverse firewall software component for dropping a packet from a first wireless device in the wireless local area network.

According to an embodiment of the present invention, the first network service software component includes a reverse firewall software component for dropping a packet from a first application software component on a first wireless device in the wireless local area network.

According to an embodiment of the present invention, the first network service software component includes a flashing software component for providing a flashing image to a first wireless device, in the wireless local area network, for updating a first wireless device capability.

According to an embodiment of the present invention, the first network's service software component includes a flashing software component for providing a flash image to a wireless device, in the wireless local area network, for adding a first wireless device capability.

According to an embodiment of the present invention, the first network service software component is a message software component for providing a message between a first wireless device and the second wireless device in the wireless local area network.

According to an embodiment of the present invention, the first network service software component is a service level enforcement software component for limiting and amount of packets transferred from a first wireless device in the wireless local area network to the wide area network during a period of time.

According to an embodiment of the present invention, the first network service software component is a Bluetooth™ LAN access profile software component.

According to an embodiment of the present invention, the first network service software component is a dial-up software component.

According to an embodiment of the present invention, the first network service software component is a virtual dial-up software component for providing packet switching in response to a circuit switching signal.

According to an embodiment of the present invention, a system for providing communication between a wide area network and a wireless local area network is provided. The system comprises a hand-held wireless device having a cellular transceiver for communicating with the wide area network. The hand-held device has a storage device for storing a routing software component for transferring a plurality of packets between the wide area network and the wireless local area network, wherein the hand-held wireless device has a wide area network address. A first wireless device has a 2.4 GHZ transceiver for transferring a first packet in the plurality of packets to the hand-held wireless device, wherein the first wireless device has a first local area network address.

According to an embodiment of the present invention, the first wireless device is selected from a group consisting of a desktop computer, a laptop computer, a personal digital assistant, a headset, a pager, a printer, a watch, a digital camera and an equivalent.

According to an embodiment of the present invention, the hand-held wireless device is a cellular telephone using a Global System for Mobile Communications ("GSM") protocol, Code Division Multiple Access ("CDMA") protocol, Universal Mobile Telecommunications Systems ("UMTS") protocol or Time Division Multiple Access ("TDMA") protocol.

According to still another embodiment of the present invention, the system comprises a second wireless device having a 2.4 GHZ transceiver for transferring a second packet in the plurality of packets to the hand-held wireless device, wherein the second wireless device has a second local area network address.

According to another embodiment of the present invention, an article of manufacture, including a computer readable medium, is provided. The computer readable medium comprises a routing software component of translating between a wide area network address and a local area network address. An interface software component allows a network service software component to be added. A short-range radio software component provides a short-range radio signal in a wireless local area network. A cellular software component provides a communication signal in a cellular network.

According to still another embodiment of the present invention, a managing processing device in a first wide area network is coupled to a hand-held device having a routing software component for transferring a plurality of packets between the first wide area network and the local area network. A device is coupled to the hand-held device and is in the local area network. The device transfers a first packet in the plurality of packets to the hand-held device.

According to another embodiment of the present invention, a device has an application, and the managing processing device has a manager software component, for accessing the application. The application may be a ring tone application or a phone book application.

According to another embodiment of the present invention, a microrouter software component stored on a first device runs an application on a second device in a local area network.

According to another embodiment of the present invention, the hand-held device includes a bridge software component for transferring a plurality of packets having an IP destination address from the wide area network to the local area network.

Other aspects and advantages of the present invention can be seen upon review of the figures, the detailed description, and the claims that follow.

BRIEF DESCRIPTION OF THE FIGURES

FIG. **1** illustrates a system according to an embodiment of the present invention.

FIG. **2** illustrates thin terminals and a wireless device according to an embodiment of the present invention.

FIGS. **3***a–b* are hardware block diagrams of a wireless device and wireless hand-held device according to an embodiment of the present invention.

FIGS. **4** and **5** are software block diagrams for a wireless device according to an embodiment of the present invention.

FIG. **6** is a software block diagram of manager software in manager server **102** illustrated in FIG. **1** according to an embodiment of the present invention.

DETAILED DESCRIPTION

I. System Overview

The following description and claims relate to a system, device and computer readable medium that monitors and reconfigures a LAN by an operator. In an embodiment of the present invention, a telecommunications operator in a WAN monitors and manages devices and/or applications in a LAN communicating with a wireless device, such as a cellular telephone. In an embodiment of the present invention, a telecommunication operator, by way of a manager server, adds LAN network services to a microrouter in a cellular telephone without user intervention.

In an embodiment of the present invention, a LAN is a network of processing devices, such as a personal computer or printer, that span a relatively small physical area. In an embodiment of the present invention, each processing device in a LAN has its own processing unit that executes a software component stored on the processing device memory, but also may access data and devices on the LAN. In an embodiment of the present invention, an Ethernet couples processing devices in a LAN. In an alternate embodiment, electromagnetic signals and wires couple processing devices in a LAN, singly or in combination.

In an embodiment of the present invention, a WAN includes multiple LANs connected over a relatively large distance. Telephone lines and electromagnetic signals, singly or in combination, couple the LANs in a WAN.

