

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
15 October 2009 (15.10.2009)

(10) International Publication Number  
**WO 2009/125396 A2**

- (51) **International Patent Classification:**  
*G06F 9/44* (2006.01)      *G06F 15/16* (2006.01)
- (21) **International Application Number:**  
PCT/IL2009/000382
- (22) **International Filing Date:**  
6 April 2009 (06.04.2009)
- (25) **Filing Language:** English
- (26) **Publication Language:** English
- (30) **Priority Data:**  
61/123,314      7 April 2008 (07.04.2008)      US
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- (81) **Designated States (unless otherwise indicated, for every kind of national protection available):** AE, AG, AL, AM,

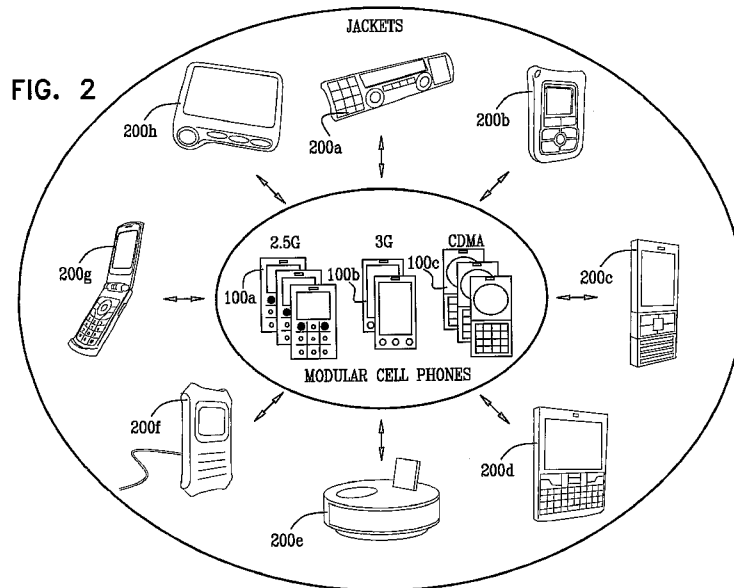
AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States (unless otherwise indicated, for every kind of regional protection available):** ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

**Published:**

— without international search report and to be republished upon receipt of that report (Rule 48.2(g))

(54) **Title:** UPDATING FIRMWARE ON MOBILE ELECTRONIC DEVICES



(57) **Abstract:** A system for updating firmware on electronic devices, including an electronic device, including a processor, a storage coupled with the processor for storing a current image of firmware that includes programmed instructions for the processor and a baseline image of firmware, an update utility coupled with the processor for instructing the processor to update the firmware stored in the storage, and a connector coupled with the processor for connecting the electronic device to a jacket, thereby enabling communication between the electronic device and the jacket, and a jacket, including a storage for storing a firmware difference image for updating the firmware in the electronic device to a newer version, and a port for connecting the electronic device connector thereto.



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## UPDATING FIRMWARE ON MOBILE ELECTRONIC DEVICES

## FIELD OF THE INVENTION

5           The field of the present invention is firmware for electronic devices.

## BACKGROUND OF THE INVENTION

10           Firmware refers to programming instructions that are embedded within an electronic device. For most electronic devices, including communication devices and PDAs, the firmware is stored in the device's memory. The electronic device enables reading and executing the programming instructions, but does not enable modification of the instructions. Unlike software, firmware cannot be modified by application  
15 programs. Instead, modification of firmware requires special external hardware. Examples of firmware include computer programs within a read-only memory (ROM) integrated circuit chip, and computer programs embedded within an erasable programmable read-only memory (EPROM) chip.

          Firmware in an electronic device needs to be updated from time to time.  
20 Updating firmware is done differently than updating software. Generally, software is updated by downloading newer software to a computer storage, and reading the newer software therefrom. In distinction, since electronic devices typically have only limited storage space, firmware updates are made by a manufacturer of the electronic device directly into the device's memory.

25           When updating firmware from a current version, say, version x, to a new version, say, version y, it is of advantage to generate a difference image, referred to herein as the "diff image" and denoted herein by  $x \rightarrow y$ , representing the difference between version x and version y; and to send only the diff image file for updating the firmware from version x to version y. The electronic device activates an update utility  
30 that receives the diff image and updates the firmware with minimal computational and storage space requirements.

Reference is now made to **FIG. 1**, which is a flowchart of a prior art method for updating firmware on an electronic device via an update server. At step **11**, the electronic device reports its current firmware version, say, version  $x$ , to a remote firmware update server. At step **12**, the update server sends a diff image,  $x \rightarrow y$ , between  
5 version  $x$  and the new version, say, version  $y$ . At step **13**, the electronic device receives the diff image  $x \rightarrow y$ . At step **14**, the electronic device executes its update utility, which applies the diff image  $x \rightarrow y$  to the current version  $x$ , to generate the new version  $y$  of the firmware.

For many electronic devices, steps **11** and **12** are performed via over the  
10 air communication. A drawback with the use of over the air communication to request and receive the data for firmware update is the time and expense occurred. Use of a diff image minimizes the amount of data transported between the update server and the electronic device, thus saving time and expense -- but nevertheless time and expense is occurred.

15 It would thus be of advantage to update firmware of electronic devices without requiring over the air communication between the electronic device and a remote update server.

## SUMMARY OF THE DESCRIPTION

Aspects of the present invention relate to updating firmware of an electronic device by attaching the device to a second device that serves as a jacket for the first device. The electronic device stores images of two versions of its firmware; namely, an image of a current version and an image of a baseline version. The current version of the firmware is used for operating the electronic device, and the baseline version is used for updating the firmware. The jacket has stored therein firmware diff image data that, when applied to the baseline image of the firmware stored in the electronic device, generates a new image of the firmware. By storing two versions of the firmware in the electronic device (current and baseline), only a single diff image is required to be stored in the jacket in order to update all older versions of the firmware. As a result, jacket storage space required for updating firmware is minimized.

