US007886093B1

(12) **United States Patent**
Chen

(10) **Patent No.: US 7,886,093 B1**
(45) **Date of Patent: Feb. 8, 2011**

(54) **ELECTRONIC DEVICE NETWORK SUPPORTING COMPRESSION AND DECOMPRESSION IN ELECTRONIC DEVICES**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 727 days.

(21) Appl. No.: **10/903,394**

(22) Filed: **Jul. 30, 2004**

Related U.S. Application Data

(60) Provisional application No. 60/491,831, filed on Jul. 31, 2003, provisional application No. 60/523,402, filed on Nov. 19, 2003.

(51) **Int. Cl.**

G06F 13/12	(2006.01)
G06F 13/38	(2006.01)

(52) **U.S. Cl.** **710/68**; 709/247

(58) **Field of Classification Search** 710/1-74
See application file for complete search history.

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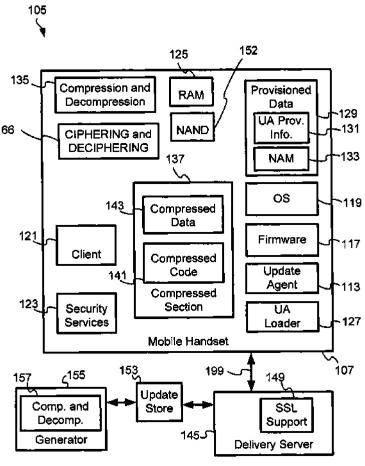
(57) **ABSTRACT**

Disclosed herein is an electronic device network including a plurality of electronic devices. The electronic devices may each have update agents capable of selectively decompressing compressed code and/or compressed data segments. The update agents may also be adapted to employ the decompressed code and data segments in conjunction with additional update information to update the firmware and/or software, compressed or otherwise, resident in the electronic devices. An update generator may be adapted to employ compression and decompression techniques to extract compressed code and data segments from a plurality of memory images stored in the electronic devices. The update generator may also be adapted to process the extracted information and generate update packages using the decompressed code and data segments and the additional update information. The update generator may also be adapted to selectively compress the update information in generated update packages usable for updating the electronic devices.

31 Claims, 4 Drawing Sheets



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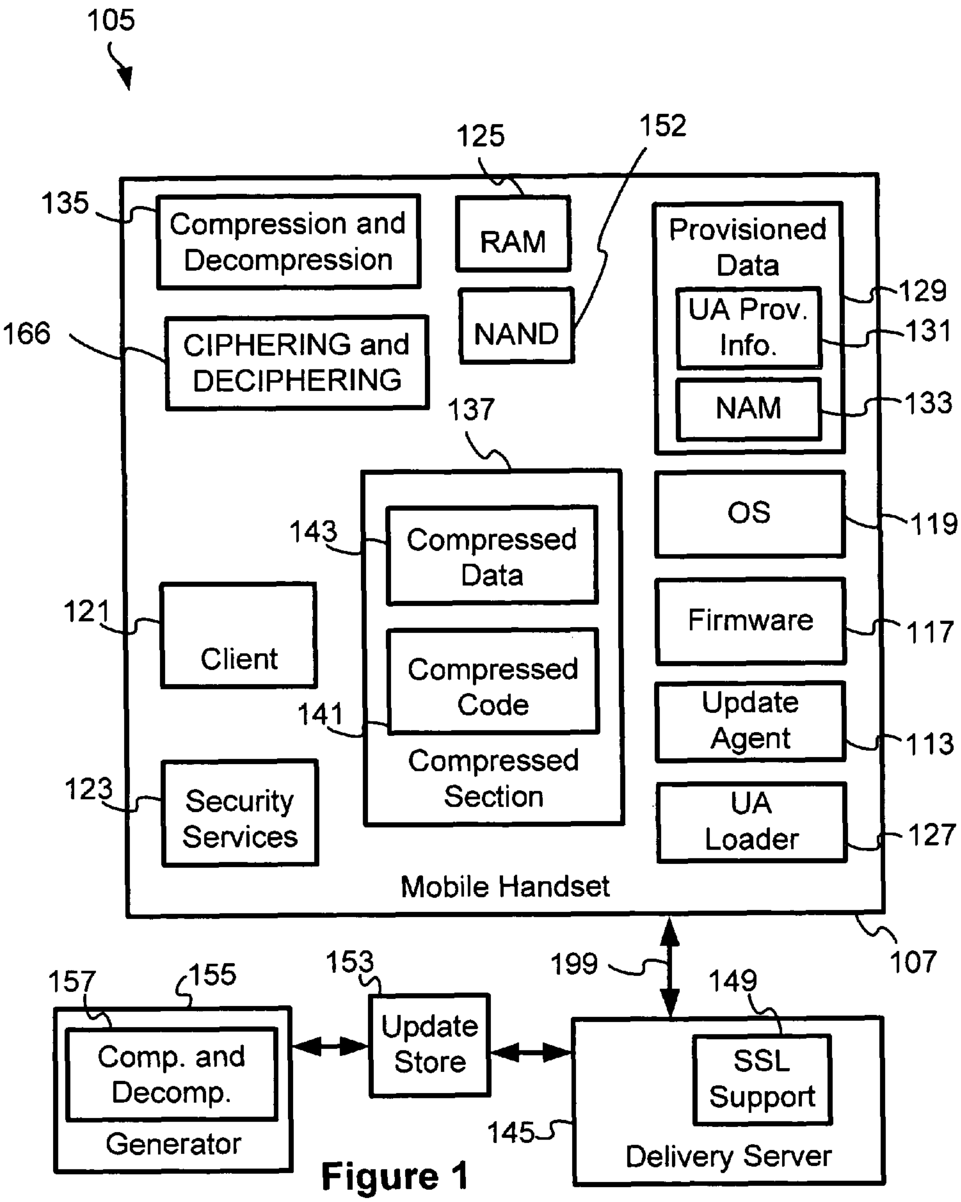
105
125
152
135
Compression and Decompression
RAM
Provisioned Data
129
UA Prov. Info.
131
NAND
166
CIPHERING and DECIPHERING
NAM
133
137
OS
119
143
Compressed Data
Firmware
117
121
Client
Compressed Code
141
Update Agent
113
Compressed Section
123
Security Services
UA Loader
127
Mobile Handset
107
157
155
153
199
149
Comp. and Decomp.
Update Store
SSL Support
Generator
145
Delivery Server