FIG. **1** illustrates system **100** according to an embodiment of the present invention. System **100** includes terminals **107** coupled to wireless device **106**. In an embodiment of the present invention, device **106** and one or more terminals **107** communicate to form a LAN **116**. In an embodiment of the present invention, terminals **107** are coupled to device **106** by short-range radio signals **110** to form LAN **116**. In an embodiment of the present invention, some or all of terminals **107** may have wired connections. In an embodiment of the present invention, terminals **107** are a desktop computer, a laptop computer, a personal digital assistant, a headset, a pager, a printer, a watch, a thin terminal, a digital camera or an equivalent. In an embodiment of the present invention, terminals **107** include a Bluetooth™ 2.4 GHz transceiver/receiver. Likewise, device **106** includes a Bluetooth™ 2.4 GHZ transceiver/receiver. In an alternate embodiment of the present invention, a Bluetooth™ 5.7 GHZ transceiver/receiver is used. Device **106** and terminals **107** hardware is illustrated in FIGS. **3***a–b*.

In alternate embodiments of the present invention, other local wireless technologies, such as 802.11 or HomeRF signals, are used to communicate between device **106** and terminals **107**.

In an embodiment of the present invention, WAN **105** is coupled to device **106**. In an embodiment of the present invention, WAN **105** includes a cellular network transmitting and receiving cellular signals **111**. In an embodiment of the present invention, cellular signals **111** are transmitted using a protocol, such as a Global System for Mobile communications ("GSM") protocol. In alternate embodiments, a Code Division Multiple Access ("CDMA"), CDMA 2000 or Time Division Multiple Access ("TDMA"), or General Packet Radio Service ("GPRS") protocol is used.

In an embodiment of the present invention, WAN **105**, carrier backbone **104**, and manager server **102** is, singly or in combination, a telecommunication network that is managed and monitored by operator **115**. In an embodiment of the present invention, IP packets are transferred between the components illustrated in FIG. **1**. In alternate embodiments of the present invention, other packet types are transferred between the components illustrated in FIG. **1**.

In an embodiment of the present invention, a network described herein is an IP public or private network, such as a corporate secured network using a Virtual Private Network ("VPN").

In an alternate embodiment of the present invention, device **106** is coupled to a landline network by an Ethernet, Digital Subscriber Line ("DSL"), or cable modem connection, singly or in combination.

In an embodiment of the present invention, device **106** is coupled to a desktop computer coupled to WAN **105** by a landline connection. In an embodiment of the present invention, device **106** is coupled to the desktop computer by short-range radio signals.

In an embodiment of the present invention, device **106** is a cellular handset or telephone. In an alternate embodiment of the present invention, device **106** is a cellular enabled PDA, wireless modem and/or wireless laptop computer.

In an embodiment of the present invention, WAN **105** is coupled to a wireless carrier internal network or carrier backbone **104**. In an embodiment of the present invention, manager server **102** is coupled to carrier backbone **104**. In an alternate embodiment of the present invention, carrier backbone **104** is coupled to Internet **103**. Server **101** is coupled to Internet **103**. In an embodiment of the present invention, servers **101** and **102** provide information, such as web pages or application software components, to terminals **107** by way of device **106**. In an embodiment of the present invention, manager server **102** provides a microrouter **404** and/or network service plug-ins **406***a–k* to device **106**, as described below. Further, manager server **102**, monitors applications and terminals in a LAN **116**. In an embodiment of the present invention, terminals **107** share services and communicate by way of device **106**.

II. Hand-held Device/Terminal Hardware

FIG. **2** illustrates embodiments of terminals **107** and device **106**. In an embodiment of the present invention, there are two types of terminals: 1) smart terminals and 2) thin terminals. Smart terminals have a relatively powerful processing unit, operating system and applications. Their main needs from a LAN are access to a WAN through TCP/IP and other network services such as storage and execution. For example, a computer notebook and PDA are smart terminals. Thin terminals have a relatively low power processing unit and operating system. They are mainly used as peripherals to an application server in a LAN **116** and their main task is user interaction, rendering output for a user and providing an application server with a user's input. For example, a watch or a messaging terminal are thin terminals.

FIG. **2** illustrates thin terminals. Voice terminal **204** includes a display **204***b* and a retractable keypad **204***a*. Messaging Terminal **203** is illustrated in a closed position with a hinge **203***a* used to open and close terminal **203**. Terminal **203** also includes a miniature QWERTY keyboard and display when opened. Device **201** includes clip **202** for a belt.

In an embodiment, device **201** is also illustrated in FIG. **2**.

FIG. **3***a* illustrates a hardware block diagram of device **106** in an embodiment of the present invention. Device **106** includes both internal and removable memory. In particular, device **106** includes internal FLASH (or Electrically Erasable Programmable Read-Only Memory ("EEPROM") and static Random Access Memory ("SRAM")) **302** and **303**, respectively. Removable FLASH memory **304** is also used in an embodiment of the present invention. Memories **302**,

303, and 304 are coupled to bus 305. In an embodiment of the present invention, bus 305 is an address and data bus. Application processor 301 is likewise coupled to bus 305. In an embodiment of the present invention, processor 301 is a 32-bit processor.

Bluetooth™ processor 307 is also coupled to bus 305. Bluetooth™ RF circuit 309 is coupled to Bluetooth™ processor 307 and antenna 313. Processor 307, RF circuit 309 and antenna 313 transceive and receive short-range radio signals to and from terminals 107, illustrated in FIG. 1, or device 350 illustrated in FIG. 3b.

Cellular, such as GSM, signals are transmitted and received using digital circuit 306, analog circuit 308, transceiver 310, receiver 311 and antenna 312. Digital circuit 306 is coupled to bus 305. In alternate embodiments, device 106 includes a display, a speaker, a microphone, a keypad and a touchscreen, singly or in combination.