The present invention is of advantage for updating firmware on a modular cell phone that may be housed within a jacket. When the cell phone is housed within a jacket, an enhanced cell phone/jacket combination device is thereby obtained, and also the firmware on the cell phone is updated. Over the air communication for updating the firmware is thus eliminated.

There is thus provided in accordance with an embodiment of the present invention a system for updating firmware on electronic devices, including an electronic device, including a processor, a storage coupled with the processor for storing a current image of firmware that includes programmed instructions for the processor and a baseline image of firmware, an update utility coupled with the processor for instructing the processor to update the firmware stored in the storage, and a connector coupled with the processor for connecting the electronic device to a jacket, thereby enabling communication between the electronic device and the jacket, and a jacket, including a storage for storing a firmware difference image for updating the firmware in the electronic device to a newer version, and a port for connecting the electronic device connector thereto, wherein the update utility instructs said electronic device processor (i) to apply the firmware difference image to the baseline image of the firmware to generate a newer version image of the firmware, and (ii) to replace the current image of the firmware in the electronic device storage with the thus generated newer version

image of the firmware, in response to connecting the electronic device connector to said jacket port.

There is additionally provided in accordance with an embodiment of the present invention a method for updating firmware on electronic devices, including, in response to an electronic device being attached to a jacket, reading a data block from a baseline image of firmware stored on the electronic device, further reading a data block from a difference image of firmware stored on the jacket, combining the data block from the difference image to the data block from the baseline image to generate a data block for a new image of firmware, replacing a current image of firmware stored on the electronic device with the data block for the new image of firmware generated by said combining, and repeating the reading, the further reading, the combining and the replacing until all required data blocks for the new image of firmware are generated.

There is further provided in accordance with an embodiment of the present invention a system for updating firmware on electronic devices, including an electronic device, including a processor, a storage coupled with the processor for storing a current image of firmware that includes programmed instructions for the processor and a baseline image of firmware, an update utility coupled with the processor for instructing the processor to update the firmware stored in the storage, and a modem coupled with the processor for enabling short range wireless communication between the electronic device and a jacket, and a jacket, including a storage for storing a firmware difference image for updating the firmware in the electronic device to a newer version, and a modem coupled with the storage for enabling short range wireless communication between the jacket and the electronic device, wherein the update utility instructs the electronic device processor (i) to apply the firmware difference image to the baseline image of the firmware to generate a newer version image of the firmware, and (ii) to replace the current image of the firmware in the electronic device storage with the thus generated newer version image of the firmware, in response to opening a short range wireless communication channel between the electronic device and the jacket.

There is yet further provided in accordance with an embodiment of the present invention an electronic device with firmware upgrade capability, including a processor, a storage coupled with the processor for storing a current image of firmware

that includes programmed instructions for the processor, and a baseline image of firmware, an update utility coupled with the processor for instructing the processor to update the firmware stored in the storage, and a network connection, for downloading a firmware difference image from an update server to the electronic device, wherein the  
5 update utility instructs the processor (i) to download the firmware difference image from the update server to the electronic device, (ii) to apply the downloaded firmware difference image to the baseline image of the firmware to generate a newer version image of the firmware, and (iii) to replace the current image of the firmware in the storage with the thus generated newer version image of the firmware.

10

## BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be more fully understood and appreciated from the following detailed description, taken in conjunction with the drawings in which:

**FIG. 1** is a flowchart of a prior art method for updating firmware on an electronic device via an update server;

**FIG. 2** is an illustration of a plurality of modular cell phones and a plurality of jackets, in accordance with an embodiment of the present invention;

**FIG. 3** is an illustration of a modular cell phone being inserted into a jacket, to obtain an enhanced cell phone/jacket combination, in accordance with an embodiment of the present invention;

**FIG. 4** is a simplified block diagram of a modular cell phone, in accordance with an embodiment of the present invention;

**FIG. 5** is a simplified block diagram of a jacket, in accordance with an embodiment of the present invention;

**FIG. 6** is a simplified flowchart of a method for updating firmware on an electronic device via a jacket, in accordance with an embodiment of the present invention; and

**FIG. 7** is a simplified workflow process diagram of a method for updating firmware in an electronic device, in accordance with an embodiment of the present invention.

## DETAILED DESCRIPTION

Aspects of the present invention relate to updating firmware on an electronic device by attaching the device to a second device that serves as a jacket for the first device.

Although the present invention applies to a wide variety of electronic devices and jackets, for the sake of definitiveness, the ensuing description relates primarily to an embodiment of the present invention wherein the electronic device is a modular cell phone, and the second device is a jacket into which the modular cell phone is inserted. The jacket enhances the modular cell phone by providing an enhanced user interface therefor, and additional capabilities such as a media player. The modular cell phone enhances the jacket by providing wireless communication. The jacket may have standalone operation capability, in which case it is also referred to as a host. Alternatively, the jacket may only be able to operate in cooperation with the modular cell phone.

Reference is now made to **FIG. 2**, which is an illustration of a plurality of modular cell phones **100a – 100c**, including 2.5G and 3G phones for a GSM network, and CDMA phones for a CDMA network, and a plurality of jackets **200a – 200h**. In accordance with an embodiment of the present invention, any one of the modular cell phones **100a – 100c** may be inserted into any one of the jackets **200a – 200h**, to obtain an enhanced cell phone/jacket combination.

Reference is now made to **FIG. 3**, which is an illustration of a modular cell phone **100** being inserted into a jacket **200**, to obtain an enhanced cell phone/jacket combination, in accordance with an embodiment of the present invention.

Reference is now made to **FIG. 4**, which is a simplified block diagram of modular cell phone **100**, in accordance with an embodiment of the present invention. Modular cell phone **100** includes six primary components, as follows: a connection controller **110**, a memory storage **115**, a modem **120** for sending and receiving data and voice communications, a power management subsystem **125**, a power amplifier **135** and a cell phone user interface **170**.