Figure 1

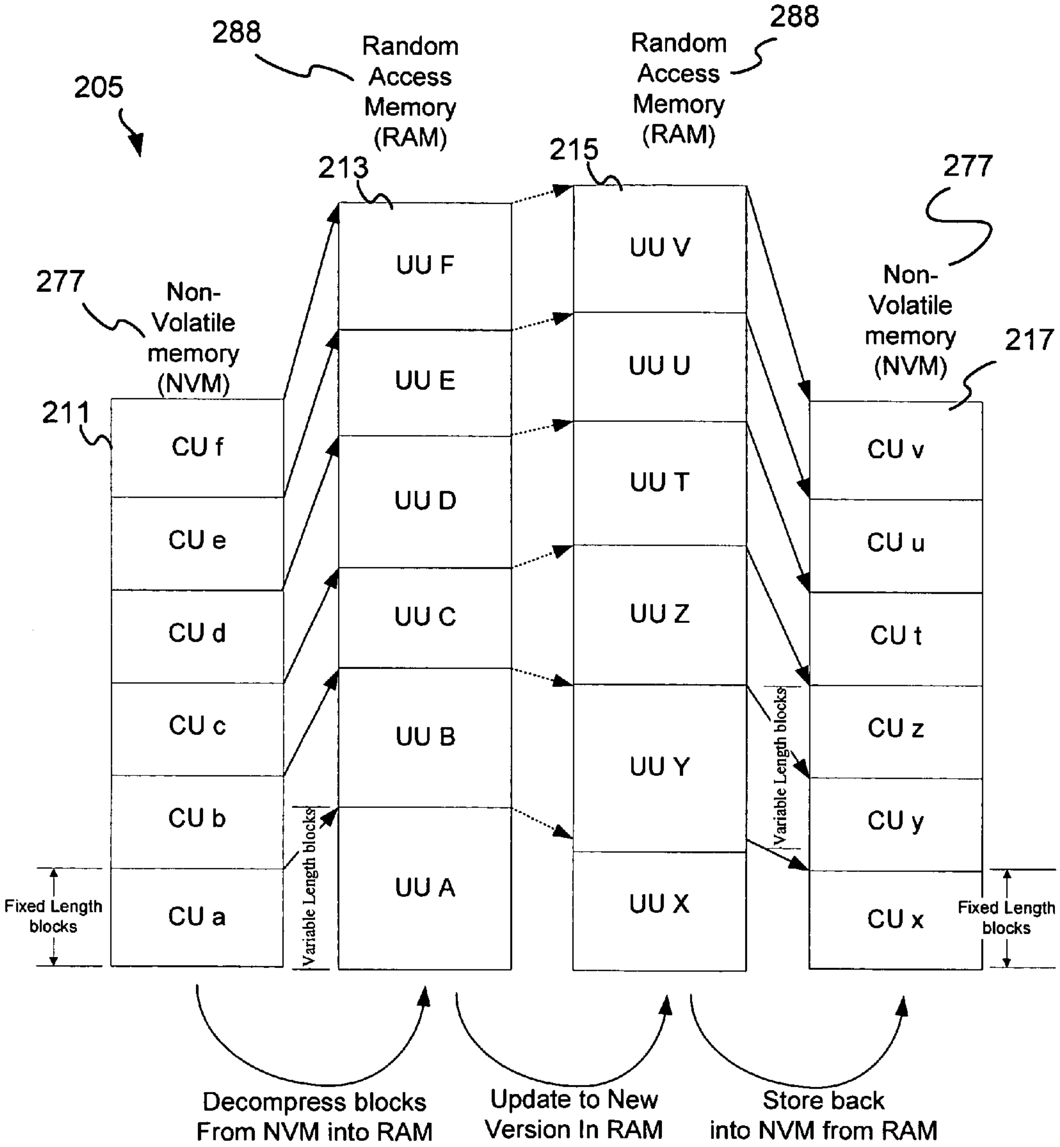
205
288
Random Access Memory (RAM)
288
Random Access Memory (RAM)
213
215
277
277
Non-Volatile memory (NVM)
Non-Volatile memory (NVM)
211
217
CU f
CU e
CU d
CU c
CU b
CU a
UU F
UU E
UU D
UU C
UU B
UU A
UU V
UU U
UU T
UU Z
UU Y
UU X
CU v
CU u
CU t
CU z
CU y
CU x
Fixed Length blocks
Variable Length blocks
Variable Length blocks
Fixed Length blocks
Decompress blocks From NVM into RAM
Update to New Version In RAM
Store back into NVM from RAM

