US006141683A

United States Patent [19]

Kraml et al.

[11] **Patent Number: 6,141,683**

[45] **Date of Patent: *Oct. 31, 2000**

[54] **METHOD FOR REMOTELY AND RELIABLY UPDATING OF THE SOFTWARE ON A COMPUTER WITH PROVISION FOR ROLL BACK**

[75] Inventors: **Mark Heinrich Kraml**, Flanders, N.J.; **Jane Mary Leonard**, Naperville, Ill.; **Harvey Rubin**, Morristown, N.J.; **Laurel Ann Salvador**, Winfield, Ill.

[73] Assignee: **Lucent Technologies, Inc.**, Murray Hill, N.J.

[*] Notice: This patent issued on a continued prosecution application filed under 37 CFR 1.53(d), and is subject to the twenty year patent term provisions of 35 U.S.C. 154(a)(2).

[21] Appl. No.: **09/016,574**

[22] Filed: **Jan. 30, 1998**

[51] **Int. Cl.**[7] **G06F 15/177**; G06F 9/445

[52] **U.S. Cl.** **709/220**; 395/712

[58] **Field of Search** 709/217, 220, 709/250; 395/712

[56] **References Cited**

U.S. PATENT DOCUMENTS

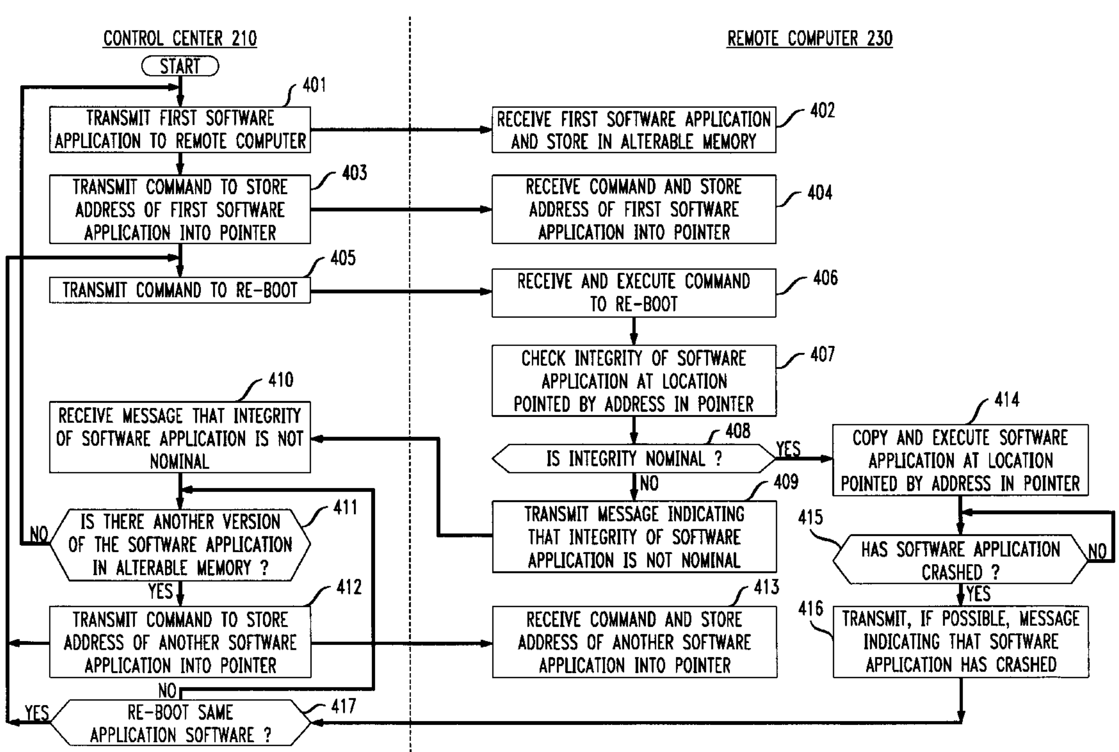
5,155,837	10/1992	Liu et al.	395/500
5,359,730	10/1994	Marron	395/650
5,481,714	1/1996	Pipkin et al.	395/700
5,555,418	9/1996	Nilsson et al.	395/700
5,625,804	4/1997	Cooper et al.	395/500
5,682,533	10/1997	Siljestroemer	395/616
5,764,992	6/1998	Kullick et al.	395/712
5,798,785	8/1998	Hendricks et al.	348/1
5,873,088	2/1999	Hayashi et al.	707/100
6,031,830	2/2000	Cowan	370/338
6,070,012	5/2000	Eitner	395/712

Primary Examiner—Zarni Maung
Assistant Examiner—Andrew Caldwell
Attorney, Agent, or Firm—DeMont & Breyer, LLC; Jason Paul DeMont; Wayne S. Breyer

[57] **ABSTRACT**

A technique for updating the software in a remote computer (e.g., a base station, a spacecraft in space, an electronic postage meter in an office, a medical monitoring device in a patient's home, etc.) from a central control (e.g., a wireless switching center, the National Aeronautics and Space Administration's Houston Control, a postage meter facility, a medical equipment manufacturer's factory, etc.) is disclosed. An illustrative embodiment of the present invention comprises: checking the integrity of a first software application at a first location in a first memory that is pointed to by a first address in a pointer; copying the first software application from the first memory to the second memory and executing the first software application from the second memory, when the integrity of the first software application is nominal; transmitting a first message indicating that the integrity of the first software application is not nominal, when the integrity of the first software application is not nominal; and receiving a first command to store a second address in the pointer, in response to the first message.