Connection controller **110** executes programmed instructions that control the data flow between modular cell phone **100** and jacket **200**. Connection controller



110 includes a firmware update utility 111 that updates the version of the firmware stored in storage 115 from time to time. As explained below with reference to FIGS. 6 and 7, storage 115 stores both a current version and a baseline version of the firmware. Storage 115 may be NOR, NAND, SD or such other non-volatile memory. Modem 120 controls the communication functionality of modular cell phone 100. Power management subsystem 125 includes charging circuitry for charging a battery 145. Power amplifier 135 includes a radio frequency (RF) interface 136, and is connected to an antenna 140. Cell phone user interface 170 includes a microphone 171 and an earpiece 173. Cell phone user interface 170 also includes an optional speaker 175, vibrator 177, keyboard 180 and display 185. It will be appreciated by those skilled in the art that cell phone user interface 170 may include additional components.

Modular cell phone 100 includes an optional audio/video subsystem 130, which includes inter alia a voice, audio and video interface.

Modular cell phone 100 includes a connector 150, which includes a jacket connector 160 and an optional USB connector 155. Modular cell phone 100 optionally includes a SIM 190.

Modular cell phone 100 operates in standalone mode or in conjunction with a jacket, such as any of jackets 200a – 200h shown in FIG. 1, when it is attached thereto via jacket connector 160.

In accordance with an embodiment of the present invention, the interface between connection controller 110 and storage 115, and the interface between connection controller 110 and modem 120 are SD interfaces. The interface between connection controller 110 and pouch jacket 160 is a customized connection interface.

Reference is now made to FIG. 5, which is a simplified block diagram of jacket 200, in accordance with an embodiment of the present invention. Jacket 200 includes a connection controller 210, a storage 215, and a cell phone connector 260 for use when modular cell phone 100 is attached to jacket 200 via the modular cell phone's jacket connector 160. Storage 215 stores a firmware diff image, for use in updating the version of the firmware stored in modular cell phone 100. Jacket 200 includes an optional auxiliary processor 205, an optional power management subsystem 225, an optional battery 245, and an optional SIM 290.

Jacket **200** includes a jacket user interface **270** including an optional microphone **271**, an optional earpiece **273**, an optional mono speaker or optional stereo speakers **275**, an optional vibrator **277**, an optional keyboard **280** and an optional display **285**. It will be appreciated by those skilled in the art that jacket user interface **270** may include additional components.

In accordance with an embodiment of the present invention, the interface between connection controller **210** and storage **215** is an SD interface. The interface between connection controller **210** and cell phone **260** is a customized connection interface.

It will be appreciated by those skilled in the art that the connection between modular cell phone **100** and jacket **200** may be via a wired connection or a wireless connection.

In accordance with an embodiment of the present invention, jacket **200** is preloaded with the newest version of the firmware for modular cell phone **100**, and the current firmware in modular cell phone **100** is updated via jacket **200**, instead of via a network over the air.

In principle, if the current version,  $y$ , of the firmware is the  $(n+1)^{st}$  version, then modular cell phone **100** may currently have any of the  $n$  previous versions of the firmware in its memory. Alternatively, modular cell phone **100** may already have the newest version in its memory. Thus it would appear that in order to accommodate all modular cell phones **100**, jacket **200** needs to store either the entire image of firmware version  $y$ , or all of the diff images  $x \rightarrow y$  for  $x = 1, 2, \dots, n$ . In order not to have to store so much data in the limited storage space of jacket **200**, a baseline version of the firmware, denoted by version  $0$ , is stored in modular cell phone **100**, in addition to the current version  $x$  that is stored therein. Consequently it suffices to store the single diff image  $0 \rightarrow y$  in jacket **200**. Since the baseline version is generally not the current firmware running in modular cell phone **100**, the baseline version may be stored in a compressed format, in order to reduce the memory required of modular cell phone **100**.

In this regard, reference is now made to **FIG. 6**, which is a simplified flowchart of a method for updating firmware on an electronic device via a jacket, in accordance with an embodiment of the present invention. At step **21** the electronic device is inserted into the jacket. The jacket contains a diff image  $0 \rightarrow y$  for updating

firmware from baseline version 0 to new version y. At step 22 a determination is made if version y is newer than the version of firmware, version x, currently stored in the electronic device. If not, then operation continues at step 23.

5 Otherwise, if version y is newer than version x, then at step 24 a data block of the baseline image of the firmware, version 0, is read from the memory of the electronic device. At step 25 the corresponding data block of the diff image 0→y is read, and applied to the baseline version 0, to generate the corresponding data block of firmware version y. At step 26 the data block of firmware version y is written to the memory of the electronic device. At step 27 a determination is made whether or not  
10 there are more data blocks to process. If so, then processing loops back to step 24 to process a next data block. Otherwise, if all data blocks have been processed, then processing then continues at step 23.

As mentioned hereinabove, in some embodiments of the present invention the baseline image stored in the electronic device is compressed, in order to  
15 reduce memory requirements. Generally, the baseline image is compressed in sectors, and therefore may be decompressed in sectors, rather than all at once. In these embodiments, step 24 is modified to include reading a compressed data block of the baseline image of the firmware, version 0, from the memory of the electronic device, and decompressing the compressed data block. After step 25, the decompressed data  
20 block is deleted to free up memory. Thus memory required of the electronic device for storing the baseline image is minimized.

In an alternate embodiment of the present invention, if the electronic device has sufficient free memory to store the entire diff image 0→y, then the entire image may be copied to the electronic device and steps 24 – 26 may be performed on  
25 the full images without the need to loop over individual data blocks. Updating full firmware images at once accelerates the update process, but requires additional memory in the electronic device.

Reference is now made to FIG. 7, which is a simplified workflow process diagram of a method for updating firmware in an electronic device, in  
30 accordance with an embodiment of the present invention. As shown in FIG. 7, the modular cell phone's update utility 111 receives as input a block of data from the diff image 0→y, and a block of data from the baseline image, version 0. Update utility 111

generates as output a block of data for an image of the new firmware version y. The output block is written over the corresponding block of data from the currently stored image of firmware version y.