Figure 2

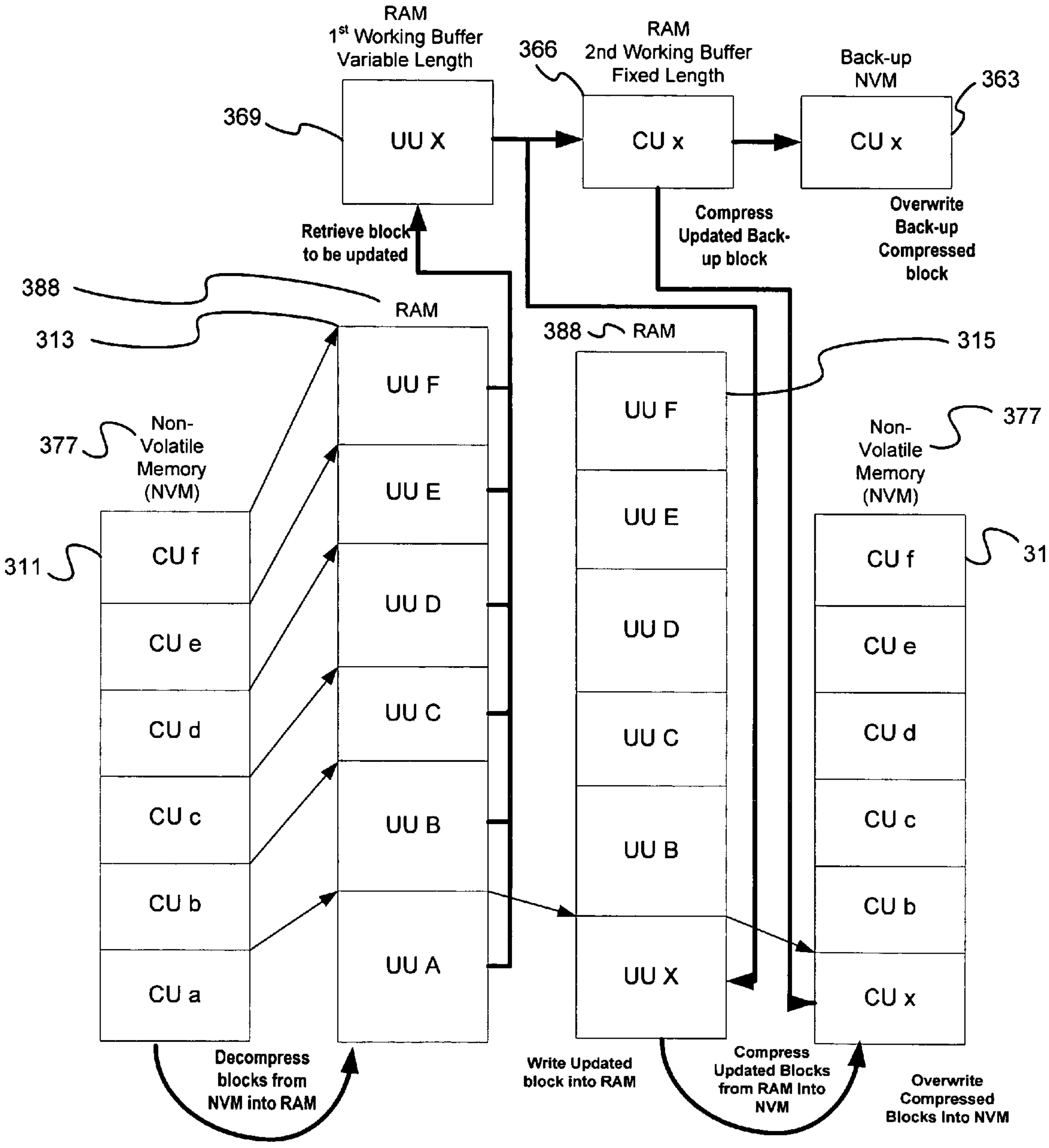
RAM
1st Working Buffer
Variable Length
369
UU X
366
RAM
2nd Working Buffer
Fixed Length
CU x
Back-up
NVM
363
CU x
Retrieve block
to be updated
Compress
Updated Back-
up block
Overwrite
Back-up
Compressed
block
388
313
RAM
388
RAM
315
377
Non-
Volatile
Memory
(NVM)
311
CU f
CU e
CU d
CU c
CU b
CU a
UU F
UU E
UU D
UU C
UU B
UU A
UU F
UU E
UU D
UU C
UU B
UU X
377
Non-
Volatile
Memory
(NVM)
317
CU f
CU e
CU d
CU c
CU b
CU x
Decompress
blocks from
NVM into RAM
Write Updated
block into RAM
Compress
Updated Blocks
from RAM Into
NVM
Overwrite
Compressed
Blocks Into NVM

FIGURE 3

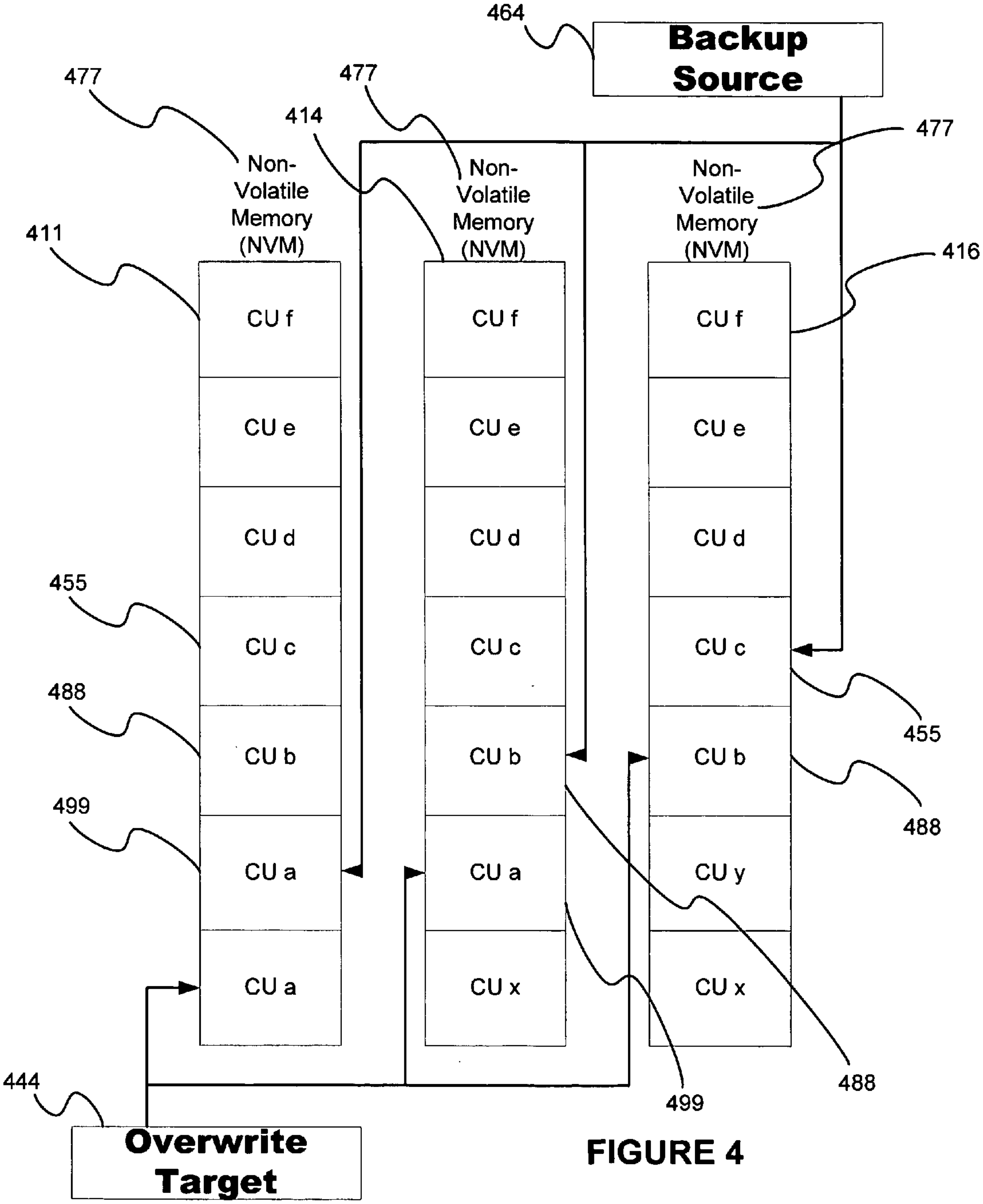
464
Backup Source
477
477
414
477
Non-Volatile Memory (NVM)
Non-Volatile Memory (NVM)
Non-Volatile Memory (NVM)
411
416
CU f
CU e
CU d
CU c
CU b
CU a
CU a
CU f
CU e
CU d
CU c
CU b
CU a
CU x
CU f
CU e
CU d
CU c
CU b
CU y
CU x
455
488
499
455
488
499
488
444
Overwrite Target

