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(54) **ASSET TRACKING APPARATUS AND METHOD**

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(52) **U.S. Cl.** **340/539.13**; 340/573.1; 340/539.1; 340/539.11; 340/539.15; 340/539.31; 340/539.32

(58) **Field of Search** 340/573.1, 539.1, 340/539.11, 539.13, 539.15, 539.31, 539.32

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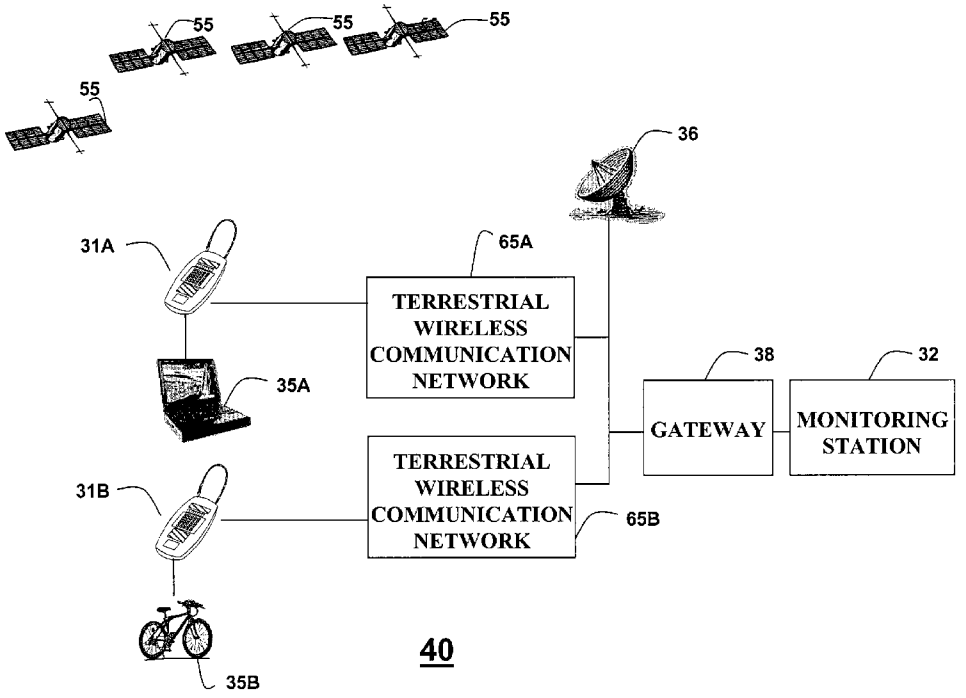
(57) **ABSTRACT**

An asset securing and tracking system **(30)** operates in conjunction with a wireless communication network **(65)** for tracking a portable asset **(35)**. The system **(30)** includes a tracking device **(31)** adapted to be attached to the portable asset **(35)** and communicate with the wireless communication network **(65)**. The tracking device **(31)** determines the location of the asset **(35)** using signals from GPS satellites **(55)** and the terrestrial wireless communication network **(65)**. A monitoring station **(32)** receives and processes a location signal regarding the geographic location of the portable asset **(35)** from tracking device **(31)** via the wireless communication network **(65)**.