Specifically, at process step 24 update utility 111 reads a block of  
 5 baseline image data from cell phone storage 115, and at process step 25 update utility 111 reads a corresponding block of diff image data from jacket storage 215. At process step 26, update utility 111 applies the diff image data to the baseline image data to generate a corresponding block of image data for the new firmware version y. Update utility 111 writes the output block over the corresponding block of data stored in storage  
 10 115 for current firmware version x. The process thus continues until all blocks for the image of firmware version y are generated.

In an alternate embodiment of the present invention, the output block may be written to a different storage location at step 26, instead of overwriting the corresponding block of firmware version x.

15 In distinction to the process shown in FIG. 7, prior art processes do not use a baseline version of firmware. Prior art processes read from current firmware version x instead of from baseline firmware version 0, at step 24.

In one embodiment of the present invention, storage 115 includes non-volatile memory, e.g., NOR memory, and modem 120 includes RAM memory.  
 20 Alternatively, the RAM memory may be a separate chip in modular cell phone 100. The firmware is stored in the NOR memory, and is updated when modular cell phone 100 is rebooted. In order for modular cell phone 100 to determine during reboot whether or not to update its firmware, a flag is set in the cell phone's RAM to indicate whether or not a newer version of the firmware than current version x is available. The  
 25 flag is set to TRUE when jacket 200 indicates that a newer version is available. The flag is stored in RAM since, otherwise, were it to be stored in NOR, then it may be overwritten during the firmware upgrade.

Subsequently, upon reboot from RAM, modular cell phone 100 performs the following logic:

```
30 if (FLAG == FALSE) then goto NOR;/regular operation from NOR
   else { /FLAG = TRUE, indicating that a firmware upgrade is available
         firmware upgrade to NOR;
```

```
        /apply diff to baseline and write output to NOR  
FLAG = FALSE;        /clear FLAG  
reboot;  
}
```

5           In reading the above description, persons skilled in the art will realize that there are many apparent variations that can be applied to the methods and systems described. Thus it will be appreciated that the connection between modular cell phone **100** and jacket **200** may be any physical or wireless connection, and is not limited to an arrangement where jacket **200** is a casing for modular cell phone **100** as illustrated in  
10 **FIG. 3**. Modular cell phone **100** may be attached to jacket **200** externally, via direct connection or via a cable. Modular cell phone **100** may be connected to jacket **200** via short range wireless communication, such as Bluetooth communication. Modular cell phone **100** may be positioned partially inside and partially outside of jacket **200**, entirely inside jacket **200**, or entirely outside of jacket **200**.

15           It will further be appreciated that jacket **200** may access another communication channel, such as an Internet connection, in addition to the limited communication channel accessible by modular cell phone **100**. For example, jacket **200** may be a host device, including inter alia a personal computer; or jacket **200** may connect to host device, such as a personal computer. When jacket **200** has access to the  
20 other communication channel, the required diff image  $0 \rightarrow y$  may be downloaded to jacket **200** via such other channel. For example, the diff image  $0 \rightarrow y$  may be downloaded to jacket **200** over the Internet.

          It will further be appreciated by those skilled in the art that the logic of **FIGS. 6** and **7** applies to remote update servers, in addition to jackets. I.e., the diff  
25 image  $0 \rightarrow y$  may be provided to modular cell phone **100** via an update server, instead of or in addition to being provided by jacket **200**.

          In the foregoing specification, the invention has been described with reference to specific exemplary embodiments thereof. It will, however, be evident that various modifications and changes may be made to the specific exemplary embodiments  
30 without departing from the broader spirit and scope of the invention as set forth in the appended claims. Accordingly, the specification and drawings are to be regarded in an illustrative rather than a restrictive sense.

## CLAIMS

What is claimed is:

1. A system for updating firmware on electronic devices, comprising:

5 an electronic device, comprising:

a processor;

a storage coupled with said processor for storing a current image of firmware that comprises programmed instructions for said processor and a baseline image of firmware;

10 an update utility coupled with said processor for instructing said processor to update the firmware stored in said storage; and

a connector coupled with said processor for connecting the electronic device to a jacket, thereby enabling communication between the electronic device and the jacket; and

15 a jacket, comprising:

a storage for storing a firmware difference image for updating the firmware in said electronic device to a newer version; and

a port for connecting said electronic device connector thereto,

20 wherein said update utility instructs said electronic device processor (i) to apply the firmware difference image to the baseline image of the firmware to generate a newer version image of the firmware, and (ii) to replace the current image of the firmware in said electronic device storage with the thus generated newer version image of the firmware, in response to connecting said electronic device connector to said jacket port.

25 2. The system of claim 1 further comprising a cable for connecting said electronic device connector to said jacket port.

30 3. The system of claim 1 wherein said jacket further comprises an Internet connection, for downloading the firmware difference image from the Internet to said jacket.

4. The system of claim 1 wherein said jacket further comprises a host connection, for downloading the firmware difference image from a host device to said jacket.

5 5. The system of claim 1 wherein said update utility instructs said processor to confirm that the current image of the firmware in said electronic device is not the newer version image of the firmware, and to only perform instructions (i) and (ii) if such confirmation is affirmative.

10 6. The system of claim 1 wherein said electronic device comprises a modular cell phone.

7. The system of claim 6 wherein said jacket further comprises a media player.

15 8. The system of claim 6 wherein said jacket further comprises a digital camera.

9. The system of claim 6 wherein said jacket further comprises a PDA.

20 10. The system of claim 6 wherein said jacket further comprises a personal computer.

25 11. A method for updating firmware on electronic devices, comprising, in response to an electronic device being attached to a jacket:

reading a data block from a baseline image of firmware stored on the electronic device;

further reading a data block from a difference image of firmware stored on the jacket;

30 combining the data block from the difference image to the data block from the baseline image to generate a data block for a new image of firmware;

replacing a current image of firmware stored on the electronic device with the data block for the new image of firmware generated by said combining; and  
repeating said reading, said further reading, said combining and said replacing until all required data blocks for the new image of firmware are generated.

5

**12.** The method of claim 11 further comprising confirming that the current image of firmware stored on the electronic device is not the new image of firmware, and wherein said reading, said further reading, said combining, said replacing and said repeating are only performed if such confirmation is affirmative.