18 Claims, 3 Drawing Sheets



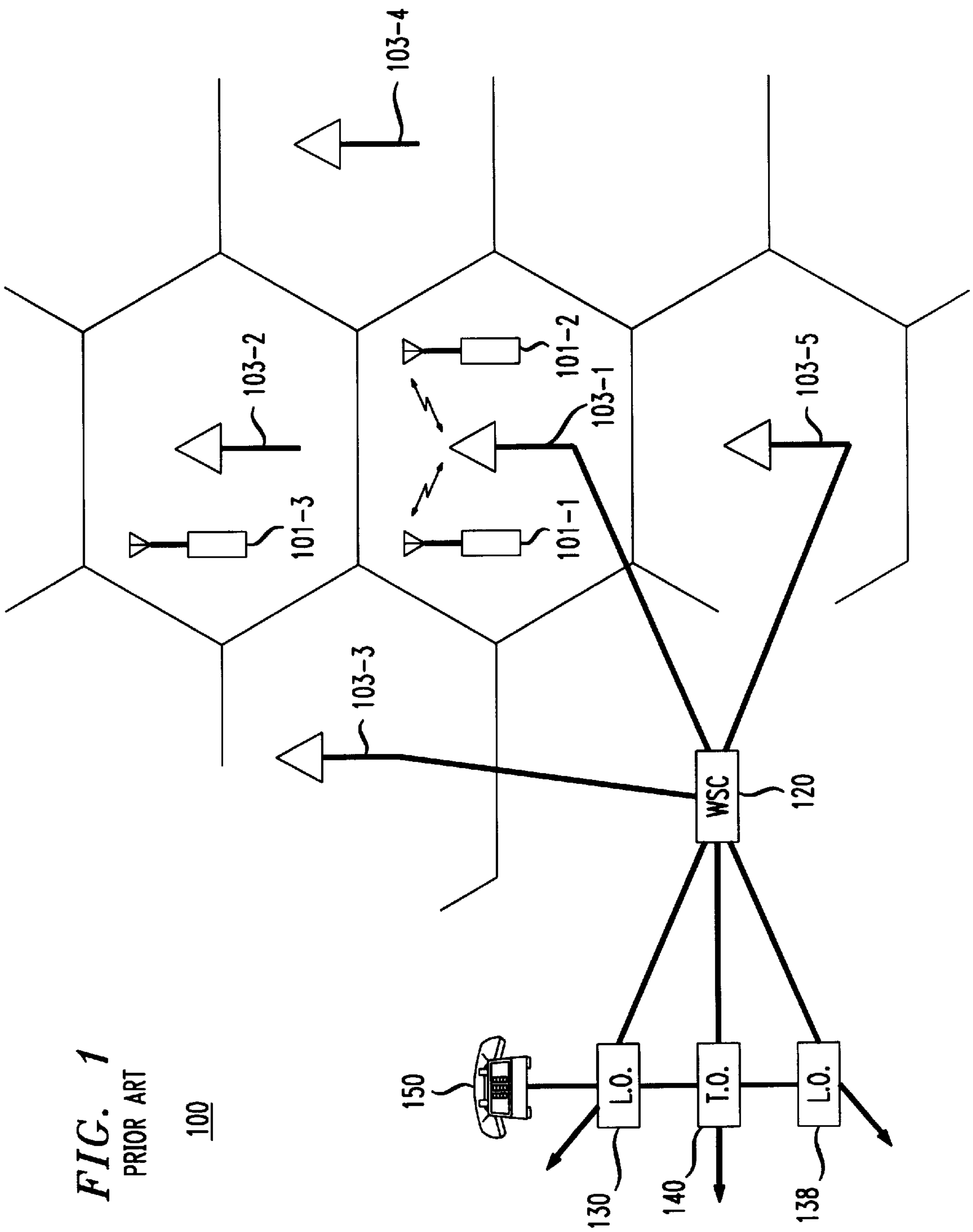


FIG. 1
PRIOR ART
100

FIG. 2

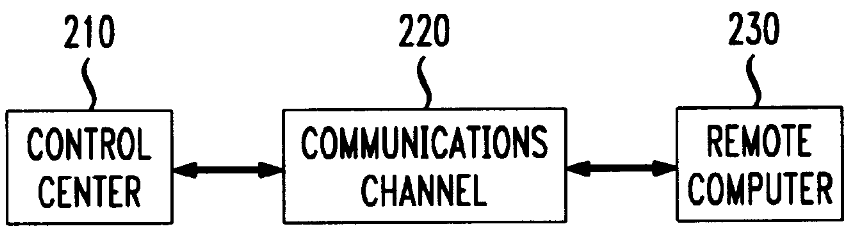
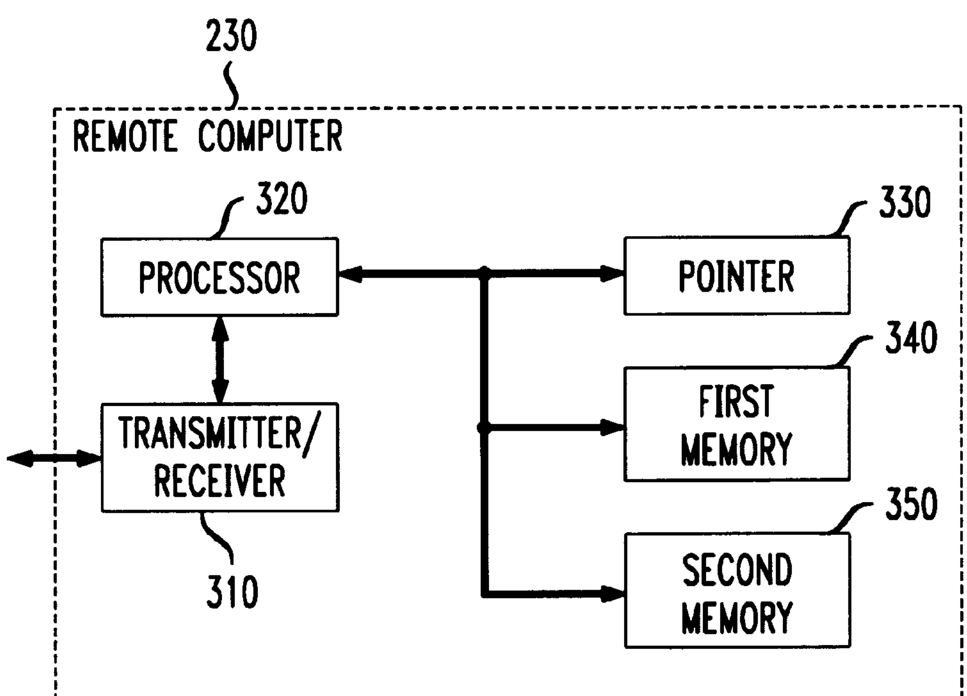