FIG. 3b illustrates device 350 that is a hand-held device in an embodiment of the present invention. Device 350, in an embodiment of the present invention, is one of the terminals 107 illustrated in FIG. 1. Similar to device 106, device 350 includes SRAM and FLASH memory 351 and 352, respectively. Memories 351 and 352 are coupled to bus 357. In an embodiment of the present invention, bus 357 is an address and data bus. Keypad 353 is also coupled to bus 357. Short-range radio signals are transmitted and received using Bluetooth™ processor 354 and Bluetooth™ RF circuit 355. Antenna 356 is coupled to Bluetooth™ RF circuit 355. In an embodiment of the present invention, antenna 356 transmits and receives short-range radio signals from device 300. In alternate embodiments, device 350 includes a display, a speaker, a microphone, a keypad and a touchscreen, singly or in combination.

III. Software

FIG. 4 illustrates a software architecture 500 for device 106 illustrated in FIG. 3a according to an embodiment of the present invention. Software 500 is stored in FLASH memory 302. In an embodiment of the present invention, software components referenced in FIGS. 4–6 represent a software program, a software object, a software function, a software subroutine, a software method, a software instance, and a code fragment, singly or in combination. In an alternate embodiment, functions performed by software components illustrated in FIGS. 4–6 are carried out completely or partially by hardware.

In an embodiment of the present invention, software 500, or components of software 500, is stored in an article of manufacture, such as a computer readable medium. For example, software 500 is stored in a magnetic hard disk, an optical disk, a floppy disk, CD-ROM (Compact Disk Read-Only Memory), RAM (Random Access Memory), ROM (Read-Only Memory), or other readable or writeable data storage technologies, singly or in combination. In yet another embodiment, software 500, or components thereof, is downloaded from manager server 102 illustrated in FIG. 1.

Software 500 includes telecommunication software or physical layer protocol stacks, in particular cellular communications software 503 and short-range radio communications software 502. In an embodiment, communication software 503 is a GPRS baseband software component used with processor 306 to transmit and receive cellular signals. In an embodiment, communication software 502 is a Bluetooth™ baseband software component used with processor 307 to transmit and receive short-range radio signals. Other telecommunication software may be used as illustrated by other basebands 501.

In an embodiment of the present invention, operating system 403 is used to communicate with telecommunications software 502 and 503. In an embodiment of the present invention, operating system 403 is a Linux operating system, EPOC operating system available from Symbian software of London, United Kingdom or a PocketPC or a Stinger operating system available from Microsoft® Corporation of Redmond, Wash. or Nucleus operating system, available from Accelerated Technology, Inc. of Mobile, Ala. Operating system 403 manages hardware and enables execution space for device software components.

Media abstraction layer 504 allows operating system 403 to communicate with basebands 503, 502 and 501, respectively. Media abstraction layer 504 and other abstraction layers, described herein, translate a particular communication protocol, such as GPRS, into a standard command set used by a device and/or terminal. The purpose of an abstraction layer is to isolate the physical stacks from the rest of the device software components. This enables future usage of different physical stacks without changing any of the upper layer software and allows the device software to work with any communication protocol.

Furthermore, Graphics User Interface ("GUI") 407 is provided to allow a userfriendly interface.

Microrouter 404 and network service plug-in 406 enables an IP based network or enhanced IP based network, respectfully.

A. Microrouter

Microrouter 404 enables an IP based network between device 106 and terminals 107. In an embodiment of the present invention, each terminal can leverage the existing IP protocol, exchange information with other terminals and gain access to a WAN through microrouter 404. Extended network services, such as network service plug-ins 406 may be added to microrouter 404. In an embodiment, manager server 102, installs microrouter 404 and network service plug-ins 406 on device 106.

FIG. 5 illustrates software components of microrouter 404. In an embodiment of the present invention, routing component 550, Bluetooth™ LAN Access Profile component 551, Point-to-Point Protocol ("PPP") component 552 and Network Address Translator ("NAT") component 553 are included in microurouter 404. In an alternate embodiment, other components, such as packet filters 562, Bluetooth™ filters 560, scheduling 563 and IP client 561 are included in microrouter 404. In still another embodiment, microrouter 404 includes hooks 590 for adding network services plug-ins 406.

1. Microrouter Services

In an embodiment, microrouter 404 services include software components for an IP LAN that has access to a WAN. In an embodiment, the software components included in a microrouter 404 are described below.

a. Bluetooth™ Access Profile ("BAP")

BAP software component 551 enables Bluetooth™ terminals to gain access to a LAN 116 and a WAN by using an IP protocol.

In an embodiment of the present invention, BAP 551 includes implementation of two Bluetooth™ usage profiles such as: 1) Bluetooth™ LAN Access Profile software and 2) Bluetooth™ Dial-Up Profile software.

Bluetooth™ LAN Access Profile software component allows a LAN Access client in a terminal to obtain an IP address and use the IP address in order to gain connectivity to other LAN terminals or to a WAN, behaving as if they were on a LAN.