10

**13.** The method of claim 11 further comprising downloading the difference image to the jacket over the Internet.

**14.** A system for updating firmware on electronic devices, comprising:

15

an electronic device, comprising:

a processor;

a storage coupled with said processor for storing a current image of firmware that comprises programmed instructions for said processor and a baseline image of firmware;

20

an update utility coupled with said processor for instructing said processor to update the firmware stored in said storage; and

a modem coupled with said processor for enabling short range wireless communication between the electronic device and a jacket; and

a jacket, comprising:

25

a storage for storing a firmware difference image for updating the firmware in said electronic device to a newer version; and

a modem coupled with said storage for enabling short range wireless communication between the jacket and the electronic device,

30

wherein said update utility instructs said electronic device processor (i) to apply the firmware difference image to the baseline image of the firmware to generate a newer version image of the firmware, and (ii) to replace the current image of the firmware in said electronic device storage with the thus generated newer version image of the



firmware, in response to opening a short range wireless communication channel between said electronic device and said jacket.

**15.** An electronic device with firmware upgrade capability, comprising:

5

a processor;

a storage coupled with said processor for storing a current image of firmware that comprises programmed instructions for said processor, and a baseline image of firmware;

10

an update utility coupled with said processor for instructing said processor to update the firmware stored in said storage; and

a network connection, for downloading a firmware difference image from an update server to the electronic device,

15

wherein said update utility instructs said processor (i) to download the firmware difference image from the update server to the electronic device, (ii) to apply the downloaded firmware difference image to the baseline image of the firmware to generate a newer version image of the firmware, and (iii) to replace the current image of the firmware in said storage with the thus generated newer version image of the firmware.

20

**16.** The system of claim 15 wherein said update utility instructs said processor to confirm with the update server that the current image of the firmware in the electronic device is not the newer version image of the firmware, and to only perform instructions (i), (ii) and (iii) if such confirmation is affirmative.

25

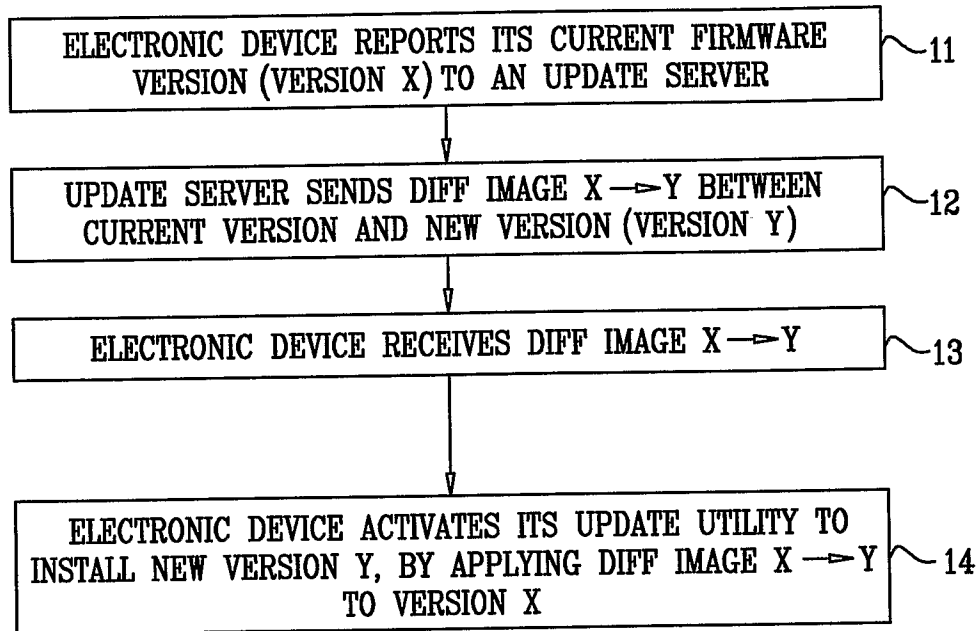
**17.** The system of claim 15 wherein the baseline image of the firmware is stored in said storage in a compressed format, and wherein said update utility further instructs said processor to decompress the baseline image of the firmware prior to applying the downloaded firmware difference image to the baseline image of the firmware.

30

**18.** The system of claim 17 wherein said update utility further instructs said processor to delete the decompressed baseline image of the firmware from said storage

subsequent to applying the downloaded firmware difference image to the baseline image of the firmware.