210
220
230
CONTROL CENTER
COMMUNICATIONS CHANNEL
REMOTE COMPUTER

FIG. 3


230
REMOTE COMPUTER
320
PROCESSOR
330
POINTER
340
FIRST MEMORY
TRANSMITTER/ RECEIVER
350
SECOND MEMORY
310

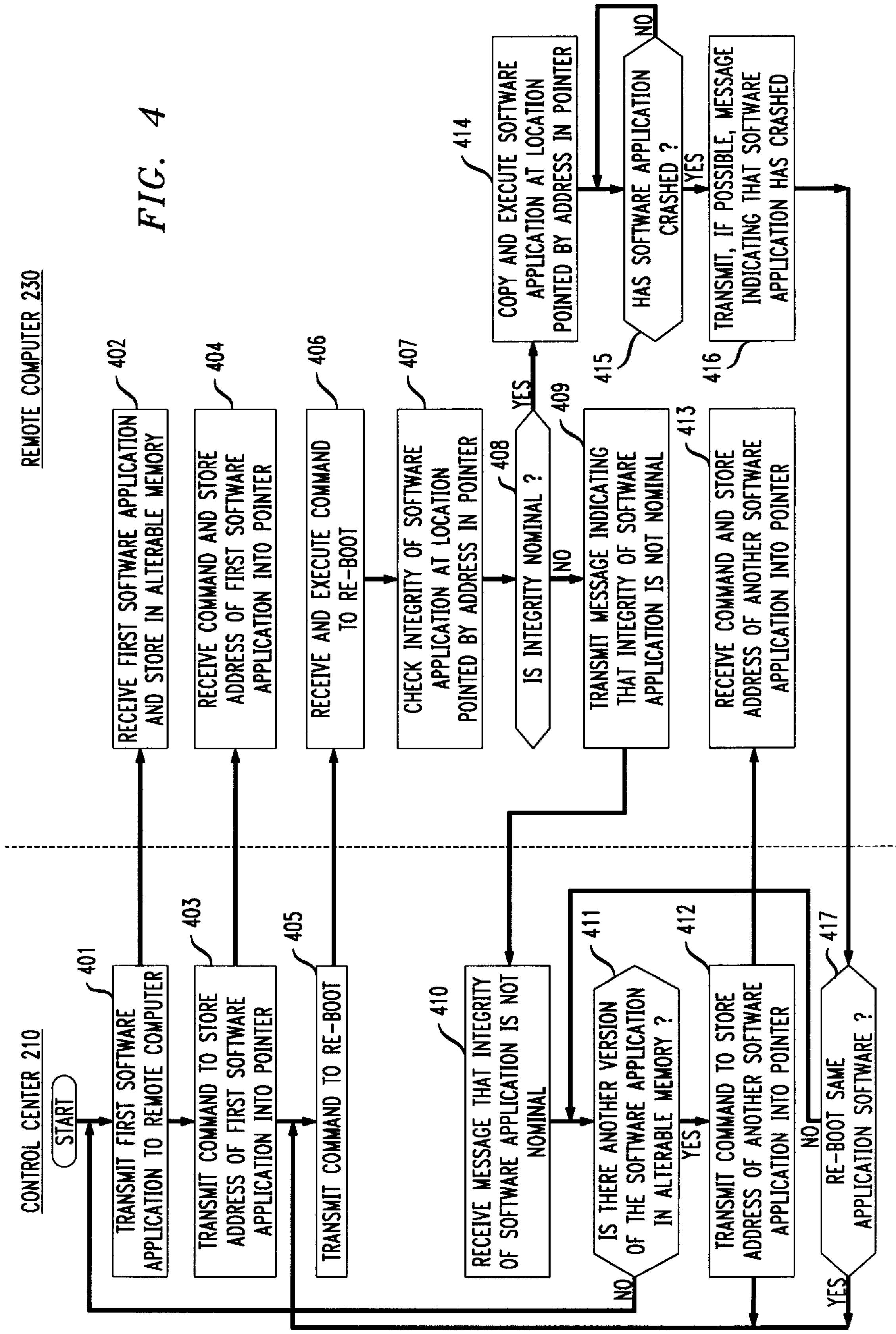

CONTROL CENTER 210
REMOTE COMPUTER 230
START
401
TRANSMIT FIRST SOFTWARE APPLICATION TO REMOTE COMPUTER
402
RECEIVE FIRST SOFTWARE APPLICATION AND STORE IN ALTERABLE MEMORY
403
TRANSMIT COMMAND TO STORE ADDRESS OF FIRST SOFTWARE APPLICATION INTO POINTER
404
RECEIVE COMMAND AND STORE ADDRESS OF FIRST SOFTWARE APPLICATION INTO POINTER
405
TRANSMIT COMMAND TO RE-BOOT
406
RECEIVE AND EXECUTE COMMAND TO RE-BOOT
407
CHECK INTEGRITY OF SOFTWARE APPLICATION AT LOCATION POINTED BY ADDRESS IN POINTER
408
IS INTEGRITY NOMINAL ?
YES
NO
409
TRANSMIT MESSAGE INDICATING THAT INTEGRITY OF SOFTWARE APPLICATION IS NOT NOMINAL
410
RECEIVE MESSAGE THAT INTEGRITY OF SOFTWARE APPLICATION IS NOT NOMINAL
411
IS THERE ANOTHER VERSION OF THE SOFTWARE APPLICATION IN ALTERABLE MEMORY ?
YES
NO
412
TRANSMIT COMMAND TO STORE ADDRESS OF ANOTHER SOFTWARE APPLICATION INTO POINTER
413
RECEIVE COMMAND AND STORE ADDRESS OF ANOTHER SOFTWARE APPLICATION INTO POINTER
414
COPY AND EXECUTE SOFTWARE APPLICATION AT LOCATION POINTED BY ADDRESS IN POINTER
415
HAS SOFTWARE APPLICATION CRASHED ?
YES
NO
416
TRANSMIT, IF POSSIBLE, MESSAGE INDICATING THAT SOFTWARE APPLICATION HAS CRASHED
417
RE-BOOT SAME APPLICATION SOFTWARE ?
YES
NO

FIG. 4

METHOD FOR REMOTELY AND RELIABLY UPDATING OF THE SOFTWARE ON A COMPUTER WITH PROVISION FOR ROLL BACK

FIELD OF THE INVENTION

The present invention relates to telecommunications in general, and, more particularly, to a method and apparatus for remotely installing software in a base station in a wireless telecommunications system.

BACKGROUND OF THE INVENTION