FIGURE 4

ELECTRONIC DEVICE NETWORK SUPPORTING COMPRESSION AND DECOMPRESSION IN ELECTRONIC DEVICES

CROSS-REFERENCE TO RELATED APPLICATIONS

The present application makes reference to, claims priority to, and the benefit of U.S. Provisional Patent Application 60/523,402 entitled "MOBILE HANDSET NETWORK WITH SUPPORT FOR COMPRESSION AND DECOMPRESSION IN THE MOBILE HANDSET", filed Nov. 19, 2003, the complete subject matter of which is hereby incorporated herein by reference in its entirety.

The present application makes reference to U.S. Provisional Patent Application 60/491,831 entitled "MOBILE HANDSET NETWORK WITH SUPPORT FOR COMPRESSION AND DECOMPRESSION IN THE MOBILE HANDSET AND GENERATOR", filed Jul. 31, 2003, the complete subject matter of which is hereby incorporated herein by reference in its entirety.

The present application also hereby incorporates herein by reference in its entirety, the complete subject matter of PCT Application having publication number WO 02/41147 A1 and PCT application number PCT/US01/44034, filed on Nov. 19, 2001.

The present application also hereby incorporates herein by reference in its entirety, the complete subject matter of U.S. Provisional Patent Application 60/249,606 filed on Nov. 17, 2000.

The present application also hereby incorporates herein by reference in its entirety, the complete subject matter of U.S. Provisional Patent Application 60/422,048, filed Oct. 29, 2002.

FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[Not Applicable]

MICROFICHE/COPYRIGHT REFERENCE

[Not Applicable]

BACKGROUND OF THE INVENTION

Electronic devices, such as mobile phones and personal digital assistants (PDA's), often contain firmware and/or application software that are either provided by the manufacturers of the electronic devices, by telecommunication carriers, or by third parties. These firmware and application software often contain bugs. New versions of firmware and software are periodically released to fix the bugs and/or to introduce new features.

Generating update packages in an efficient mode when at least a portion of the firmware and/or software to be updated is compressed and/or encrypted is a complex and challenging process. Updating code in electronic devices when the code to be updated is compressed and/or encrypted is also a challenging task.

Update programs, code, or functions employed to update the firmware and/or software components in electronic devices may also need to be changed, modified, and/or updated. However, portions or blocks of the information being updated may not fit into the memory available in the electronic device during an update. Changes to firmware and/or software components may need to be performed in a fault tolerant mode, however a fault tolerant update may be difficult to implement.

Electronic devices may employ non-volatile memory to store code and/or data. Sometimes, more than one type of memory device may be employed. Updating code and/or data distributed across multiple memory devices and memory device types may be difficult, especially, if the memory devices are produced by different manufacturers.

Further limitations and disadvantages of conventional and traditional approaches will become apparent to one of ordinary skill in the art through comparison of such systems with the present invention as set forth in the remainder of the present application with reference to the drawings.

SUMMARY OF THE INVENTION

Aspects of the present invention may be found in a method of updating compressed information in an electronic device. The method may comprise decompressing at least one block of information to be updated, updating at least a portion of decompressed contents of the at least one block of information, and compressing the updated contents of the at least one block of information.

In an embodiment according to the present invention, the method may further comprise retrieving and updating one block at a time.

In an embodiment according to the present invention, the method may further comprise retrieving a plurality of blocks and updating one block at a time.

In an embodiment according to the present invention, the method may further comprise backing up the at least one block of information during an update.

In an embodiment according to the present invention, backing up the at least one block of information may comprise storing a compressed version of the at least block of information being updated.

In an embodiment according to the present invention, backing up the at least one block of information may comprise storing a decompressed updated version of the at least one block of information.

In an embodiment according to the present invention, updating at least a portion of decompressed contents of the at least one block of information may comprise overwriting at least a portion of the contents of the at least one block of information with updated information.

In an embodiment according to the present invention, updating at least a portion of decompressed contents of the at least one block of information may comprise modifying at least a portion of the contents of the at least one block of information with updated information.

In an embodiment according to the present invention, updating at least a portion of decompressed contents of the at least one block of information may comprise using a set of executable instructions to convert the at least a portion of decompressed contents to an updated contents.

In an embodiment according to the present invention, decompressing at least one block of information to be updated may comprise adjusting one of a size or length of the block of information during decompression.

In an embodiment according to the present invention, compressing the updated contents of the at least one block of information may comprise adjusting one of a size or length of the block of information during compression.

Aspects of the present invention may be found in a method of fault tolerant updating of compressed information in an electronic device. The method may comprise decompressing contents of at least one block of information to be updated, temporarily storing the at least one block of information, and compressing contents the at least one block of information after the contents have been updated.

In an embodiment according to the present invention, temporarily storing the at least one block of information may comprise storing the at least one block of information in compressed form before being updated.

In an embodiment according to the present invention, temporarily storing the at least one block of information may comprise storing the at least one block of information after contents of the at least one block of information have been updated.

In an embodiment according to the present invention, the method may further comprise updating at least a portion of one block of information one block at a time.

In an embodiment according to the present invention, updating at least a portion of one block of information may comprise updating decompressed contents of the at least one block of information by overwriting at least a portion of the decompressed contents of the at least one block of information with updated information.

In an embodiment according to the present invention, updating at least a portion of one block of information may comprise updating decompressed contents of the at least one block of information by modifying at least a portion of the decompressed contents of the at least one block of information with updated information.

In an embodiment according to the present invention, updating at least a portion of one block of information comprises updating decompressed contents of the at least one block of information by converting at least a portion of decompressed contents of the at least one block of information to an updated contents using a set of executable instructions.

In an embodiment according to the present invention, decompressing at least one block of information to be updated may comprise adjusting one of a size or length of the block of information during decompression.

In an embodiment according to the present invention, compressing the updated contents of the at least one block of information may comprise adjusting one of a size or length of the block of information during compression.