5 Claims, 4 Drawing Sheets



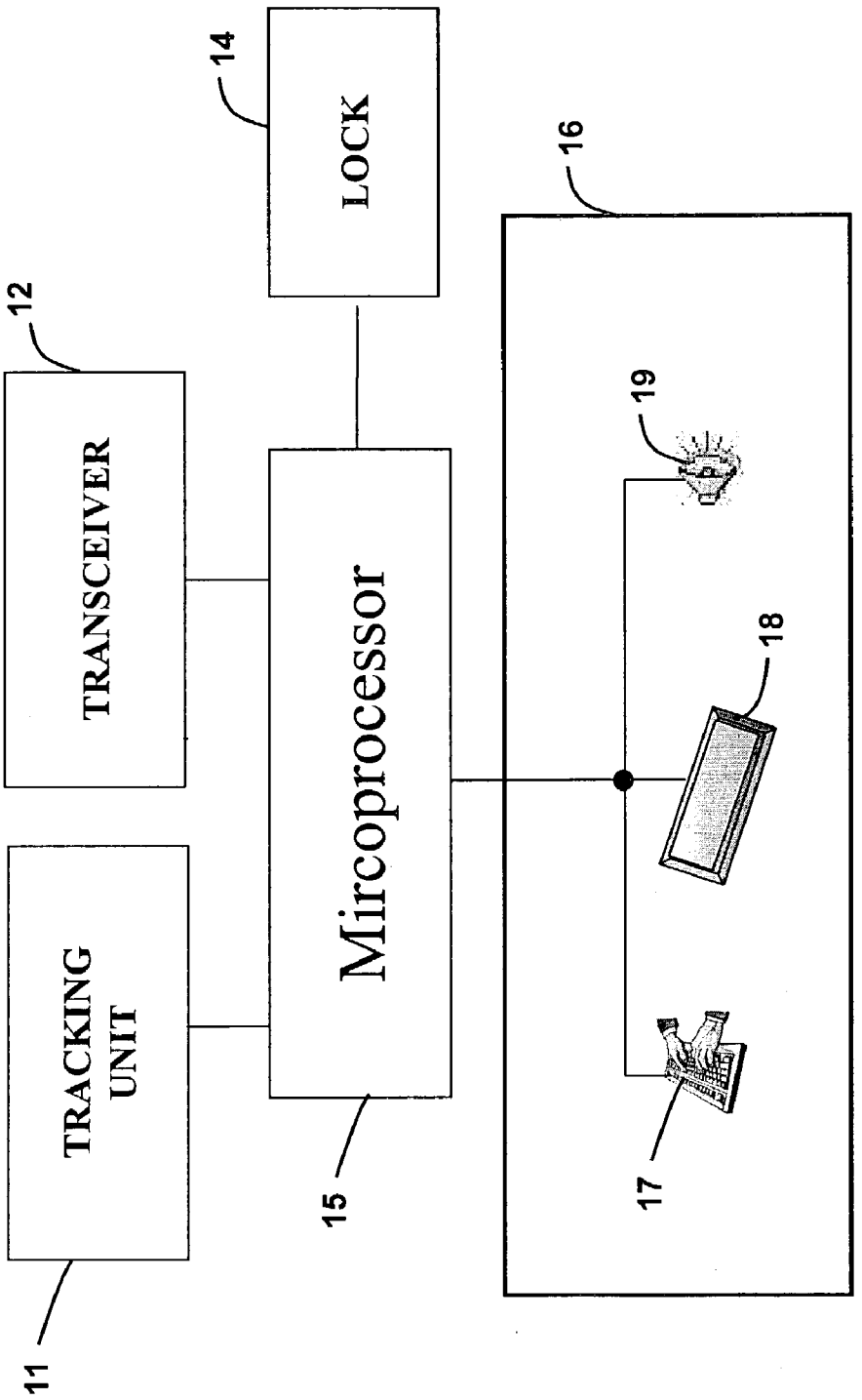

14
LOCK
16
12
TRANSCEIVER
19
Mircoprocessor
18
TRACKING UNIT
15
17