FIG. **1** depicts a schematic diagram of a portion of a typical wireless telecommunications system in the prior art, which system provides wireless telecommunications service to a number of wireless terminals (e.g., wireless terminals **101-1** through **101-3**) that are situated within a geographic region. The heart of a typical wireless telecommunications system is Wireless Switching Center ("WSC") **120**, which may also be known as a Mobile Switching Center ("MSC") or Mobile Telephone Switching Office ("MTSO"). Typically, Wireless Switching Center **120** is connected to a plurality of base stations (e.g., base stations **103-1** through **103-5**) that are dispersed throughout the geographic area serviced by the system and to local and long-distance telephone and data networks (e.g., local-office **130**, local-office **139** and toll-office **140**). Wireless Switching Center **120** is responsible for, among other things, establishing and maintaining calls between wireless terminals and between a wireless terminal and a wireline terminal, which is connected to the system via the local and/or long-distance networks.

The geographic area serviced by a wireless telecommunications system is partitioned into a number of spatially distinct areas called "cells." As depicted in FIG. **1**, each cell is schematically represented by a hexagon; in practice, however, each cell usually has an irregular shape that depends on the topography of the terrain serviced by the system. Typically, each cell contains a base station, which comprises the radios and antennas that the base station uses to communicate with the wireless terminals in that cell and also comprises the transmission equipment that the base station uses to communicate with Wireless Switching Center **120**.