Aspects of the present invention may be found in a system for updating compressed information. The system may comprise at least one electronic device comprising compressed information and an update generator for generating updates for updating the compressed information resident in the at least one electronic device in a fault tolerant manner.

In an embodiment according to the present invention, the electronic device may comprise a compressed section of non-volatile memory. The compressed section may comprise at least one of compressed data and compressed code.

In an embodiment according to the present invention, the electronic device may comprise one of a unitary decompression/compression engine and a separate decompression engine and a separate compression engine.

In an embodiment according to the present invention, the electronic device may comprise a back-up non-volatile storage for ensuring continuity of an update procedure and preventing loss of information. At least one block of information may be stored in the back-up non-volatile storage during the update procedure.

In an embodiment according to the present invention, the electronic device may comprise random access memory for performing an update on decompressed blocks of information.

In an embodiment according to the present invention, the electronic device may comprise a non-volatile memory adapted to contain blocks of information comprising one of a uniform size and a uniform length.

In an embodiment according to the present invention, the electronic device may comprise a random access memory adapted to contain blocks of information comprising one of a variable size and a variable length.

In an embodiment according to the present invention, the electronic device comprises one of a unitary ciphering/deciphering engine and a separate ciphering engine and a separate deciphering engine.

These and other advantages, aspects, and novel features of the present invention, as well as details of illustrated embodiments, thereof, will be more fully understood from the following description and drawings.

BRIEF DESCRIPTION OF SEVERAL VIEWS OF THE DRAWINGS

FIG. **1** is a block diagram illustrating an electronic device network adapted to employ compression and decompression techniques during an update of partially or totally compressed firmware and/or software components in electronic devices in accordance with an embodiment of the present invention;

FIG. **2** is a block diagram illustrating a method of updating compressed firmware and/or software components residing in non-volatile memory in an electronic device in accordance with an embodiment of the present invention;

FIG. **3** is a block diagram illustrating a method of preventing loss of information and ensuring continuity of an update procedure by storing updated memory blocks in a fault tolerant manner during an update of firmware and/or software components in an electronic device in accordance with an embodiment of the present invention; and

FIG. **4** is a diagram illustrating a method of preventing loss of information and ensuring continuity of an update procedure by backing up and overwriting at least one compressed block of information during an update of an electronic device in accordance with an embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Electronic devices may be adapted to access servers to retrieve update information for updating electronic devices. An electronic device may be, for example, a mobile electronic device having software/firmware, such as, mobile cellular phone handsets, personal digital assistants (PDA's), pagers, MP3 players, digital cameras, etc. Update information may comprise information that modifies or changes firmware and/or software components installed in the electronic device. Update information may also add new services to the electronic device, as desired by a service provider, device manufacturer, or an end-user.

Aspects of the present invention may be found in a fault tolerant method of updating a compressed information file. The compressed information file may be stored in compressed form in a non-volatile memory device, for example, a flash memory device. The compressed information file may comprise code and/or data. The memory may be erased before reprogramming. The memory may be overwritten, without being erased, during updating and/or reprogramming.

In an embodiment according to the present invention, a fault tolerant method may comprise preventing loss of information, in the event that power failure occurs, during a reprogramming event. In an embodiment according to the present invention, a fault tolerant method may comprise ensuring continuity of an updating and/or reprogramming procedure, in the event that power failure occurs, during the updating and/or reprogramming procedure.

Information, residing in the electronic devices to be updated, may comprise code and/or data. The code and/or data may be organized/arranged in units or blocks of information. The blocks of information may also be called compressed units/blocks and update units/blocks herein. In an embodiment according to the present invention, the size of a particular memory block in non-volatile memory may be fixed and may be a parameter of a manufacturer's hardware configuration of an electronic device. In an embodiment according to the present invention, the size of a particular memory block usable for updating may be variable according to the demands placed upon the memory during a processing event.

In an embodiment according to the present invention, a compressed unit/block may comprise a set of compressed code/data. In an embodiment according to the present invention, compression and decompression of the code/data may be performed independently, for example, one block or unit at a time. In an embodiment according to the present invention, several or all of the blocks may be compressed and decompressed simultaneously. The size of a compressed unit/block may be arranged according to particular electronic device memory constraints. The electronic device memory may be arranged as a single block of memory or a plurality of memory sub-blocks.

In an embodiment according to the present invention, an update unit/block may comprise a logical block of memory in random access memory (RAM). When a compressed unit/block is decompressed from non-volatile memory (NVM) into RAM, the block may be designated an update unit/block because the decompressed block may be changed, modified, overwritten, and/or updated.

In an embodiment according to the present invention, an update generator may be adapted to generate an update unit/block or a set comprising a plurality of update unit/blocks for use in updating one of firmware and/or software in electronic devices. Each update unit/block may have the same or a different size or length, i.e., the amount of decompressed information resident in each update unit/block may vary from block to block. Each compressed block may comprise a uniform length. Each update unit/block may have a variable size or length.

An update package may comprise a firmware/software update that may be used to modify or change a version of a particular firmware/software, for example, upgrading to a newer version. The information in the update package may comprise, for example, a set of executable instructions for converting a first version of firmware/software ("code") to a second version of code. In an embodiment according to the present invention, an update package may also add new services to the electronic device or delete services, as desired by the service provider or an end-user. An update package may also be referred to in abbreviated form herein as an update.

In an embodiment according to the present invention, the electronic device may comprise an update generator. The update generator may be adapted to process (i.e., update) update units/blocks. In an embodiment according to the present invention, updating update units/blocks may comprise overwriting the decompressed information resident in the update units/blocks with new or different (updated) information.

In an embodiment according to the present invention, the update generator may be adapted to process (i.e., update) update units/blocks comprising a plurality of non-uniform (i.e., variable) sizes. The ability of the update generator to process (i.e., update) update units/blocks is not hampered by update units/blocks comprising variable amounts of decompressed information (i.e., those having variable size or length).

In an embodiment according to the present invention, the update generator may also be adapted to determine different split boundaries between individual update units/blocks. For example, a different split boundary may be employed after the update units/blocks have been updated in order to permit the variable-sized updated blocks to be compressed into blocks of fixed size for storage in the NVM. The size may be fixed in accordance with electronic device specifications or by the non-volatile memory device specifications.

FIG. **1** is a block diagram illustrating an electronic device network, for example, mobile handset network **105**, adapted to employ compression and decompression techniques to update partially or totally compressed firmware **117** and/or software in electronic devices, for example, mobile handset **107**, in accordance with an embodiment of the present invention.