Bluetooth™ Dial-Up Profile software component enables a terminal to dial-up to any termination number and get IP services from that termination. In addition, a Bluetooth™ Dial-Up Profile ("DUP") software component emulates termination in device **106**. In an embodiment, microrouter **404** has either a Bluetooth™ LAN Access Profile software component or a Bluetooth™ Dial-Up Profile software component. In an alternate embodiment, microrouter **404** includes both Profile software components. In a Bluetooth™ Dial-Up Profile software component mode, a terminal dials a predefined number, for example 999, for which microrouter **404** will not actually dial the number over a cellular network, but emulates as if the number was dialed and a modem answered the call. Microrouter **404** will provide the terminal with an IP address and access to WAN **105**. From the terminal's point of view it is as if the terminal dialed a number 999 to a modem and received an IP service from that modem, but in reality the terminal used DUP to obtain packet switching access to WAN **105** and the call was actually terminated at microrouter **404**.

b. Routing

Routing software component **550** is responsible for transferring IP packets either in a LAN or toward a WAN. In a LAN **116**, Routing **550** handles broadcasting IP packets and transferring IP packets between terminals. Routing **550** is also responsible for LAN IP Broadcast emulation.

Routing component **550** is responsible for IP packet queuing/dropping. A IP packet dropping software component is used for reducing congestion caused by having more than one terminal connected simultaneously. In an embodiment of the present invention, routing **550** includes a queuing software component, Quality of Service software component or equivalent for queuing IP packets. Likewise, routing component **550** includes a dropping software component that is configured by manager server **102**, a user or any other remote entity. In an embodiment of the present invention, manager server **102** defines and loads an IP packet queuing/dropping software component. An operator **115** will be able to define a particular queuing/dropping software component that is suitable for a particular LAN **116** or user. A user will have a better LAN **116**, and thus a better user experience, without having to configure or monitor a LAN **116**.

In an alternate embodiment of the present invention, routing software component **550** is a bridge software component for transferring an IP address.

c. PPP

In an embodiment of the present invention, microrouter **404** includes a PPP software component **552**, such as a PPP server that is the termination for a LAN access profile software component. A PPP server provides IP network information, such as an IP address, DNS address or the like, to a terminal.

d. NAT

NAT software component **553** is used because 1) only one public IP address is typically made available to a cellular telephone and 2) in order to conserve public IP addresses provided by an operator. In an embodiment of the present invention, WAN **105**, and in particular, a cellular packet switching network provides device **106** with one public IP address. A LAN **116** however includes more than one participating terminal. In order to provide IP addresses to all terminals **107**, private LAN IP addresses will be used for LAN terminals while NAT **553** is responsible for translations between private LAN IP addresses and public WAN addresses, and vice versa.

2. Hooks to Extended Network Service Plug-Ins

In an embodiment of the present invention, microrouter **404** includes hooks **590** allowing for the extension of microrouter **404** networking services, such as plug-ins **406**. In an embodiment of the present invention, hooks **590** are application program interfaces ("API") for plug-ins **406**.

In an embodiment of the present invention, Microrouter **404** is programmed to have only basic network abilities and a very low footprint, or in other words require very little memory, for example 100 K bytes, in order to be stored in a device **106**, such as a cellular telephone. However, in some instances more network services will be needed. Further, operators may want the ability to add and sell network services after the device **106** is sold and in operation without user intervention. A user may be less likely to purchase a network service if the user has to return device **106** to the manufacture or inconvenient site.

For these and other reasons, the microrouter **404** includes hooks **590** that enable plug-ins **406** to be implemented in an embodiment of the present invention. This plug-in capability does not define a full execution environment but defines a small framework for implementing code, which can plug-in and extend microrouter **404** network services. In an embodiment of the present invention, hooks **590** is not a user application framework, plug-in code abilities are limited and serves only as an extension to network services.

Plug-ins **406** are fully activated by microrouter **404**, which has full control over them in an embodiment of the present invention. In some sense, plug-ins are like a Dynamic Link Library ("DLL") that have a predetermined set of functions that a microrouter can call in order for them to realize the needed functionality.

Below describes software components included in hooks **590** for implementing plug-ins **406** according to an embodiment of the present invention. In an alternate embodiment, other software components are included or replace illustrated software components in hooks **590**. For example, software components implementing functionality used by all plug-ins **406**, such as hooks for centralized configuration and backend connectivity, are included in hooks **590** in an embodiment of the present invention. These included software components in hooks **590** will save resources and allow for efficient operation.

a. Packet Filters

Packet filters software component **562** allows plug-ins **406** to process IP packets going either internally in a LAN **116** or externally to and from a WAN. By enabling plug-ins **406** to process IP packets and change any part of a packet, drop a packet or generate more packets, microrouter **404** is able to include multiple other added extended network services. For example, microrouter **404** is able to include a VPN, a firewall, tag packets, monitor packets and other extended network services described below. In an embodiment of the present invention, a packet filters **562** is a data path for transferring IP packets that are accessible by plug-ins **406**.

b. Bluetooth™ Filters

Bluetooth™ filters software component **560** enables plug-ins **406** to process Bluetooth™ information. In an embodiment, Bluetooth™ filters **560** processes a pairing request event and provides a PIN number. In an embodiment of the present invention, Bluetooth™ filters **560** enable added network services such as PIN management, denying access to a LAN **116** from a terminal, authenticating a terminal, pairing through a interactive voice response ("IVR") system or the Internet. In an embodiment of the present invention,

a Bluetooth™ filters **560** is a data path for transferring Bluetooth™ information that is accessible by plug-ins **406**.

c. Scheduling

In order for plug-ins **406** to be able to generate events, traffic or do periodic tasks, a scheduling software component **563** enables a plug-in to receive a callback periodically or when required by the plug-in. For example, Scheduling **563** enables a statistics plug-in to send statistic information on terminal and application usage every X hours or calculated average traffic at a selected terminal.

d. IP Client

In an embodiment of the present invention, IP Client **561** makes available IP services to plug-ins **406** so a plug-in can obtain an IP address, send IP packets and/or receive IP packets. Thus, IP Client software component **561** enables a plug-in to obtain a private IP address from microrouter **404** and connect to a backend server, such as manager server **102**. An IP client **561** plug-in can implement a TCP/IP stack or User Datagram Protocol ("UDP"). In an embodiment of the present invention, IP Client plug-in **561** uses all necessary microrouter **404** network services, such as packet filters **562** or NAT **553**. From a microrouter **404** perspective, an IP Client **561** is treated like any other terminal on a LAN **116**.