For example, when wireless terminal **101-1** desires to communicate with wireless terminal **101-2**, wireless terminal **101-1** transmits the desired information to base station **103-1**, which relays the information to Wireless Switching Center **120**. Upon receipt of the information, and with the knowledge that it is intended for wireless terminal **101-2**, Wireless Switching Center **120** then returns the information back to base station **103-1**, which relays the information, via radio, to wireless terminal **101-2**.

A software application at each base station controls, among other things, the task of regulating the flow of information within that cell. As is well-known in the prior art, the software application can be complex and can require periodic or sporadic updates either to replace a corrupt software application or to provide an enhanced software application.

For example, the software application controlling a base station might comprise an error caused by a mistake in the logic in designing the software application, or an error caused by the corruption of one or more bits constituting the copy of the software application stored at the base station. The latter error can be caused by, for example, lightning, electrical surges on the power supply, solar flares, etc. Alternatively, the software application in the base station might need to be updated because a new version of software application has been developed that adds a new feature to the base station.

In either case, the new software application must be installed at the base station: (1) while the base station is performing its desired functionality, and (2) in a reliable manner. For example, a base station provides telecommunications services to customers **24** hours per day, and often, as in the case of 911 calls, the urgency of the calls is such that the base station should not be removed from service while the new software application is installed. Furthermore, the installation of the new software application and the design of the base station must be such that if there are any problems with the new software application, the base station is robust and able to recover while minimizing any disruption in service to customers.

A first method in the prior art for installing a software application in a base station is for the technician to physically transport the medium (e.g., a diskette, a CD-ROM, etc.) embodying the software application to the base station and to manually install the new software application into the base station. A wireless telecommunications system can comprises thousands of base stations that are dispersed over a vast geographic region and, therefore, it can be prohibitively slow or expensive or both to dispatch a technician to each base station. Although this method for installation can be performed while the base station is running, assuming that the base station has appropriate multitasking software, the reliability of this method is not clear. For example, if the newly installed software application crashes while the technician is at the base station, the technician can quickly re-install the software application. In contrast, if the new software application crashes after the technician has left the base station, service at the base station could be disrupted for a considerable period until the technician is able to return to the base station.

A second method in the prior art involves utilizing the communications channel between the wireless switching center and the base station to transport the software application. First the new software application is stored on a computer at the wireless switching center and a technician is dispatched to each base station, in turn. In accordance with this method, the technician does not transport a medium embodying the software application. The technician does, however, manually enter commands into the base station's console directing the base station to retrieve the software application from the wireless switching center and to store it into the base station's memory. After the software application is stored, the technician directs the base station to begin executing it. If the application fails while the technician is at the base station, the technician can re-install the software application, or, if the technician suspects a programming error, the technician can direct the base station to retrieve a prior, previously-tested software application from the wireless switching center and to store it into the base station's memory.

The second method is advantageous in that it allows a software application to be installed at the base station that is very recently created, and might not have been available to the technician when th, technician was last at his or her service facility. Furthermore, this method is advantageous because it enables the technician to have access to several versions of the software application, in case one version does not work. The second method is disadvantageous, however, because, like the first prior art method, it is slow, expensive, and offer's no more reliability than the first prior art method.

A third method in the prior art involves remotely directing the base station from the wireless switching center to install and execute a software application. This method is advantageous in that it eliminates the delay and expense of dispatching a technician to the base station, and allows very-recently developed software to be installed at the base station. This method is disadvantageous, however, in that if the software application crashes, the base station can be out of service while the software application is being re-installed. And because the software application can comprise megabytes of data, re-installation can take several minutes.

Therefore, the need exists for a technique for installing a software application at a base station reliably, inexpensively, and while the base station is performing its intended functionality.

SUMMARY OF THE INVENTION

Some embodiments of the present invention are capable of installing a new version of a software application in a remote computer (e.g., a base station, a spacecraft in space, an electronic postage meter in an office, a medical monitoring device in a patient's home, etc.) from a central control (e.g., a wireless switching center, the National Aeronautics and Space Administration's Houston Control, a postage meter facility, a medical equipment manufacturer's factory, etc.) with fewer costs and disadvantages than techniques in the prior art. In particular, some embodiments of the present invention are capable of installing a new version of a software application in a remote computer while the remote computer is executing an older version of the software application and in such a manner that if the new version of the software application is or becomes unusable for any reason, the remote computer can quickly "roll-back" to the older version (i.e., execute the older version instead of the newer version).

For example, consider a base station that is running an old version of a software application and that can have its functionality improved by a new version of the software application. Because the owner of a base station only earns revenue while the base station is operating, and because a base station provides essential public services (e.g., "911" service, etc.), it is detrimental to remove a base station from service to install the new version of the software application. Rather, it would be advantageous if the new version of the software application could be installed in the base station while the base station is operating—and, furthermore, while the base station is executing the older version of the software application.