11

FIG. 1

10

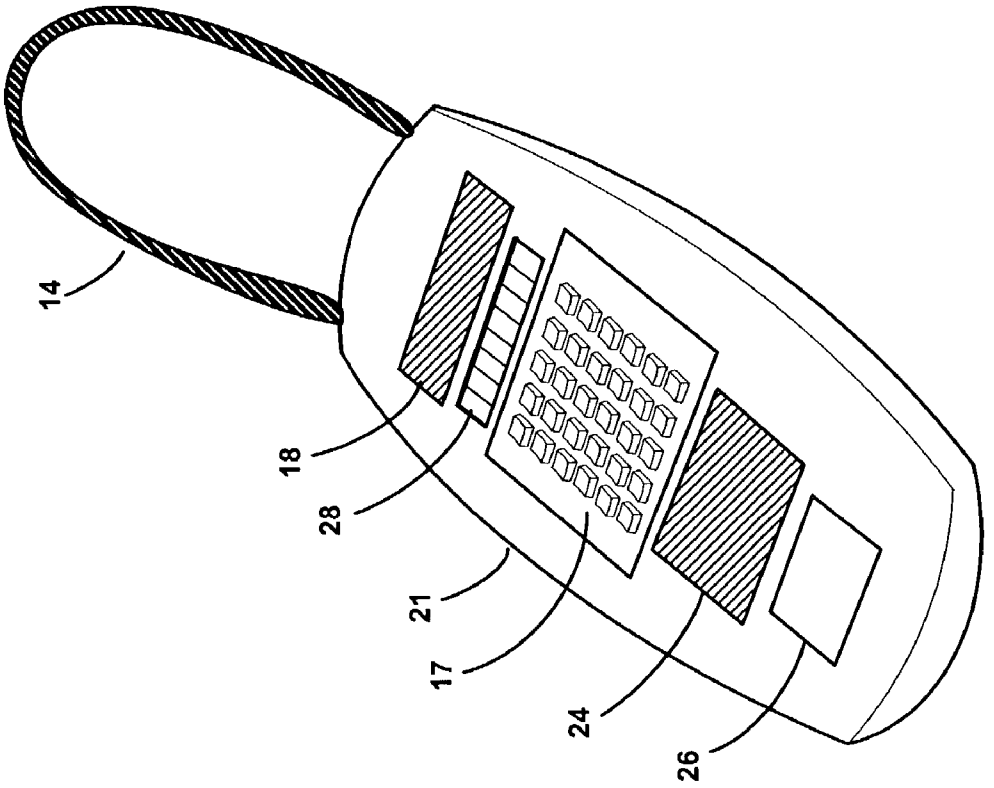
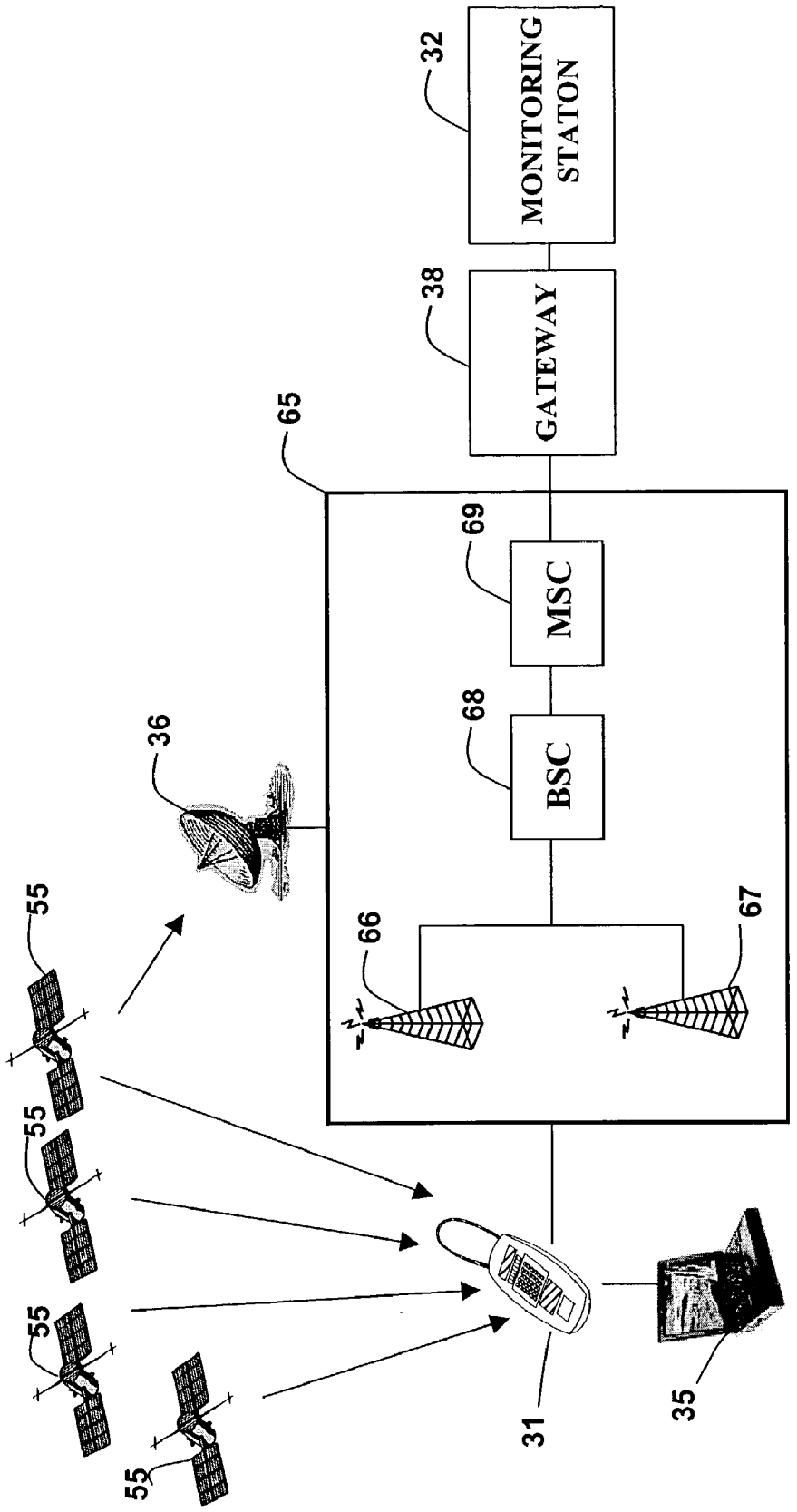
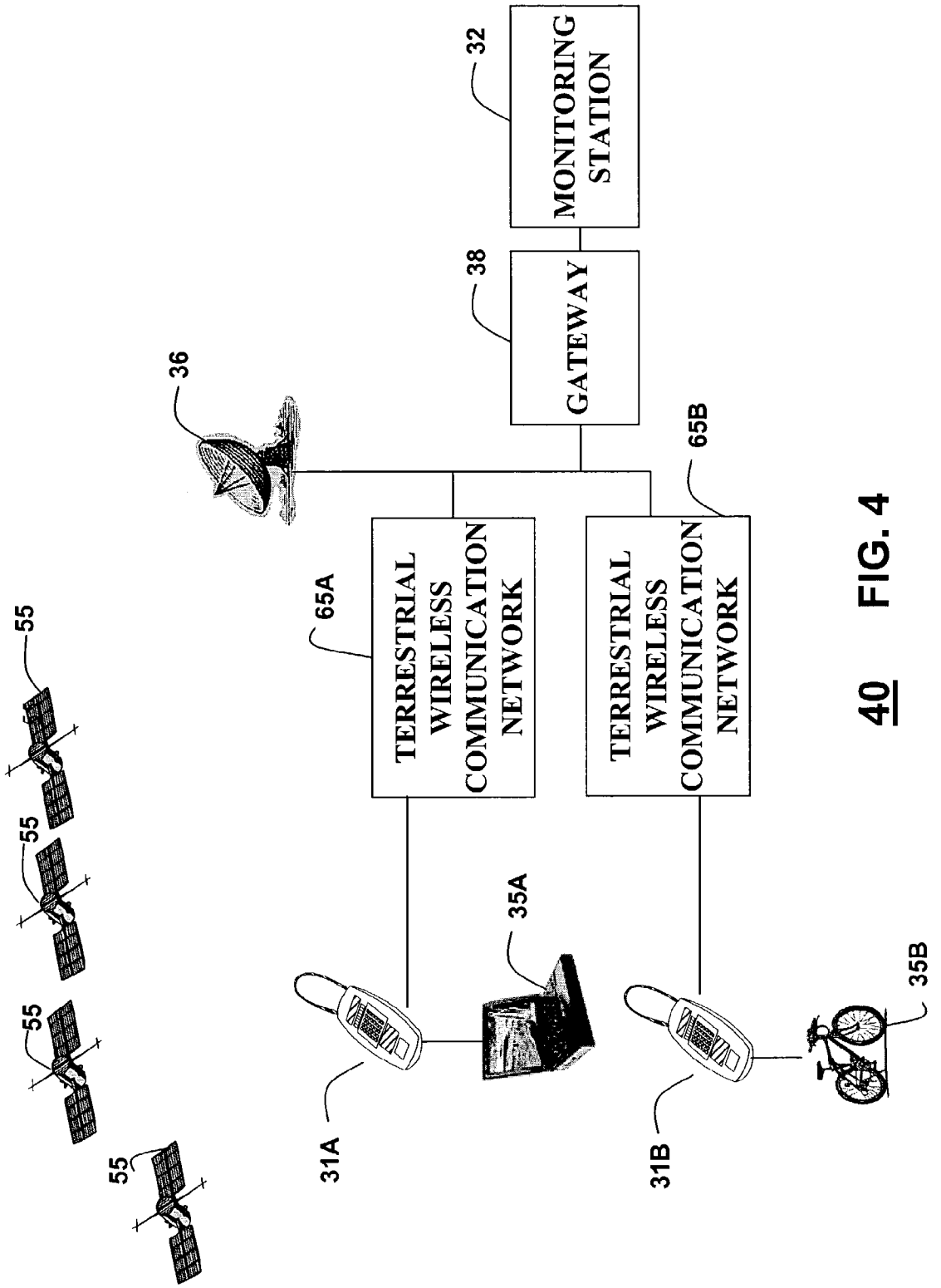