3. Plug-In Loader

A plug-in can be attached to a microrouter **404** during or after manufacturing. In an embodiment of the present invention, a plug-in is stored or programmed in device **106** before shipping from a manufacture. Alternately, a plug-in is downloaded from manager server **102** at run-time over WAN **105**.

A plug-in loader software component **554**, as illustrated in FIG. **5**, is responsible for loading plug-ins **406**, programming of plug-ins **406** and notification of newly available plug-in **406** to microrouter **404** in an embodiment of the present invention.

In an embodiment of the present invention, plug-in loader **554** will use operating system **403** capabilities for programming a file system and access of plug-ins **406**. In an alternate embodiment of the present invention, plug-in loader **554** uses a plug-in directory in a dedicated memory space of device **106**.

4. Microrouter Extended Service Plug-Ins

Below describes microrouter **404** extended service plug-ins **406** in an embodiment of the present invention. In various embodiments of the present invention, one or more of plug-ins **406** are attached to microrouter **404**. In alternate embodiments, other plug-ins are attached to microrouter **404**. In an embodiment of the present invention, a device manufacturer, terminal manufacturer, an operator **115** and/or other third party provides a plug-in.

a. Bluetooth™ Terminal Pairing Management ("BTPM")

BTPM software component plug-in **406***a* is responsible for PIN management and authenticating terminals for participating in a LAN **116**. BTPM **406***a* allows an operator **115** to control which terminal can connect to a LAN **116**. For example, an operator **115** can deny a terminal from pairing to a LAN **116**, or can approve a terminal for pairing. In an embodiment of the present invention, pairing is done over an IVR, the Internet and/or by a user.

b. VPN

VPN software component plug-in **406***b* enables a secure link to a network, such as a private corporate network. VPN enables terminals to connect to a corporate file server, exchange server or an equivalent. VPN **406***b* uses packet filters **562** in order to identify packets that are routed to a corporate LAN IP subnet. In an embodiment of the present invention, VPN **406***b* then encrypts and tunnels the identified IP packets.

c. Firewall

Firewall software component plug-in **406***c* protects a LAN **116** from intruders and hackers. In an embodiment of the present invention, Firewall **406***c* uses packet filters **562** for identifying IP packets from non-authorized sources and IP packets that are sent to non-authorized servers. In an embodiment of the present invention, firewall **406***c* enables Uniform Resource Locator ("URL") filtering.

d. Statistics

In an embodiment of the present invention, statistics software component plug-in **406***d* collects usage profiles and statistics on 1) which terminal in a LAN **116** is used, 2) how much traffic is generated by each terminal, and 3) by each application. Statistics **406***d* enables an operator **115** to promote used terminals and build billing schemes.

e. Link Optimizations

Implementing direct TCP/IP and Internet application protocols over WAN **105**, and in particular a wireless network, produces poor performance because of low bandwidth, transmission delays and high data error rates. In order to solve the poor performance but still enable terminals to use standard TCP/IP, a Link Optimization software component plug-in **406***e* is provided. Link Optimization **406***e* traps all TCP/IP and specific Internet application protocols, such as Simple Mail Transfer Protocol ("SMTP") and Hypertext Transfer Protocol ("HTTP"), and converts the protocol to an optimized protocol. Link Optimization **406***e* then sends the converted packets to a backend server, such as manager server **102**, which than deconverts the packets and sends them onto the Internet. In an embodiment of the present invention, terminals and users are not aware of using Link Optimization **406***e*.

f. Reverse Firewall

As opposed to a typical LAN firewall that protects a LAN **116** from intruders and hackers from the Internet or another network, a Reverse Firewall ("RFW") software component plug-in **406***g* protects an operator **115** or another network from terminals and applications on a LAN **116** generating traffic toward those networks. RFW **406***g* enables an operator **115** or another entity to define and enforce usage policies for applications/terminals on a LAN **116**. RFW **406***g* prevents unnecessary costly transmission costs. Enforcement of usage policies at the LAN level (i.e. at device **106**) prevents expensive packets from going through a cellular network that will be eventually dropped. Further, packets that may be later dropped do not use the limited cellular transmission bandwidth.

In an embodiment of the present invention, RFW **406***g* is attached to a cellular handset that has Bluetooth™ capability for implementing a LAN **116** and GSM/GPRS for cellular access to a WAN **105** (i.e. Internet or any other network). RFW **406***g* is programmed to drop packets based on the originating terminal, originating application/terminal pair or original application. For example, if a user has a PDA and a Notebook, an operator **115** can configure for File Transfer Protocol ("FTP") packets from the PDA to be dropped if FTP from a PDA is not allowed, or for example to drop video streaming packets originated from the Notebook if video streaming is something the operator **115** does not allow.