In some embodiments of the present invention, the new version of the software application is installed into the base station's memory without overwriting the old version of the software application. If the new version of the software application crashes, or otherwise becomes unusable, then the base station can begin using the old version of the software application immediately because it is already stored in the base station. In otherwords, if the new version of the software application crashes or is otherwise unusable, the base station need not suspend operation while the new version of the software application is being retransmitted and re-installed—the base station can operate, albeit possibly with diminished functionality, using the old version of the software application until the new version has been re-installed in the base station.

An illustrative embodiment of the present invention comprises: checking the integrity of a first software application at a first location in a first memory that is pointed to by a first address in a pointer; copying the first software application from the first memory to the second memory and executing the first software application from the second memory, when the integrity of the first software application is nominal; transmitting a first message indicating that the integrity of the first software application is not nominal, when the integrity of the first software application is not nominal; and receiving a first command to store a second address in the pointer, in response to the first message.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** depicts a schematic diagram of a wireless telecommunications in the prior art.

FIG. **2** depicts a block diagram of the illustrative embodiment of the present invention.

FIG. **3** depicts a block diagram of the salient components of the remote computer depicted in FIG. **2**.

FIG. **4** depicts a flowchart of the steps performed by the illustrative embodiment of the present invention.

DETAILED DESCRIPTION

FIG. **2** depicts a block diagram of an illustrative embodiment of the present invention, which enables a command center to control, monitor, program and re-program a remote computer, which can be separated from the command center by a vast distance.

The illustrative embodiment depicted in FIG. **2** advantageously comprises: control center **210**, communications channel **220** and remote computer **230**. Control center **210** is advantageously a facility (e.g., a wireless switching center, the National Aeronautics and Space Administration's Houston Control, a postage meter facility, a medical equipment manufacturer's factory, an automobile manufacturer, etc.) that is capable of controlling, monitoring, programming and re-programming remote computer **230** (e.g., a wireless base station, a spacecraft in space, a postage meter in an office, a medical monitor in a person's home, an automobile, etc.) via communications channel **220**. Communications channel **220** can be a wireless or wireline connection, in well-known fashion, which communicatively connects remote computer **230** to control center **210**. Control center **210** advantageously comprises all of the equipment that is capable of receiving messages from remote computer **230** and transmitting commands and files to remote computer **230**. It will be clear to those skilled in the art how to make and use control center **210** and communications channel **220**.

FIG. **3** depicts a block diagram of the salient components of remote computer **230**, which advantageously comprises: transmitter/receiver **310**, processor **320**, pointer **330**, first memory **340**, and second memory **350**, interconnected as shown. Transmitter/receiver **310** is advantageously capable of receiving commands and data from control center **210** and of transmitting messages and data to control center **210**, in well-known fashion via either a wireless or wireline channel. Processor **320** is advantageously an appropriately-programmed general-purpose processor or a hard-wired special-purpose processor that is capable of interfacing with transmitter/receiver **310**, pointer **330**, first memory **340** and alterable memory **350**, in well-known fashion.

Pointer **330** is advantageously a location in a non-volatile memory or a register or an entry in a directory, which contains the address (e.g., a file descriptor for a flat or hierarchical file system, a binary address, etc.) of a location in first memory **340**, in well-known fashion.

First memory **340** is advantageously a non-volatile memory (e.g., a flash memory, etc.), which contains a thoroughly-tested bootstrapping program (e.g., an operating system, a monitor, etc.) that is automatically executed when remote computer **230** undergoes a cold re-boot. First memory **340** also advantageously contains at least a new version of the desired software application and at least one older version of the software application.

Although only the new version of the software application is necessary for execution, first memory **340** advantageously holds an older version of the software application for the same reason that an automobile carries a spare tire. Although a spare tire is typically an identical replacement for a punctured tire, the older version of the software application is, in contrast, typically not a identical replacement for the newer version of the software application. Typically, the newer version provides more functionality than the older version, but the older version, while less advantageous in terms of functionality, provides some functionality until the newer version can be fixed and re-installed in remote computer **230**.

Therefore, remote computer **230** advantageously uses the newer version of the software application, when and if possible, and uses the older version of the software application if the newer version is or becomes unusable for any reason.

Second memory **350** is advantageously a volatile memory (e.g., high-speed SRAM, etc.) that is of sufficient capacity to store any one version of the software application. Advantageously, processor **320** can read from and write to second memory **350** more quickly than processor **320** can read from and write to first memory **340**. In other words, first memory **340** is used to store several versions of the software application before they are copied into second memory **350** for execution. Second memory **350** and first memory **340** are advantageously, but not necessarily, in the same address space.

FIG. **4** depicts a flowchart of the salient steps performed by the illustrative embodiment of the present invention. The operation of the illustrative embodiment is recursive and, therefore, references to particular versions of the software application can be articulated only in relative, in contrast to absolute, terms.

When the flowchart in FIG. **4** begins, remote computer **230** is presumed to be operating normally and executing version "n" of the software application from second memory **350**. Furthermore, version n (the newer version) and version n−1 (the older version) of the software application are both stored in first memory **340**.