In FIG. **1**, the electronic device network, for example, the mobile handset network **105** may be adapted to employ compression and decompression techniques. The electronic device network, for example, mobile handset network **105** may comprise an update generator **155** capable of generating updates that may be employed to update firmware **117** and/or software components in electronic devices, for example, mobile handset **107**. The update generator **155** may comprise a combined compression and decompression engine **157**. In an embodiment according to the present invention, the update generator **155** may also comprise a separate compression engine and a separate decompression engine.

The electronic device network, for example, mobile handset network **105**, may also comprise an update store **153** operatively connected to the update generator **155**. The update store **153** may be adapted to serve as a repository for one or a plurality of partially or wholly generated updates. The electronic device network, for example, mobile handset network **105**, may also comprise a delivery server **145** adapted to dispense generated updates via a communication link **199** to a plurality of electronic devices, for example, mobile handset **107**. The delivery server **145** may be operatively connected to the update store **153** and therefore also to the update generator **155** according to an embodiment of the present invention.

The operative connections between update generator **155**, the update store **153**, and the delivery server **145** illustrated in FIG. **1**, are exemplary and other connective arrangements may also be employed. The communications link **199** may, for example, comprise at least one of a wire, a cable, an optical fiber, and a wireless connection, for example. The delivery server **145** may also comprise a secure socket layer (SSL) support engine **149** for ensuring secure communication between the delivery server **145** and a plurality of electronic devices, for example, mobile handset **107**.

In an embodiment according to the present invention, an electronic device, for example, mobile handset **107** may be adapted to retrieve generated updates from the delivery server **145** to update firmware **117** and/or software components resident in the electronic device. In an embodiment according to the present invention, at least a portion of firmware **117** and/or software components resident in the electronic device may be compressed and/or encrypted.

In an embodiment according to the present invention, compression algorithms may be installed in the electronic devices, for example, mobile handset **107**. The installed compression algorithms may be implemented in hardware in an embodiment according to the present invention. The installed compression algorithms may be implemented in firmware **117** and/or software components in another embodiment according to the present invention.

In an embodiment according to the present invention, the compression algorithms may be employed to decompress compressed code and/or compressed data segments that may be stored in the compressed data section **143** and the compressed code section **141**, respectively, in a compressed section **137**. The decompressed code and/or data segments may be updated in RAM **125** using updates downloaded or otherwise transferred to the electronic device, for example, mobile handset **107**. Once the decompressed code is updated, (e.g., updates may be performed in a fault tolerant mode), the code may be compressed again and stored in non-volatile memory in the electronic device.

In an embodiment according to the present invention, fault tolerant updating of firmware **117** and/or software components comprising compressed code and/or compressed data segments may be conducted in the electronic device, for example, mobile handset **107**. A fault tolerant update agent, for example, update agent **113**, may be employed to update the firmware **117** and/or software components in electronic devices, for example, mobile handset **107**.

In an embodiment according to the present invention, the compression and decompression algorithms may be embedded in a compression engine accessible by the update generator. In an embodiment according to the present invention, the compression engine may comprise a software engine accessible by the update generator.

In an embodiment according to the present invention, electronic devices, for example, mobile handset **107**, may comprise compression and decompression components **135**, an update download client **121**, a security services component **123**, and a compressed section **137**. The compressed section **137** may at least comprise a compressed data section **143** and a compressed code section **141**. The compressed section may comprise non-volatile memory. The electronic devices, for example, mobile handset **107**, may also comprise a provisioned data component **129**. The provisioned data component **129** may at least comprise an update agent (UA) provisioning information section **131** and a number assignment module (NAM) **133**.

In an embodiment according to the present invention, the electronic devices, for example, mobile handset **107** may also comprise an operating system (OS) **119**, firmware **117**, update agent **113**, and an update application (UA) loader **127**. The update agent **113** may be capable of employing the compression and decompression components **135** to update the firmware **117** and/or software component in the electronic devices, for example, mobile handset **107**.

In an embodiment according to the present invention, at least a portion of the firmware **117** and/or software components may be compressed and reside in the compressed section **137**, that may comprise a non-volatile memory. In an embodiment according to the present invention, the update agent **113** may be capable of conducting fault-tolerant updates.

In an embodiment according to the present invention, the update agent **113** may comprise an update core engine (not shown in FIG. **1**). In an embodiment according to the present invention, the compressed code stored in compressed code section **141** and the compressed data stored in compressed data section **143** may also be ciphered. The electronic device, for example, mobile handset **107** may also comprise ciphering and deciphering components **166** employable to facilitate updating of firmware **117** and/or software components in the electronic devices. In an embodiment according to the present invention, the information to be updated in an electronic device may be decompressed, deciphered, updated, enciphered, and compressed as part of an update procedure. In an embodiment according to the present invention, the information to be updated may also be decrypted and encrypted as part of an update procedure.

In an embodiment according to the present invention, the update generator **155** may be capable of processing an old memory image and a new memory image of electronic device firmware **117** and/or software components in creating an update. At least a portion of the firmware **117** and/or software components may be compressed employing compression techniques, ciphered employing ciphering techniques, and encrypted employing encryption techniques. At least a portion of the firmware **117** and/or software components may be decompressed employing decompression techniques, deciphered employing deciphering techniques, and decrypted employing decryption techniques. The compression techniques employed in the electronic device network and the electronic devices themselves may comprise, for example, zip, gzip, winzip, LZ compression, etc., for example.

In an embodiment according to the present invention, the compression/decompression engine **157** in update generator **155** may decompress the compressed data and/or compressed code in both the old memory image and the new memory image to generate an update usable to update a current memory image of the electronic devices, for example, mobile handset **107**.

In an embodiment according to the present invention, electronic devices, for example, mobile handset **107** may comprise and employ NAND-type non-volatile memory **152** (that may also be referred to as NAND-flash memory) to store data and/or code. The NAND-type non-volatile memory may be used to back up information (as a backup resource) currently being updated to ensure fault tolerant updating, i.e., avoiding loss of information and ensuring continuity of an update in the event a power failure should occur during the update procedure. The stored data and/or code may be decompressed by the compression and decompression component **135** in the electronic device, for example mobile handset **107**.