1/7

**FIG. 1**  
(PRIOR ART)

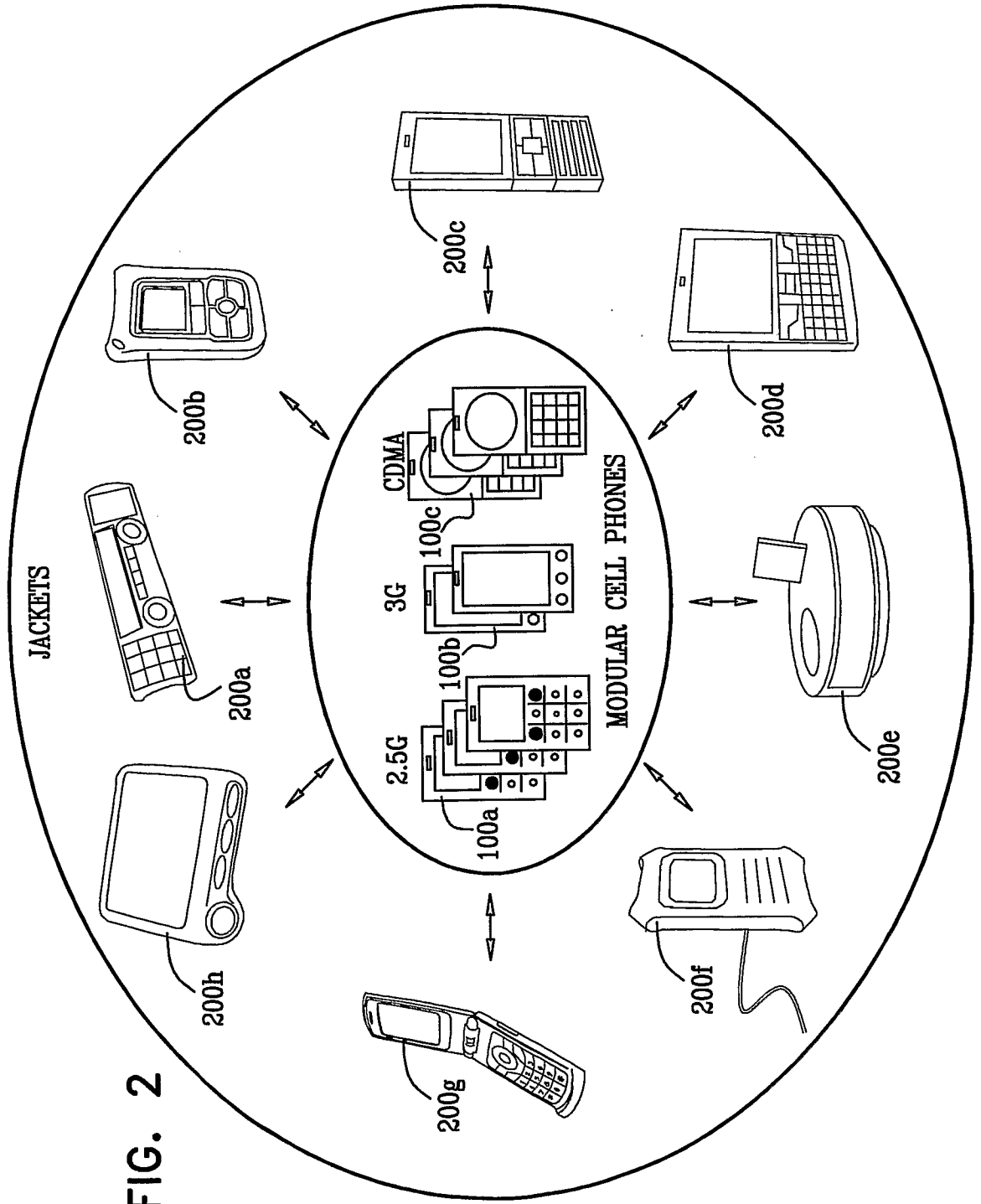


FIG. 2

FIG. 3