Another example includes blocking Notebook usage of such software as Napster in order to avoid cellular unintended usage by users and associated cost.

g. Terminal Programming Over Bluetooth™ ("TPB")

TPB software component plug-in **406***f* enables the programming of terminals **107** over Bluetooth™ and over a cellular network. In an embodiment of the present invention, programming a terminal is accomplished by "flashing" or

programming EEPROM memory in a terminal. An operator **115** or manufacturer can transfer a flash image to be flashed to device **106** having microrouter **404**, and terminals **107** to be flashed. TPB **406***f* communicates with a Flashing software component in a terminal to 1) initiate the flashing process, 2) authenticate the flash image and 3) secure the flashing process.

In an embodiment of the present invention, flashing is done by transferring a full flash image. Alternatively, if there is not enough memory for the full flash image in device **106**, the flash image is transferred block by block to eventually be flashed.

TPB **406***f* enables customizing a terminal, fixing software running on a terminal, and adding applications and/or improvements.

h. Short Message System ("SMS") Plug-In

SMS software component plug-in **406***h* allows terminals **107** to send messages between each other in a LAN **116**. In an embodiment of the present invention, a terminal is a Messaging Terminal that enables Instant Messaging over IP. In an alternate embodiment of the present invention, SMS **406***h* enables standard legacy SMS or Instant Messaging over SMS.

In an embodiment of the present invention, SMS **406***h* is an SMS server for terminals **107** and an SMS termination for device **106**. In this way, a protocol will be defined that enables each terminal to send a packet to SMS **406***h* with a destination device phone number+message text. SMS **406***h* then send the SMS message to a cellular network.

SMS **406***h* also serves as an SMS receiver in an embodiment of the present invention. A terminal can inquire SMS **406***h* for received SMS messages and fetch those messages. In still another embodiment of the present invention, a terminal will also receive an IP broadcast message each time an SMS message is received by device **106**.

i. Service Level Verification ("SLV")/Enforcement ("SLE")

SLV/SLE software component plug-in **406***i* enables an operator **115** to verify and enforce service level agreements with users. If an operator **115** wants to enforce service levels, such as specifically limiting the amount of traffic over a cellular network, SLV/SLE **406***i* is added in order to avoid usage of expensive airtime.

In an embodiment of the present invention, SLV/SLE **406***i* allows a user to generate an unlimited amount of cellular traffic from device **106** during the night but a limited amount during the day. So during the day, if the limited amount is exceeded no more traffic can be generated from device **106** and packets are dropped by SLV/SLE **406***i*. Similar policies may likewise be enforced. SLV/SLE **406***i* also identifies and notifies operator **115** of missed cellular network usage by a particular user due to enforcement in an embodiment of the present invention.

j. Device Resources Access ("DRA")

DRA software component plug-in **406***j* enables terminals to gain access (according to defined restrictions) to device **106** resources. This enables a terminal to implement a Device Resources Access protocol over IP in order to gain access to any of the following resources: 1) phone book, 2) play a ring tone, 3) initiate a call, 4) user interface, or 5) other device resources.

DRA **406***j* enables a terminal to read/modify/add phone book entries in a phone book stored on device **106**. In a preferred embodiment, a vCard format is used to exchange entry information between device **106** and terminals **107**. This enables a better consistent experience for users. For example, DRA **406***j* provides a user immediate access to a device **106** phone book entries for sending a message from a messaging terminal without having to type the contact information from the phone book.

DRA **406***j* enables a user to be alerted by using a device **106** ring buzzer. Thus, a terminal in LAN **116** can use a device **106** ring buzzer for alerting a user.

DRA **406***j* enables a terminal, such as a PDA or an Outlook application on a notebook computer, to initiate a telephone call at device **106**. In an embodiment of the present invention, clicking a phone icon near a phone number on a notebook display initiates a cellular telephone call.

Likewise, DRA **406***j* enables a terminal to interact with a user through device **106** menus and input components.

k. Terminal Management/Monitoring ("MNG")

MNG software component plug-in **406***k* enables management, configuration and monitoring of terminals **107** in an embodiment of the present invention. Instead of each terminal implementing a proprietary management protocol and console, each terminal exposes a "registry" of parameters and MNG **406***k* implements a protocol enabling a managing server **102** to browse this registry, get values and set values.

IV. Usage Scenarios

A. PDA Synchronizes Against the Corporate Exchange Server

In this scenario, a user is a traveling professional who has a PDA and needs to synchronize it against a corporate exchange server while on the road. This synchronization needs to be done securely as the only way to enter the corporate network is via a certified and Information Technology ("IT") manager approved VPN.

The user also has a cellular telephone having a microrouter **404** and VPN client **406***j*, which the IT manager installed. The IT manager used the remote management capabilities of the cellular telephone in order to configure a VPN to connect to the corporate network, as well as configured the firewall to block Internet access while the VPN is in use. The user is totally unaware of the VPN and its configurations.

As the user turns on the PDA, which is a Bluetooth™ equipped PDA with a LAN Access profile implementation, the PDA connects to the cellular telephone via the BAP **551** utilizing Bluetooth™. The PDA receives a private IP address.

The user loads the PDA synchronization software, which is configured to synchronize against the corporate exchange server. When hitting the "Synchronize" button, the PDA opens a TCP connection to the IP address of the corporate network.

The IP packets travel across the Bluetooth™ air interface to the cellular telephone using a PPP protocol and PPP **552**. When reaching the cellular telephone, the packets go through NAT **553** and the private IP address is translated to a public IP address. The public IP address goes to VPN **406***f*, which identifies the destination as the corporate LAN. VPN **406***f* packages the packet over an Internet tunnel, encrypts and signs it. The packet is then sent through the cellular air interface and the Internet, reaching the corporate VPN and exchange servers. The PDA is totally unaware of this process.