In an embodiment according to the present invention, updating the code/data in the NAND-type memory **152** by update agent **113** may require retrieving components (code and/or data) one block at a time. By backing up a single block of information (code and/or data) at a time, continuity of an update in the event of a power failure during the update may be ensured. Additionally, by backing up a single block of information (code and/or data) at a time, loss of information may be avoided. In an embodiment according to the present invention, the retrieved components may also be decompressed one block at a time during retrieval.

In an embodiment according to the present invention, a block of code/data in the NAND-type memory **152** may be decompressed to restore the code/data in the blocks while updating a current block in RAM **125**. In an embodiment according to the present invention, the current block in the RAM **125** may be updated in fault tolerant mode. In an embodiment according to the present invention, the updated block may be written back into the NAND-type memory **152** for subsequent restoration.

In an embodiment according to the present invention, a working bank of memory in the RAM **125** may be expanded beyond one block in length. A decompressed current block from the NAND-type memory **152** may occupy more than one block in RAM **125**. After update completion, the decompressed code/data in the working block may be written back into the current block in NAND-type memory **152**.

FIG. **2** is a block diagram **205** illustrating a method of updating compressed firmware and/or software components in an electronic device, for example, the mobile handset **107** illustrated in FIG. **1**, in accordance with an embodiment of the present invention.

FIG. **2** illustrates a plurality of compressed blocks **211** (for example, CU a, CU b, CU c, . . . , CU f) of code/data to be updated, that are resident in non-volatile memory (NVM) **277**. The compressed blocks **211** may be decompressed from the NVM **277** into RAM **288** in the electronic device, for example, the mobile handset **107** illustrated in FIG. **1**, creating a plurality of update blocks **213** (for example, UU A, UU B, UU C, . . . , and UU F) of code/data.

An update agent, for example, update agent **113** illustrated in FIG. **1**, resident in the electronic device may update the plurality of update blocks **213** in RAM **288** by employing one or more of a plurality of updates and creating a plurality of updated blocks **215** in the RAM **288**.

In an embodiment according to the present invention, the plurality of update blocks **213** of code/data may be updated to create the plurality of updated blocks **215** of code/data, one block at a time. In another embodiment according to the present invention, all of the plurality of update blocks **213** of code/data may be simultaneously updated by a plurality of updates, creating the plurality of updated blocks **215** of code/data. After update completion, the updated blocks **215** of code/data may be compressed into second compressed units **217** (for example, CU x, CU a, . . . , CU f) and may be copied into non-volatile memory **277**.

In an embodiment according to the present invention, an update generator, for example, update generator **155** illustrated in FIG. **1**, may be used to generate the update packages used to update the information in update blocks **213**. In an embodiment according to the present invention, an update core engine may also be employed in the electronic device for carrying out the updates. In an embodiment according to the present invention, the update core engine may be a component of an update agent, for example, update agent **113** illustrated in FIG. **1**. In an embodiment according to the present invention, the update core engine may be adapted to update firmware and/or software one block at a time.

FIG. **3** is a diagram illustrating a method preventing loss of information by storing updated memory blocks in a fault tolerant manner during an update of one of firmware and/or software components in an electronic device, in accordance with an embodiment of the present invention. FIG. **3** illustrates a fault tolerant update information back-up procedure.

In an embodiment according to the present invention, firmware and/or software components resident in electronic devices may be updated. In prior art electronic devices, when/if a power failure occurs during an update of an electronic device, the potential exists for information (code/data) to be lost or misplaced in the electronic device. Information residing in RAM, for example, may be particularly vulnerable because information in RAM is lost when power to the RAM is interrupted. Information residing in a non-volatile memory when/if a power failure occurs may be safely retained. However, upon power-up, the electronic device may not be able to locate, properly address, and/or identify the stored information, rendering the stored information unusable. The loss of information during an update may damage the electronic device and/or render the electronic device inoperable. In an embodiment according to the present invention, loss of update information may be prevented, by employing the fault tolerant updating method set forth herein.

Referring to FIG. **3**, compressed blocks **311** (for example, CU a, CU b, CU c, . . . , CU f) of code/data residing in non-volatile memory **377** (NVM) may be decompressed from the NVM **377** to RAM **388**. The compressed blocks **311** may be uniform in length. The RAM **388** may comprise a plurality of decompressed update blocks **313** (for example, UU A, UU B, UU C, . . . , UU F). The decompressed update blocks **313** may comprise various lengths.

The decompressed blocks **313** may be retrieved, for example, one block at a time, from the RAM **388** and placed in a first working buffer **369** of variable length. In the first working buffer **369**, the update block **313** may be updated. In an embodiment according to the present invention, updating may comprise overwriting/modifying the entire contents of the update block **313** in the first working buffer **369** with different/updated information. In an embodiment according to the present invention, updating may comprise overwriting a portion of the contents of the update block **313** in the first working buffer **369** with different/updated information.

After the update block **313** has been updated, a back-up copy of the updated block may be compressed from the first working buffer **369** to a second working buffer **366**. The first working buffer **369** may comprise blocks having varying lengths to facilitate updating. The second working buffer **366** may comprise blocks having uniform lengths corresponding to the uniform length of blocks in the non-volatile memory device, for example, NVM **377**. The contents of the first working buffer **369** may be compressed into the second working buffer **366**, and subsequently into the back-up NVM **363**. By saving the compressed update block in the back-up NVM **363**, should a power failure occur, the electronic device, upon re-boot and restart, may continue the update without loss of information and/or continuity. The update may resume where the update was abruptly interrupted by the power failure.

The updated block **315** may also be compressed from the first working buffer **369** into RAM **388**. The updated block **315** may also be stored in NVM **377**. A previous block, for example block **317** in NVM **377** may be overwritten with the compressed updated block of information.

FIG. **4** is a diagram illustrating a method of backing up a block of information during an update of an electronic device, for example, the mobile handset **107** illustrated in FIG. **1**, in accordance with an embodiment of the present invention. FIG. **4** illustrates a non-volatile memory device **477** (NVM) comprising a plurality of memory blocks **411**, **414**, and **416** (labeled for example, CU a, CU b, CU c, . . . , CU f). FIG. **4** also illustrates a backup source **464** (non-volatile memory) memory location and an overwrite target **444** memory location.

Aspects of the present invention may be found in avoiding loss of information and ensuring continuity of an update procedure when performing updates of firmware and/or software components in electronic devices by backing up an updated block of information in a fault tolerant manner. Updates may be performed on update blocks, for example, **499**, **488**, and **455**, and each update block may be updated independent of other update blocks, i.e., each update block may receive different update information than any other update block. An update block, for example, **499**, **488**, and **455**, may be reconstructed, in the event of update interruption due to a power failure, for example, by evaluating the stored corresponding compressed block stored in backup source **464**, for example, or by evaluating information stored where the update block originated (for example, in non-volatile memory).