At step **401**, control center **210** advantageously transmits the newest version of the software application, version n+1, to remote computer **230**, in well-known fashion via communications channel **220**.

At step **402**, remote computer **230**, under the control of version n, stores version n+1 into first memory **340**, in well-known fashion. In some embodiments of the present invention, control center **210** can direct the exact location in second memory **350** into which the version n+1 is stored, or, alternatively, control center **210** can allow remote computer **230** to decide the location. When remote computer **230** decides the location, that location is advantageously stored in a non-volatile memory or is transmitted to control center **210** or both.

Advantageously, all versions of the software application are capable of multi-tasking. In particular, version n is advantageously capable of performing its desired functionality (i.e., the functionality for which it was designed and built) and of receiving and storing version n+1 of the software application into an unused portion of first memory **340**.

At step **403**, control center **210** transmits a command to remote computer **230** directing remote computer **230** to store into pointer **330** the address of the location in first memory **340** where version n+1 is stored. It is not necessary that control center **210** knows the address of the location where the first software application is stored as long as remote computer **230** knows the address and is capable of executing the command. In general, however, it is advantageous that either control center **210** or remote computer **230** or both know the address.

At step **404**, remote computer **230**, under the control of version n, stores the address of version n+1 into pointer **330**, in well-known fashion. At this point, remote computer **230** contains copies of at least three versions of the software application: version n−1 (the oldest), version n (the one currently running), and version n+1 (the newest).

At step **405**, control center **210** transmits a command to remote computer **230** directing processor **320** to re-boot, in well-known fashion.

At step **406**, remote computer **230** begins the process of re-booting, in well known fashion, which advantageously comprises executing the bootstrapping program in first memory **340**.

At step **407**, processor **320**, under the control of the bootstrapping program, checks the integrity of whatever version of the software application is currently pointed to by the address contained in pointer **330**. The integrity of the software application can be checked, for example, by computing the Cyclic Redundancy Checksum ("CRC") code of the software application against a stored checksum, in well-known fashion. It will be clear to those skilled in the art how to check the integrity of a program, file or other string of symbols.

At step **408**, remote computer **230**, under the control of the bootstrapping program, makes the decision to follow one of two courses of action. When the integrity of the checked version is nominal, then control passes to step **414**. For the purposes of this specification, the term "nominal" means that the bits constituting that version of the software application are not corrupted. When the integrity of the checked version is not nominal, then control passes to step **409**.

At step **409**, remote computer **230**, under the control of the bootstrapping program, advantageously transmits a message to control center **210** indicating that the integrity of the checked version is not nominal.

At step **410**, control center **210** receives the message from remote computer **230** indicating that the integrity of the checked version is not nominal.

At step **411**, control center **210** determines whether version n remains in first memory **340**. When it does, control passes to step **412**; otherwise control passes to step **401**.

At step **412**, control center **210** transmits a command to remote computer **230** directing remote computer **230** to store the address of the location of version n into pointer **330**. From step **412**, control passes to step **405**.

At step **413**, remote computer **230**, under control of the bootstrapping program, receives and executes the command to store the address of the location of version n into pointer **330**. It is not necessary that control center **210** knows the address of the location where version n is stored as long as remote computer **230** knows the address and is capable of executing the command. In general, however, it is advantageous that either control center **210** or remote computer **230** or both know the address.

At step **414**, remote computer **230**, under control of the bootstrapping program, copies the software application at the location in first memory **340** pointed to by the address contained in pointer **330** (ie., version n+1) into second memory **350**, and begins execution of version n+1 from second memory **350**.

At step **415**, remote computer **230** determines, if possible, if version n+1 has crashed. When version n+1 has not crashed, control remains at step **415**. When version n+1 has crashed, then control passes to step **416**. While remote computer **230** is executing version n+1, it is advantageously transmitting telemetry data to command center **210** regarding the status of remote computer **230**.

At step **416**, remote computer **230** transmits a message, if possible, to control center **210** indicating that version n+1 has crashed. When remote computer **230** is unable to transmit a message indicating that version n+1 has crashed, perhaps because the crash has corrupted and frozen remote computer **230**, control center **210** is advantageously capable of inferring the crash from changes in telemetry data from remote computer **210**.

At step **417**, control center **210** advantageously receives the message indicating that version n+1 has crashed and decides if version n+1 should be re-booted, or, alternatively, if a roll-back to version n should be initiated. The functionality afforded by step **417** is advantageous because it enables control center **210** to try version n+1 several times to be convinced that it is flawed before initiating the roll-back to version n. If control center **210** desires to re-boot version n+1, control passes to step **405**; alternatively, control passes to step **411**. Alternatively, if control center **210** infers from changes in telemetry data that remote computer **230** has crashed, then control center **210** spontaneously passes control to step **405**. The illustrative embodiment continues the process of rolling back to earlier versions (e.g., version n−1, version n−2, etc.) until a version is located whose integrity is nominal and until the newest version (e.g., version n+1, version n+2, etc.) can be installed, or re-installed, and executed by remote computer **230**.