FIG. 2

20


32
MONITORING STATON
38
GATEWAY
65
69
MSC
68
BSC
36
66
67
55
55
55
55
31
35

30 FIG. 3


MONITORING STATION
32
GATEWAY
38
36
TERRESTRIAL WIRELESS COMMUNICATION NETWORK
65A
TERRESTRIAL WIRELESS COMMUNICATION NETWORK
65B
55
55
55
55
31A
35A
31B
35B

40 FIG. 4

ASSET TRACKING APPARATUS AND METHOD

FIELD OF THE INVENTION

The present invention relates, in general, to asset tracking and, more specifically, to device and method for securing and tracking a portable object.

BACKGROUNDS OF THE INVENTION

In our fast paced and highly mobile society, people increasingly rely on portable electronics equipment, for example, laptop computers, personal digital assistants (PDA), personal communication system (PCS) devices, etc. to improve their productivity or enrich their lives. However, people often lose portable electronics equipment due to theft or misplacement. The cost of losing portable equipment includes not only the replacement cost of the hardware and the software installed thereon, but also the loss of the data stored in the equipment and the loss of productivity.

Cable locks are often used for securing laptop computers to fixed items to deter theft. Cable locks are simple to use and relatively inexpensive. However, the cables can be cut or sheared by a determined larcenist. Furthermore, once a portable asset is stolen or otherwise lost, it is nearly impossible for the owner to track and retrieve it.

Accordingly, it would be advantageous to have an apparatus and method for effectively securing portable objects. It would be beneficial for the apparatus to be able to be securely attached to the portable object. It would be beneficial for the apparatus and the method to be able to track the portable object over a large geographic area and under a variety of conditions. Further, would be beneficial to generate an alarm signal when the portable object is not in the possession of its owner.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a functional block diagram illustrating an apparatus for securing and tracking an object in accordance with the present invention;

FIG. **2** shows a perspective view of an asset securing and tracking device in accordance with the present invention;

FIG. **3** is a schematic diagram illustrating an asset tracking system in accordance with the present invention; and

FIG. **4** is a schematic diagram showing another asset tracking system in accordance with the present invention.

DETAILED DESCRIPTION OF VARIOUS EMBODIMENTS

Various embodiments of the present invention are described hereinafter with reference to the figures. Elements of like structures or function are represented with like reference numerals throughout the figures. The figures are only intended to facilitate the description of specific embodiments of the invention. They are not intended as an exhaustive description of the invention or as a limitation on the scope of the invention. In addition, an aspect described in conjunction with a particular embodiment of the present invention is not necessarily limited to that embodiment and can be practiced in conjunction with any other embodiments of the invention.