B. PDA Synchronizes Against a Notebook on the LAN

In this scenario, the user, as described above, needs to synchronize the PDA with a notebook computer.

The notebook has a Bluetooth™ card with a LAN access profile. Once the notebook is turned on, it connects to the user's cellular telephone having microrouter **404** and receives a private IP address.

The user runs the same synchronization software on his PDA, only this time chooses to synchronize with the notebook.

When hitting the "Synchronize" button on the PDA, the PDA opens a TCP connection to the notebook's IP address.

An IP packet travels, from the PDA, through the Bluetooth™ interface over a PPP protocol and reaches routing **550** in microrouter **404** that identifies the packet destined to a private IP address of the notebook. The IP packet is then sent to the notebook through the notebook's Bluetooth™ interface over a PPP protocol.

C. Web Pad Browsing the Internet

In this scenario, a user has a Web Pad equipped with a Bluetooth™ interface with a LAN access profile. The Web Pad is connected to the cellular telephone having microrouter **404**, which is in the users bag, and receives a private IP address through the LAN access profile. The Web Pad also has a web browser.

The user pulls out his Web Pad, goes to a URL line of the browser and types http://www.iximobile.com. The web browser first has to translate the name www.iximobile.com into a public IP address. This is done using a Domain Naming Service ("DNS") protocol. The Web Pad already received the private IP address of a DNS plug-in when it connected to the cellular telephone. The Web Pad sends a resolve request to the DNS plug-in software component in microrouter **404**. DNS software component looks at its cache for the name. If the name is not available, the DNS plug-in software component goes to the next DNS on a WAN **105** to get the public IP address of the name. In both cases, the DNS eventually gets the public IP address for www.iximobile.com and sends the reply back to the Web Pad. In an embodiment of the present invention, a DNS software component is a plug-in **406** or a hook **590**.

When the Web Pad receives the public IP address of the web site, it opens a TCP connection at port **80** of that public IP address in order to implement the HTTP protocol and get the HTML page to display.

V. Manager Server

In an embodiment of the present invention, Manager server **107**, illustrated in FIG. **1**, includes Manager software component **700** illustrated in FIG. **6**. In an embodiment of the present invention, manager software **700** is used to load micro router **404** and plug-ins **406** into device **106**. In an additional embodiment of the present invention, manager software **700** is used to manage, configure and collect data from LAN **116**. In still another embodiment of the present invention, manager software **700** is not used with LAN **106**.

Manager server **102** includes a Proliant server available from Compaq® Computer Corporation of Houston Tex. having a Windows® 2000 operating system available from Microsoft® Corporation in an embodiment of the present invention.

In an embodiment of the present invention, manager **700** has an IP interface in order to gain access to microrouter **404** and access a device notification service, such as SMS **406***h*. Manager **700** can be installed on any network that has IP connectivity to microrouter **404**. Manager **700** can be installed by a service provider on Internet **103**, or by an operator **115** on its IP backend network having server **102**.

Manager **700** includes two software components, network manager **701** and extended network manager **702**, in an embodiment of the present invention.

Network manager **701** is responsible for, but not limited to, the following functions: 1) configuring an IP parameter, such as IP domain range or policies, 2) configuring plug-ins **406** currently installed and executed, 3) enabling/disabling an installed plug-ins **406**, 4) loading new plug-ins in microrouter **404**, and 5) removing plug-ins **406** from microrouter **404**.

Network extended manager **702** is responsible for, but not limited to, the following functions: 1) collecting usage profiles for each microrouter **404** and each terminal in LAN **116**, 2) managing PINs, such as denying access to LAN **116** for a particular terminal or approving access to LAN **116** for other terminals, 3) managing security, such as configuring VPN **406***b* or configuring Firewall **406***c*, 4) configuring Link Optimization **406***e*, and 5) configuring Quality of Service ("QoS") parameters in microrouter **404**.

In an embodiment of the present invention, plug-in manager software components **706***a–f* are stored in manager server **102** and use network manager software component **701** and/or extended network manager software component **702** for accessing and controlling network plug-ins **406***a–k*. For example, a plug-in manager software component **706***d* is used to obtain statistics information from statistics plug-in **406***d* in microrouter **404**. In an embodiment of the present invention, there is a corresponding plug-in manager software component in manager software **700** for every plug-in software component in microrouter **404**.

VI. Conclusion

The foregoing description of the preferred embodiments of the present invention has been provided for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Obviously, many modifications and variations will be apparent to practitioners skilled in the art. The embodiments were chosen and described in order to best explain the principles of the invention and its practical applications, thereby enabling others skilled in the art to understand the invention for various embodiments and with the various modifications as are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the following claims and their equivalents.

What is claimed is:

1. A hand-held device for enabling communication between one or more devices connected to one or more cellular networks and one or more devices connected to a wireless local area network, comprising:

a) a first transceiver to communicate with the one or more devices connected to said one or more cellular networks by sending and receiving cellular signals, the first transceiver having a cellular network address;

b) a second transceiver to communicate with the one or more devices connected to the wireless local area network by sending and receiving short-range radio signals;

c) a storage device to store:

c.1. a router software component to transfer a plurality of data packets between the one or more devices connected to the one or more cellular networks and the one or more devices connected to the wireless local area network by the cellular signals and the short-range radio signals; and

c.2. an interface software component to add a first network service software component that provides one or more network services to the wireless local area network, the first network service software component loaded into the storage device from the one or more devices connected to the one or more cellular networks: and one or more processors connected to the storage device to process the cellular signals and the short-range radio signals,

wherein the cellular network includes a plurality of public IP addresses and the wireless local area network includes a plurality of private IP addresses, and wherein the router software component translates a first IP address in the plurality of public IP addresses to a second IP address in the plurality of private IP addresses.