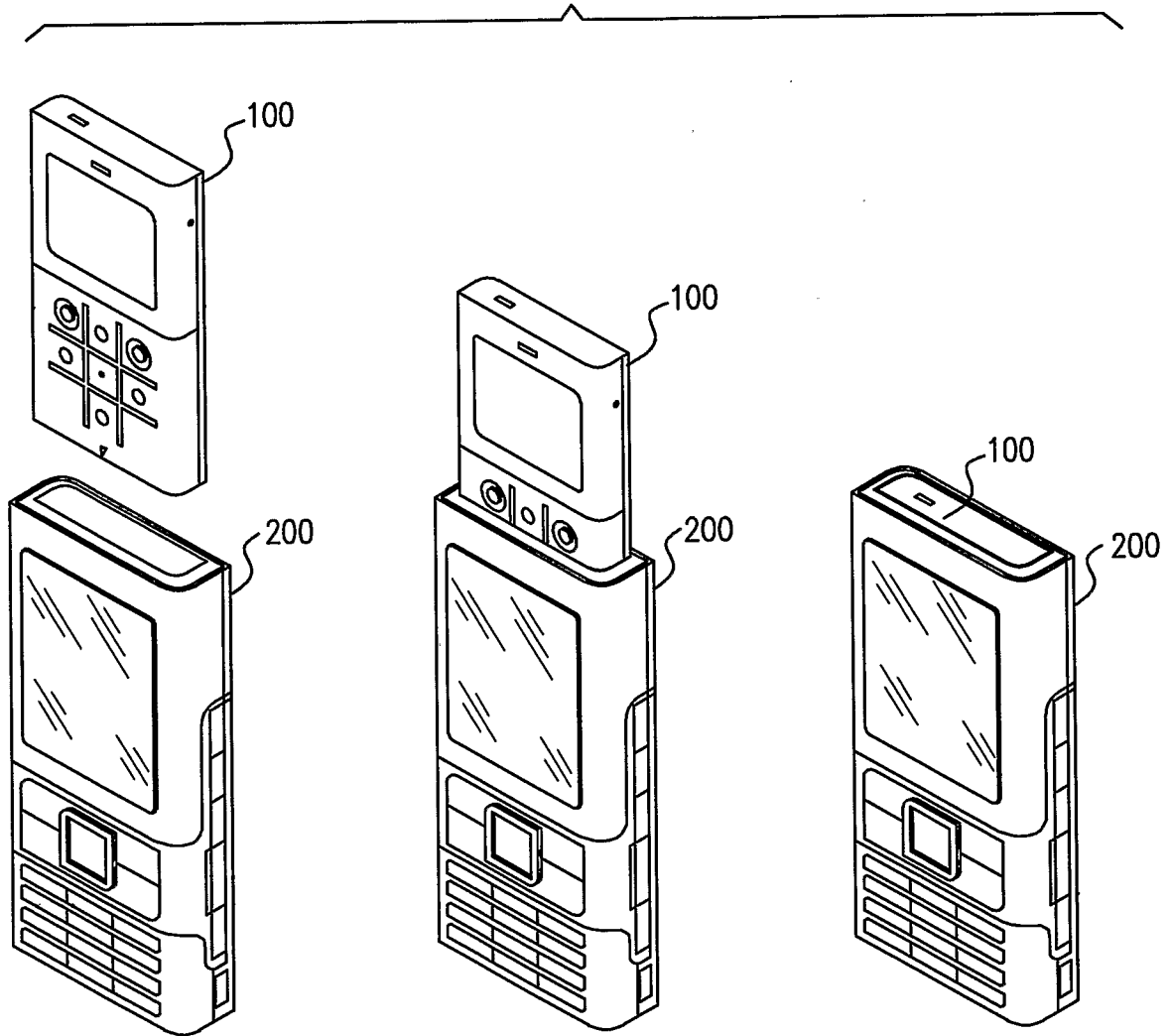


FIG. 4

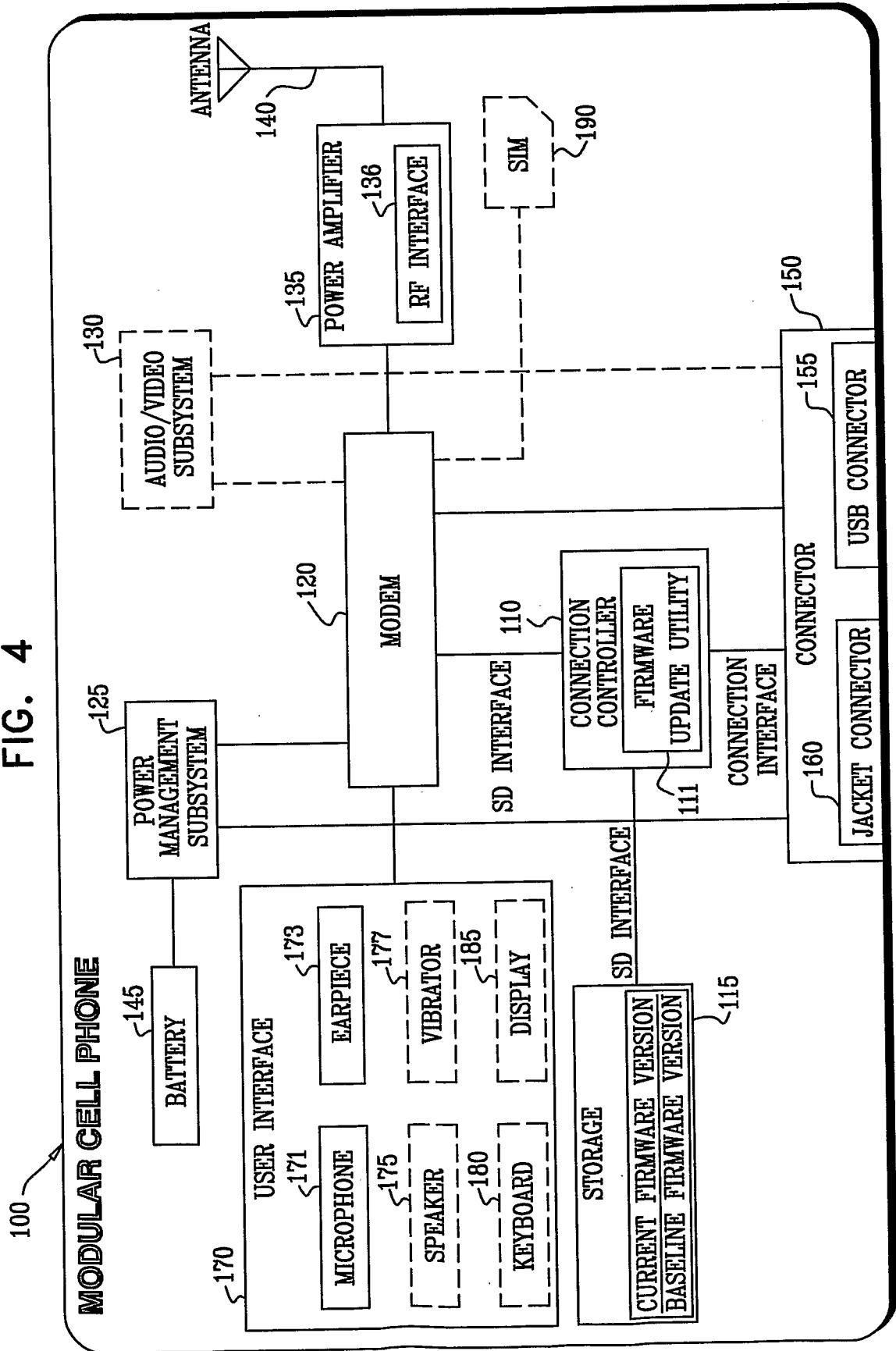


FIG. 5