FIG. **1** is a functional block diagram illustrating an apparatus **10** in accordance with an embodiment of the present invention. Apparatus **10** is used for securing and tracking an object (not shown in FIG. **1**) such as a computer, a camera, a camcorder, a bicycle, a scooter, a motorcycle, a piece of luggage, a handbag, a backpack, etc. Apparatus **10** can also be referred to as an asset securing device, an asset tracking device, an electronic locking device, etc.

In this embodiment, apparatus **10** includes a tracking unit **11** and a radio frequency (RF) transceiver **12** coupled to a signal processor **15**. Tracking unit **11**, which is also referred to as a tracking device, a geographic positioning device, etc., includes a global positioning system (GPS) receiver to determine the geographic location of the object using signals from the GPS satellites. In a preferred embodiment the GPS receiver includes a wireless assisted GPS (AGPS) device, and signal processor **15** includes a microprocessor. RF transceiver **12** may be an element of tracking unit **11**. Apparatus **10** also includes user interface **16** coupled to microprocessor **15**. FIG. **1** shows interface **16** including a keypad **17**, a visual display **18**, and an audio alarm **19**.

In accordance with one embodiment of the present invention, apparatus **10** includes a lock **14** configured to securely attach apparatus **10** to the object to be tracked. In this embodiment, apparatus **10** also includes a frame, a casing, or an enclosure (not shown in FIG. **1**) mechanically coupled to lock **14** for holding different components of apparatus **10** together. In accordance with the present invention, lock **14** can have various types locking/unlocking mechanisms, e.g., mechanical, optical, magnetic, electrical, etc. In one embodiment, lock **14** includes a cable made of a sturdy material, such as metal, hard plastic, or fibers that are capable of securing the object to another item. In another embodiment, lock **14** is an electronic lock coupled to microprocessor **15**. Microprocessor **15** controls the operation of electronic lock **14** in response to signals from interface **16** or from a remote monitoring station (not shown in FIG. **1**).

In accordance with another embodiment of the present invention, apparatus **10** is embedded in the object to be tracked. The object, e.g., a portable computer, with apparatus **10** embedded therein, is capable of tracking its own geographic location. In one embodiment, the elements of apparatus **10** are embedded directly into the object. In another embodiment, apparatus **10** includes a structure, e.g., a frame or a case, (not shown in FIG. **1**) that holds the elements in apparatus **10** together. The structure is attached to the object. This allows apparatus **10** to be easily detached from the object, which may be desirable in certain circumstances and applications, e.g., detaching apparatus **10** from the object for maintenance, for upgrading, for attaching to another object for tracking, etc.

With apparatus **10** embedded in the object, some elements in apparatus **10** may serve multiple functions. By way of example, microprocessor **15** may also serve as a microprocessor of a computer to be tracked using apparatus **10**. Also by way of the example, radio frequency transceiver **12** may also serve as a wireless modem of the computer or share the same antenna with the wireless modem of the computer. Sharing the functional elements between apparatus **10** and the tracked object improves the overall cost efficiency of the object.

FIG. **1** shows interface **16** including keypad **17**, visual display **18**, and audio alarm **19**. They serve to establish a communication link between a user and microprocessor **15**. For example, the user may enter user commands or security codes into microprocessor **15** through keypad **17**. Visual display **18** may display the status of apparatus **10**, e.g., whether lock **14** is in a lock position or an unlock position, whether the user entered commands or security codes are valid, whether apparatus **10** is within the coverage area of a

terrestrial wireless communication network, whether the battery (not shown in FIG. **1**) needs recharging, etc. Audio alarm **19** may be activated by microprocessor **15** when the object is not in the possession of its owner. For example, microprocessor **15** may activate audio alarm **19** when an invalid security code is entered at keypad **17**. Microprocessor **15** may also activate audio alarm **19** in response to a command from a monitoring station (not shown in FIG. **1**).

It should be understood that interface **16** is optional in accordance with the present invention. Furthermore, interface **16** is not limited to including keypad **17**, visual display **18**, and audio alarm **19**, as shown in FIG. **1**. In accordance with an alternative embodiment of the present invention, apparatus **10** is embedded in the object to be tracked and invisible from the exterior of the object. In this embodiment, apparatus **10** does not include keypad **17** and visual display **18**. Alternatively, apparatus **10** may use the interface of the tracked object, e.g., the keyboard, visual display, and the sound system of a portable computer, as its interface **16**. In another alternative embodiment, interface **16** may include a pattern recognition device (not shown in FIG. **1**) in addition to or in place of keypad **17**. The pattern recognition device may recognize the fingerprint and/or the eye pupil pattern of the owner. In yet another alternative embodiment, interface **16** includes a writing pad (not shown in FIG. **1**) for handwriting. In yet another alternative embodiment, interface **16** includes a thumbwheel (not shown in FIG. **1**) input.

FIG. **2** illustrates a perspective view of a portable asset securing and tracking device **20** in accordance with the present invention. In accordance with a preferred embodiment, asset securing and tracking device **20** is functional similar to apparatus **10** described herein above with reference to FIG. **1**. Device **20** has a hard casing holding and enclosing various functional components, e.g., tracking unit **11**, transceiver **12**, and microprocessor **15** as shown in FIG. **1**. In a preferred embodiment, casing **21** is water proof and shock proof, thereby protection the functional components therein from potential hazardous environment and tampering.