2. The hand-held device of claim **1**, wherein the plurality of data packets includes an Internet Protocol ("IP") packet.

3. The hand-held device of claim **1**, wherein the one or more cellular networks are connected to the Internet.

4. The hand-held device of claim **1**, wherein the one or more cellular networks are connected to a corporate network.

5. The hand-held device of claim **1**, wherein the one or more cellualr networks are connected to a private IP network.

6. The hand-held device of claim **1**, wherein the wireless local area networks include a Bluetooth™ wireless local area network.

7. The hand-held device of claim **1**, wherein the wireless local area networks include a 802.11 wireless local area network.

8. The hand-held device of claim **1**, wherein the router software component includes a network address translator ("NAT") software component to translate between the cellular network address and a first wireless local area network address.

9. The hand-held device of claim **1**, wherein the router software component includes a network address port translation ("NAPT") software component to translate between the cellular network address and a first wireless local area network address.

10. The hand-held device of claim **1**, wherein the router software component includes a local routing software component to route an IP packet between a first wireless device in the wireless local area network and a second wireless device in the wireless local area network.

11. The hand-held device of claim **1**, wherein the first network service software component is a pairing management software component to determine whether a first wireless device, which is connected to the wireless local area network, is responsive to a signal from the one or more devices connected to the one or more cellular networks.

12. The hand-held device of claim **1**, wherein the first network service software component is a virtual private network software component to establish a secure link.

13. The han-held device of claim **1**, wherein the first network service software component is a firewall software component.

14. The hand-held device of claim **1**, wherein the first network service software component is a statistics software component to collect usage information of the wireless local area network.

15. The hand-held device of claim **14**, wherein the statistics software component collects usage information of a first wireless device in the wireless local area network.

16. The hand-held device of claim **14**, wherein the statistics software component collects usage information of an application software component in a first wireless device in the wireless local area network.

17. The hand-held device of claim **1**, wherein the first network service software component includes a link optimization software component to convert an IP packet included in the plurality of data packets from a first wireless device in the wireless local area network to an optimized cellular protocol packet.

18. The hand-held device of claim **1**, wherein the first network service software component includes a reverse firewall software component to drop a packet included in the plurality of data packets from a first wireless device in the wireless local area network.

19. The hand-held device of claim **1**, wherein the first network service software component includes a reverse firewall software component to drop a packet included in the plurality of data packets from a first application software component on a first wireless device in the wireless local area network.

20. The hand-held device of claim **1**, wherein the first network service software component includes a flashing software component to provide a flash image to a first wireless device, in the wireless local area network, to update capability of the first wireless device.

21. The hand-held device of claim **1**, wherein the first network service software component includes a flashing software component to provide a flash image to a first wireless device, in the wireless local area network, that repairs the first wireless device.

22. The hand-held device of claim **1**, wherein the first network service software component includes a flashing software component to provide a flash image to a first wireless device, in the wireless local area network, to add capability of the first wireless device.

23. The hand-held device of claim **1**, wherein the first network service software component is a message software component to provide a message between a first wireless device and a second wireless device in the wireless local area network.

24. The hand-held device of claim **1**, wherein the first network service software component is a service level enforcement software component to limit an amount of packets transferred from a first wireless device in the wireless local area network to the one or more cellular networks during a period of time.

25. The hand-held device of claim **1**, wherein the first network service software component is a Bluetooth™ LAN Access Profile software component.

26. The hand-held device of claim **1**, wherein the first network service software component is a Bluetooth™ Dial-Up Profile software component.

27. The hand-held device of claim **1**, wherein the first network service software component is a Virtual Bluetooth™ Dial-Up Profile software component to provide packet switching in response to a circuit switching signal.

28. A system for enabling communication between one or more devices connected to one or more cellular networks and one or more devices connected to a wireless local area network, the system comprising:

a) a managing processing device connected to the one or more cellular networks for managing, collecting and configuring data in the wireless local area network;

b) a hand-held device connected to the managing processing device and connected to the wireless local area network, the handheld device comprising:

b.1. a router software component to transfer a plurality of packets between one or more devices connected to the one or more cellular networks and the one or more devices connected to the wireless local area network by the cellular signals and the short-range radio signals; and

b.2. an interface software component to add a first network service software component that provides one or more network services to said wireless local area network, the first network service software component

loaded into the hand-held device by the managing processing device, including a managing software component, sending the cellular signals over the one or more cellular networks; and

c) a device connected to the hand-held device and connected to the wireless local area network to transfer a first packet in the plurality of packets to the hand-held device, wherein the router software component maintains a first IP session link with a first cellular network in the one or more cellular networks and a second IP session link with a second cellular network in the one or more cellular networks.

29. The system of claim **28**, wherein the router software component tunnels the plurality of packets to the managing processing device and wherein the managing processing device processes the plurality of packets.

30. The system of claim **28**, wherein the router software component maintains a first IP session link with a first cellular network in the one or more cellular networks responsive to an amount of IP packets received in the plurality of packets.

31. The system of claim **28**, wherein the router software component initiates a first IP session link with a first cellular network in the one or more cellular networks responsive to a signal from the managing processing device.

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