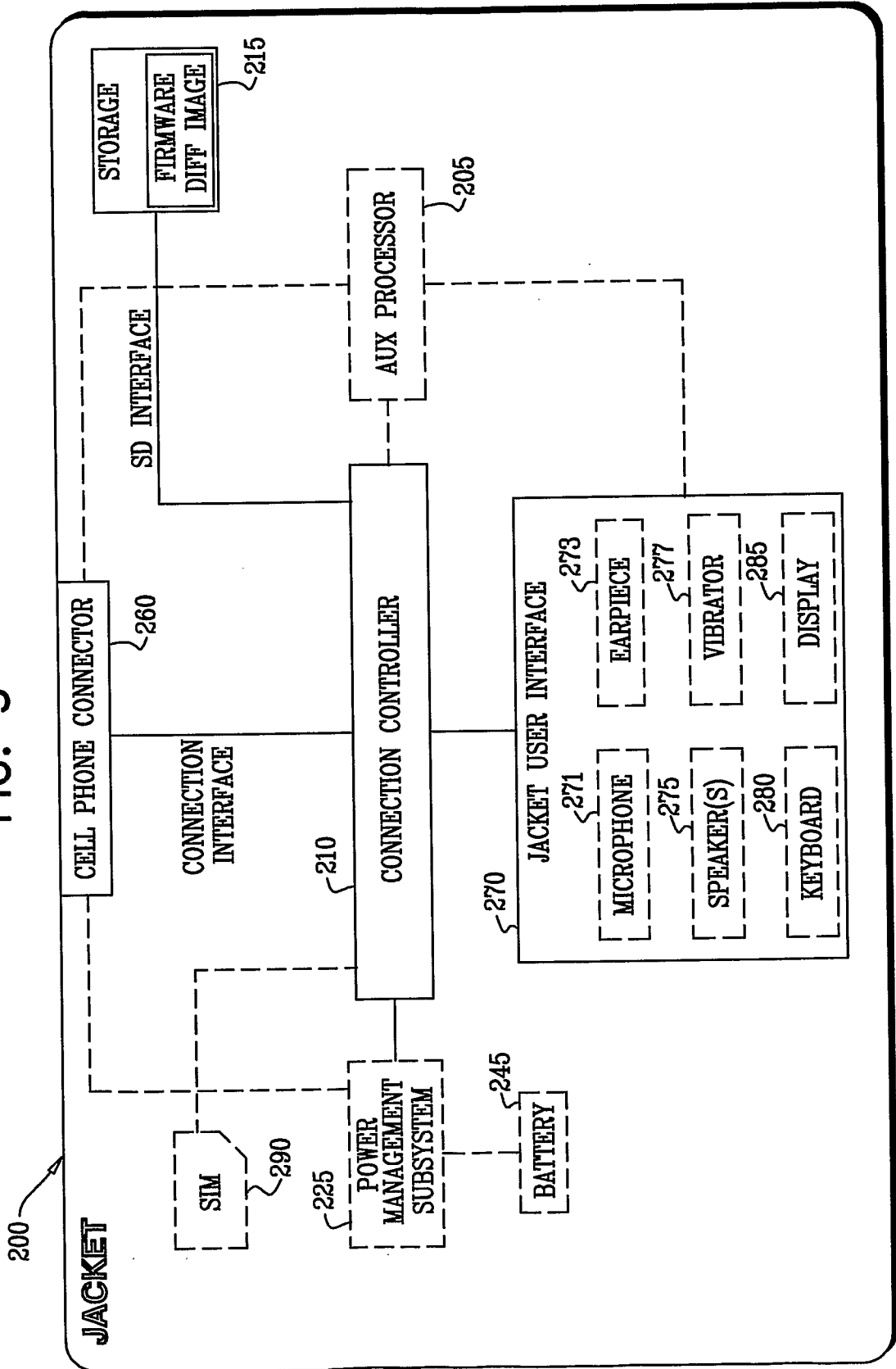


FIG. 6

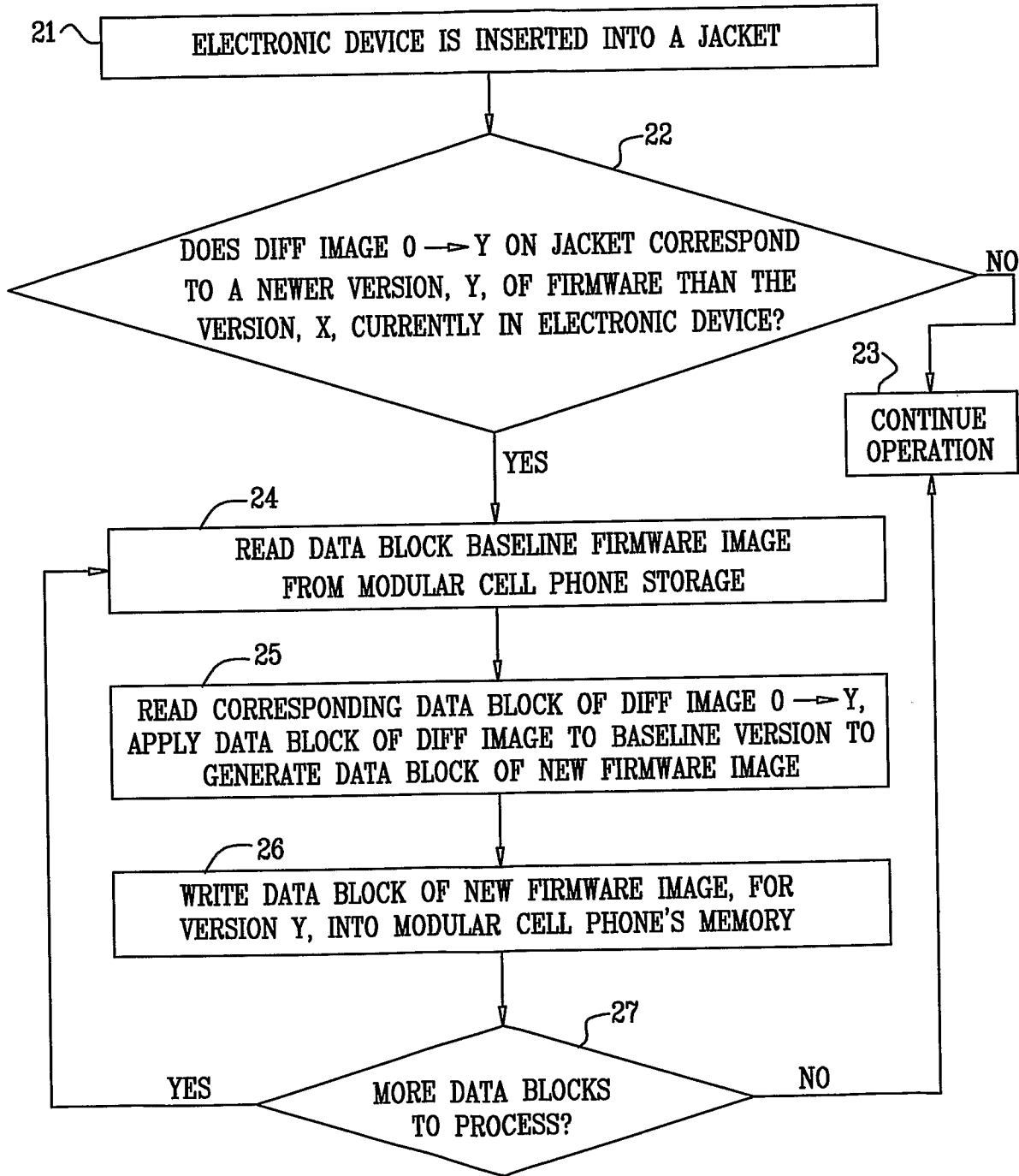




FIG. 7