A lock **14** is mechanically coupled to casing **21** for attaching device **20** to the object to be secured or tracked. FIG. **2** shows lock **14** as a steel cable lock in accordance with an embodiment of the present invention. Cable lock **14** is capable of attaching device **20** to more than one objects simultaneously. Cable lock **14** is also capable of securing the object to a fixed item, e.g., a bicycle rack. Lock **14** may be opened and closed using a key, which may be mechanical, optical, magnetic, electrical, etc. Lock **14** may also be operated in response to the commands from microprocessor **15**.

Device **20** also includes an alpha numeric keypad **17** and a liquid crystal display (LCD) panel **18** on the surface of casing **21**, which are parts of interface **16** described above with reference to FIG. **1**. FIG. **2** shows that interface **16** also includes a finger print identification faceplate **24**. Faceplate **24** is coupled to microprocessor **15** (shown in FIG. **1**) for verifying the identity of the person who seeks to operate device **20**, e.g., unlocking lock **14**, deactivating the tracking function, turning off the audio alarm, etc. If the finger print read through faceplate **24** does not match that of the owner, device enters a security mode. In the security mode, device **20** rejects any further input from the user until a valid finger print identification is provided. Device **20** further performs various functions to secure the object, which functions include, but are not limited to, sending out location signals indicating the location of the object, activating the audio alarm, etc.

Device **20** also includes a battery compartment **26** and a solar panel **28**. Battery compartment **26** encloses a power source for operating device **20**. Solar panel **28** functions to recharge the power source in battery compartment **26**. In accordance with a preferred embodiment, battery compartment **26** includes a tampering proof cover, thereby avoiding device **20** being deactivated by an unauthorized user.

It should be noted that solar panel **28** is an optional feature in device **20**. In an alternative embodiment, device **20** includes a power source recharging adapter, in addition to or in place of solar panel **28**, for recharging the power source. In yet another alternative embodiment, the power source in device **20** includes a non-rechargeable high energy density battery, e.g., a lithium battery, which can be replaced.

FIG. **3** is a schematic diagram illustrating an asset securing and tracking system **30** in accordance with an embodiment of the present invention. System **30** operates in conjunction with a wireless communication network **65** for tracking a portable asset or object **35**. By way of example, FIG. **3** shows object **35** as a portable computer.

Asset securing and tracking system **30** includes a tracking device **31** configured to be attached to object **35** for tracking object **35**. In accordance with a preferred embodiment of the present invention, tracking device **31**, which is also referred to as an asset tracking unit or an asset securing apparatus, is functionally similar to apparatus **10** described herein above with reference to FIG. **1**. Asset securing and tracking system **30** also includes a monitoring station **32** that monitors and tracks the geographic location of object **35**. Specifically, monitoring station **32** sends a tracking command to tracking device **31** via wireless communication network **65** and receives a location signal indicating the geographic location of object **35** from tracking device **31** via wireless communication network **65**.

In accordance with a preferred embodiment of the present invention, tracking device **31** includes a GPS or an AGPS device that is functionally similar that described herein above with reference to tracking unit **11** shown in FIG. **1**. Using GPS and AGPS to determine the geographic location of an object are described in "Geolocation and Assisted-GPS" by Goran M. Djuknic and Robert E. Richton, published on May 31, 2002 on line at the web page http://www.lucent.com/livelink/090094038000e51f_White_paper.pdf, which is incorporated herein by reference in its entirety.

A GPS receiver in tracking device **31** determines the geographic location of object **35** using signals from GPS satellites **55**. The GPS includes a constellation of twenty-four satellites for providing coded signal coverage throughout the world at a frequency of 1574.42 mega-Hertz (MHz). The GPS receiver in tracking device **31** receives and processes the coded signals from at least four GPS satellites to determine the location of object **35** (longitude, latitude, and altitude). However, the GPS receiver cannot effectively determine the location when tracking device **31** is not in the direct lines of sight from the GPS satellites. This may happen when tracking device **31** is indoors, surrounded by high rise buildings, or under a canopy of trees.

An AGPS device uses signals from GPS satellites **55** and signals from base stations, e.g., base stations **66** and **67** shown in FIG. **3**, in terrestrial wireless communication network **65**, in determining the geographic location of tracking device **31**. When tracking device **31** is in the lines of sight of the GPS satellites, it uses signals from both GPS satellites **55** and base station **66** or **67** to calculate its location. This will generally increase the accuracy of tracking device **31**. In addition, the AGPS device is capable of

determining the location of tracking device **31** even when it is not in the lines of sight from GPS satellites **55** by processing the signals from base station **66** or **67**.

Terrestrial wireless communication network **65** may be any kind of wireless communication network. For example, network **65** may be a network dedicated for asset tracking purpose. In a preferred embodiment, network **65** is an existing cellular telephone network that provides coverage over a wide geographic area. A cellular telephone network typically includes base station controllers (BSC), e.g., a BSC **68** shown in FIG. **3**, and mobile switching centers (MSC), e.g., a MSC **69** shown in FIG. **3**. BSC **68** and MSC **69** serve to establish communication between tracking device **31** and different base stations **66** depending on the location of tracking device **31** in the cellular network **65**. Furthermore, network **65** may employ various kinds of multiple access standards for the multiple access of network **65**, e.g., time division multiple access (TDMA), frequency division multiple access (FDMA), code division multiple access (CDMA), a combination of different multiple access standards, etc.