The technique depicted in FIG. **4** is recursive, and advantageously: (1) enables the software in remote computer **230** to be updated while remote computer **230** is operating, (2) is reliable in that it enables remote computer **230** to roll-back to previous versions of the software application, if they exist, while reducing any disruption in the provisioning of service, and (3) is inexpensive.

It is to be understood that the above-described embodiments are merely illustrative of the invention and that many variations may be devised by those skilled in the art without departing from the scope of the invention. It is therefore intended that such variations be included within the scope of the following claims and their equivalents.

What is claimed is:

1. A method comprising:

checking the integrity of a first software application at a first location in a first memory that is pointed to by a first address in a pointer;

copying, after said checking the integrity of said first software application, said first software application from said first memory to said second memory and executing said first software application from said second memory when the integrity of said first software application is nominal;

transmitting a first message indicating that the integrity of said first software application is not nominal, when the integrity of said first software application is not nominal; and

receiving a first command to store a second address in said pointer, in response to said first message.

2. The method of claim **1** further comprising checking the integrity of a second software application at a second location in said first memory that is pointed to by said second address.

3. The method of claim **2** further comprising:

executing said second software application, when the integrity of said second software application is nominal; and

transmitting a second message indicating that the integrity of said second software application is not nominal, when the integrity of said second software application is not nominal.

4. The method of claim **3** further comprising:

receiving a copy of said first software application, in response to said second message; and

storing said copy of said first software application at a third location in said first memory.

5. The method of claim **4** wherein said first location equals said third location.

6. The method of claim **3** further comprising:

receiving a second command to store a third address in said pointer;

checking the integrity of said copy of said first software application in said first memory, which is pointed to by said third address in said pointer;

copying copy of said first software application from said first memory to said second memory arid executing said copy of said first software application from said second memory, when the integrity of said first software application is nominal; and

transmitting a third message indicating that the integrity of said copy of said first software application is not nominal, when the integrity of said copy of said first software application is not nominal.

7. An apparatus comprising:

a processor for checking the integrity of a first software application at a first location in a first memory that is pointed to by a first address in a pointer, and for copying, after said checking the integrity of said first software application, said first software application from said first memory to a second memory and executing said first software application from said second memory when the integrity of said first software application is nominal;

a transmitter for transmitting a first message indicating that the integrity of said first software application is not nominal, when the integrity of said first software application is not nominal; and

a receiver for receiving a first command to store a second address in said pointer, in response to said first message.

8. The apparatus of claim **7** wherein said processor checks the integrity of a second software application in said first memory that is pointed to by a second address in said pointer.

9. The apparatus of claim **8** wherein said processor executes said second software application, when the integrity of said second software application is nominal; and said transmitter transmits a second message indicating that the integrity of said second software application is not nominal, when the integrity of said second software application is not nominal.

10. The apparatus of claim **8** wherein said receiver receives a copy of said first software application, in response to said second message; and said processor stores said copy of said first software application at a third location in said first memory.

11. The apparatus of claim **10** wherein said first location equals said third location.

12. The apparatus of claim **10** wherein:

said processor receives a second command to store said third address in said pointer, and checks the integrity of said copy of said first software application in said first memory that is pointed to by said third address in said pointer, and executes said copy of said first software application, when the integrity of said copy of said first software application is nominal; and

said transmitter transmits a third message indicating that the integrity of said copy of said first software application is not nominal, when the integrity of said copy of said first software application is not nominal.

13. A method comprising:

transmitting a first software application to a remote computer for storage in a first location in a first memory that is pointed to by a first address;

transmitting a first command to said remote computer directing said remote computer to store said first address in a pointer;

receiving a first message from said remote computer indicating that the integrity of said first software application in said first memory is not nominal; and

transmitting a second command to said remote computer directing said remote computer to store a second address, which points to a second software application in a second location in said first memory, in said pointer, in response to said first message.

14. The method of claim **13** further comprising:

receiving a second message from said remote computer indicating that the integrity of said second software application in said first memory is not nominal;

transmitting a copy of said first software application to said remote computer for storage in a third location in said first memory that is pointed to by a third address; and

transmitting a third command to said remote computer directing said remote computer to store said third address in said pointer.

15. The method of claim **14** wherein said first location equals said third location.

16. A wireless switching center comprising:

means for transmitting a first software application to a remote computer for storage in a first location in a first memory that is pointed to by a first address;

means for transmitting a first command to said remote computer directing said remote computer to store said first address in a pointer;

means for receiving a first message from said remote computer indicating that the integrity of said first software application in said first memory is not nominal; and

means for transmitting a second command to said remote computer directing said remote computer to store a second address, which points to a second software application in a second location in said first memory, in said pointer, in response to said first message.

17. The wireless switching center of claim **16** further comprising:

means for receiving a second message from said remote computer indicating that the integrity of said second software application in said first memory is not nominal;

means for transmitting a copy of said first software application to said remote computer for storage in a third location in said first memory that is pointed to by a third address; and

means for transmitting a third command to said remote computer directing said remote computer to store said third address in said pointer.

18. The wireless switching center of claim **17** wherein said first location equals said third location.

* * * * *