In an embodiment with asset tracking device **31** including an AGPS device, asset tracking system **30** also includes an AGPS server **36** communicating with wireless communication network **65**. AGPS server **36** functions to generate coded positioning signals of base stations **66** and **67** in wireless communication network **65** in accordance with the signals from GPS satellites **55**. In other words, AGPS server **36** synchronizes the coded positioning signals of base stations **66** and **67** in terrestrial wireless communication network **65** with the signals of GPS satellites **55**. In accordance with one embodiment of the present invention, AGPS server **36** is stationary and is locked to the signals from a predetermined set of GPS satellites. In accordance with another embodiment of the present invention, AGPS server **36** selectively locks onto the signals from the GPS satellites for optimal signal transmission quality.

Asset tracking system **30** further includes a network gateway **38** coupled to monitoring station **32**. Network gateway **38** serves to relay the signals between monitoring station **32** and wireless communication network **65**. The signal transmission between gateway **38** and wireless communication network **65** can be either wired or wireless in accordance with the present invention. It should be noted that network gateway **36** is optional in accordance with the present invention. Furthermore, network gateway **38** is not limited to being an element in asset tracking system **30** separate from monitoring station **32**. In accordance with an alternative embodiment of the present invention, network gateway **38** is an integral part of monitoring station **32**.

In operation according to an embodiment of the present invention, tracking device **31** tracks the geographic location of object **35** using signals from GPS satellites **55** and terrestrial wireless communication network **65**. In one embodiment, tracking device **31** periodically sends out location signals indicating the location of object **35**. Monitoring station **32** receives the location signals via wireless communication network **65** and network gateway **38**, thereby tracking the geographic location of object **35**. In another embodiment, tracking device **31** transmits the location signal in response to a tracking command from monitoring station **32** transmitted through wireless communication network **65**. Monitoring station **32** may periodically send out the tracking commands to keep tracking object **35**. Monitoring station **32** may also send out the tracking command in response to the owner of object **35** reporting the loss of object **35**. After receiving the location signal from tracking device **31**, monitoring station **32** may direct the owner or the law enforcement authority to object **35**.

FIG. **4** is a schematic diagram illustrating an asset tracking system **40** in accordance with another embodiment of the invention. System **40** operates in conjunction with multiple wireless communication networks for asset tracking. By way of example, FIG. **4** shows asset tracking system **40** operating with two terrestrial wireless communication networks **65**A and **65**B.

Asset securing and tracking system **40** includes a tracking device **31**A configured to be attached to an object **35**A for tracking object **35**A, and a tracking device **31**B configured to be attached to an object **35**B for tracking object **35**B. In accordance with a preferred embodiment of the present invention, tracking devices **31**A and **31**B are functionally similar to apparatus **10** described herein above with reference to FIG. **1**. Asset securing and tracking system **40** also includes a monitoring station **32** that monitors and tracks the geographic locations of objects **35**A and **35**B. Specifically, monitoring station **32** receives location signals indicating the geographic locations of objects **35**A and **35**B from tracking devices **31**A and **31**B, respectively, via at least one of wireless communication networks **65**A and **65**B.

Asset tracking system **40** further includes a network gateway **38** serving to relay the signals between monitoring station **32** and wireless communication networks **65**A and **65**B. The signal transmission between gateway **38** and wireless communication networks **65**A and **65**B can be either wired or wireless in accordance with the present invention.

In accordance with a preferred embodiment of the present invention, each of tracking devices **31**A and **31**B includes a GPS or an AGPS device that is functionally similar to that described herein above with reference to tracking unit **11** shown in FIG. **1**. If at least one of tracking devices **31**A and **31**B is an AGPS device, asset tracking system **40** also includes an AGPS server **36** communicating with at least one of wireless communication networks **65**A and **65**B. AGPS server **36** functions to generate the coded positioning signals in at least one of wireless communication networks **65**A and **65**B in accordance with the signals from GPS satellites **55**. In other words, AGPS server **36** synchronizes the coded positioning signals of at least one of terrestrial wireless communication networks **65**A and **65**B with the signals of GPS satellites **55**. In accordance with one embodiment of the present invention, AGPS server **36** is locked to the signals from a predetermined set of GPS satellites. In accordance with another embodiment of the present invention, AGPS server **36** selectively locks onto the signals from the GPS satellites for optimal signal transmission quality.

By way of example, FIG. **4** shows asset tracking devices **31**A and **31**B communicating with monitoring station **32** via networks **65**A and **65**B, respectively. Furthermore, asset tracking devices **31**A and **31**B receive coded signals from networks **65**A and **65**B, respectively, in determining the locations of respective objects **35**A and **35**B. Also by way of example, wireless communication networks **65**A and **65**B are wireless networks operated by different wireless service providers.

Generally, different service providers operate wireless communication networks covering different areas, having different communication standards, e.g., TDMA, CDMA, global system for mobile communication (GSM), etc., operating at different frequency bands, e.g., 800 MHz, 1900 MHz, etc., or having different bandwidths and data transmission rates. In accordance with an embodiment of the present invention, asset tracking system **40** is operated in

conjunction with multiple wireless communication networks to provide asset tracking over a wide geographic area. Asset tracking devices **31**A and **31**B may be single mode devices compatible with a particular network or multiple mode devices compatible with more than one wireless communication networks.

The operation of asset tracking system **40** in securing and tracking objects **35**A and **35**B is similar to those described herein above with reference to FIGS. **1** and **3**. It should be understood that although FIG. **4** shows asset tracking system **40** including two asset tracking devices, **31**A and **31**B, and operating in conjunction with two terrestrial wireless communication networks, **65**A and **65**B, this is not intended as a limitation on scope of the present invention. In accordance with the present invention, asset tracking system **40** may include one or many tracking devices for securing and tracking a single or multiple objects. The total number of tracking devices simultaneously operating in asset tracking system **40** may be limited by the data processing capacity of monitoring station **32** and data transmission capacity of network gateway **38**. Furthermore, asset tracking system **40** may operate in conjunction with any number of wireless communication networks. In addition, different terrestrial wireless communication networks, **65**A and **65**B, may receive the GPS satellite synchronizing signals from one AGPS server **36**, or may receive the synchronizing signals from different AGPS servers.

An apparatus and method for tracking portable objects has been provided. In accordance with the present invention, a tracking device is attached to the object to be secured or tracked. The tracking device tracks the location of the object using coded signals for the GPS satellites. Optionally, the tracking device further uses the coded signals from a terrestrial wireless communication network in determining the location of the tracked object. A monitoring station communicates with the tracking device via the terrestrial wireless communication network and receives the location signals transmitted from the tracking device.

The application of tracking objects is not limited to securing portable assets. The asset tracking apparatus and process in accordance with the present invention are applicable in any area where tracking the location of an object is desirable, e.g., in the areas of cargo transportation and package delivery. In addition, the tracking device and process in accordance with the present invention are also applicable in tracking animals or even humans. For example, law enforcement authority may use the tracking system of the present invention in tracking people released on bond or on parole. Many other modifications may be made by those skilled in the art after browsing the specification without departing from the spirit and scope of the invention.

While the invention is susceptible to various modifications and alternative constructions, certain illustrated embodiments thereof are shown in the drawings and have been described above in detail. It should be understood, however, that there is no intention to limit the invention to the specific form or forms disclosed, but on the contrary, the intention is to cover all modifications, alternative constructions, and equivalents falling within the spirit and scope of the invention. The present invention is limited only by the claims that follow.

What is claimed is:

1. An apparatus for tracking an object, comprising:
a geographic positioning device;
a radio frequency transceiver;
a signal processor coupled to said geographic positioning device and to said radio frequency transceiver, said signal processor being programmed to broadcast a location signal indicating a geographic location of the object determined by said geographic positioning device through said radio frequency transceiver; and
a lock for securing the apparatus to the object,
wherein said geographic positioning device, said radio frequency transceiver, said signal processor, and said lock are embedded in the object.

2. An apparatus for tracking an object, comprising:
a geographic positioning device configured to be attached to the object;
a radio frequency transceiver;
a signal processor coupled to said geographic positioning device and to said radio frequency transceiver, said signal processor being programmed to broadcast a location signal indicating a geographic location of the object determined by said geographic positioning device through said radio frequency transceiver;
a lock for securing the apparatus to the object; and
a frame holding said geographic positioning device, said radio frequency transceiver, and said signal processor, said frame being adapted for being secured to the object with the lock, wherein said frame is attached to an interior of to the object.

3. An apparatus for tracking an object, comprising:
a geographic positioning device configured to be attached to the object;
a radio frequency transceiver;
a signal processor coupled to said geographic positioning device and to said radio frequency transceiver, said signal processor being programmed to broadcast a location signal indicating a geographic location of the object determined by said geographic positioning device through said radio frequency transceiver;
a lock for securing the apparatus to the object; and
a frame holding said geographic positioning device, said radio frequency transceiver, and said signal processor, said frame being adapted for being secured to the object with the lock, wherein said lock is configured to removably attach said frame to the object.

4. An apparatus for tracking an object, comprising:
a geographic positioning device configured to be attached to the object;
a radio frequency transceiver;
a signal processor coupled to said geographic positioning device and to said radio frequency transceiver, said signal processor being programmed to broadcast a location signal indicating a geographic location of the object determined by said geographic positioning device through said radio frequency transceiver;
a lock for securing the apparatus to the object; and
a user interface coupled to said signal processor, wherein said user interface includes a pattern recognition device.

5. A method for tracking a portable object, comprising:
embedding a tracking device in the portable object;
tracking a location of the portable object using a first plurality of signals from a plurality of global positioning system (GPS) satellites;
transmitting a location signal indicating the location of the portable object; and
receiving and processing the location signal at a monitoring station.

* * * * *