Storing (backing-up) a compressed block corresponding to a current working update block during the update procedure in backup source **464**, for example, may ensure that loss of information is avoided. Therefore, a fault tolerant update may comprise safeguarding update information (the compressed block stored in backup source **464**) so that a current working block (the block being updated) may be reconstructed should a power failure occur during the update.

Aspects of the present invention may be found in a method of performing a fault tolerant update on an information file (e.g., code/data) in an electronic device. In an embodiment according to the present invention, an information file (i.e., block of information) may be stored in compressed form in non-volatile memory **477**, for example, in an electronic device while the decompressed information file (i.e., block of information) is being updated in RAM, for example, RAM **388** illustrated in FIG. **3**, during an electronic device update procedure.

In an embodiment according to the present invention, when a compressed block of information is decompressed out of NVM **411** into RAM, for example, RAM **388** illustrated in FIG. **3**, a compressed version of the same block may also be written (stored) in a particular, but temporary, non-volatile memory location, for example, backup source **464**, for easy reference during a restart or reboot after a power failure or other update interruption. As each block is subsequently processed, the compressed version of the current working block may be overwritten into an overwrite target **444**, for example, block CU a, illustrated in FIG. **4**.

Accordingly, the present invention may be realized in hardware, software, or a combination of hardware and software. The present invention may be realized in a centralized fashion in at least one computer system, or in a distributed fashion where different elements are spread across several interconnected computer systems. Any kind of computer system or other apparatus adapted for carrying out the methods described herein is suited. A typical combination of hardware and software may be a general-purpose computer system with a computer program that, when being loaded and executed, controls the computer system such that it carries out the methods described herein.

The present invention may also be embedded in a computer program product, which comprises all the features enabling the implementation of the methods described herein, and which when loaded in a computer system is able to carry out these methods. Computer program in the present context means any expression, in any language, code or notation, of a set of instructions intended to cause a system having an information processing capability to perform a particular function either directly or after either or both of the following: a) conversion to another language, code or notation; b) reproduction in a different material form.

While the present invention has been described with reference to certain embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted without departing from the scope of the present invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the present invention without departing from its scope. Therefore, it is intended that the present invention not be limited to the particular embodiment disclosed, but that the present invention will include all embodiments falling within the scope of the appended claims.

What is claimed is:

1. A method of updating compressed information in an electronic device, the method comprising:

decompressing one of at least one block of information to be updated;

after decompressing, updating at least a portion of decompressed contents of the one of the at least one block of information, using update information received by the electronic device;

after updating, compressing an amount of the updated decompressed contents of the one of the at least one block of information, wherein the amount to be compressed is predetermined by a generator of the update information external to the electronic device;

after compressing, storing the compressed updated decompressed contents in the one or another of the at least one block of information; and

repeating the decompressing, updating, compressing, and storing in a block by block fashion until each block in the at least one block of information has been updated.

2. The method according to claim **1**, further comprising retrieving and updating one block at a time.

3. The method according to claim **1**, further comprising retrieving a plurality of blocks and updating one block at a time.

4. The method according to claim **1**, further comprising storing a duplicate copy of the one of the at least one block of information during an update.

5. The method according to claim **4**, wherein storing the duplicate copy of the one of the at least one block of information comprises storing a compressed version of the one of the at least one block of information.

6. The method according to claim **4**, wherein storing the backup copy of the one of the at least one block of information comprises storing the updated decompressed contents of the one of the at least one block of information.

7. The method according to claim **1**, wherein updating at least a portion of decompressed contents of the one of the at least one block of information comprises overwriting at least a portion of the decompressed contents of the one of the at least one block of information with updated information.

8. The method according to claim **1**, wherein updating at least a portion of decompressed contents of the one of the at least one block of information comprises modifying at least a portion of the decompressed contents of the one of the at least one block of information with updated information.

9. The method according to claim **1**, wherein updating at least a portion of decompressed contents of the one of the at least one block of information comprises using a set of executable instructions to convert the at least a portion of decompressed contents to an updated contents.

10. The method according to claim **1**, wherein decompressing the one of the at least one block of information to be updated comprises adjusting one of a size and length of the block of information during decompression.

11. The method according to claim **1**, wherein compressing the updated contents of the one of the at least one block of information comprises adjusting one of a size and length of the block of information during compression.

12. A method of fault tolerant updating of compressed information in an electronic device, the method comprising:

decompressing contents of at least one block of information to be updated;

temporarily storing in non-volatile memory a duplicate copy of the at least one block of information;

after decompressing, compressing a predetermined amount of the updated contents of the at least one block of information, after the contents have been updated using update information received by the electronic device from a remote source;

after compressing, storing the compressed updated contents in the at least one block of information;

repeating the decompressing, temporarily storing, compressing, and storing after compression until all of the at least one block of information have been updated; and

wherein the update information communicates the predetermined amount of the updated decompressed contents to be compressed for each of the at least one block to be updated, and comprises information enabling the electronic device to resume updating the compressed information at a point of abnormal interruption of the updating.

13. The method according to claim **12**, wherein temporarily storing the duplicate copy of the at least one block of information comprises storing the at least one block of information in compressed form before being updated.

14. The method according to claim **12**, wherein temporarily storing the duplicate copy of the at least one block of information comprises storing the at least one block of information after contents of the at least one block of information have been updated.

15. The method according to claim **12**, further comprising updating at least a portion of one block of information at a time.

16. The method according to claim **15**, wherein updating at least a portion of one block of information comprises updating decompressed contents of the at least one block of information by overwriting at least a portion of the decompressed contents of the at least one block of information with updated information.

17. The method according to claim **15**, wherein updating at least a portion of one block of information comprises updating decompressed contents of the at least one block of information by modifying at least a portion of the decompressed contents of the at least one block of information with updated information.

18. The method according to claim **15**, wherein updating at least a portion of one block of information comprises updating decompressed contents of the at least one block of information by converting at least a portion of decompressed contents of the at least one block of information to an updated contents using a set of executable instructions.

19. The method according to claim **12**, wherein decompressing at least one block of information to be updated comprises adjusting one of a size and length of the block of information during decompression.

20. The method according to claim **12**, wherein compressing the updated contents of the at least one block of information comprises adjusting one of a size and length of the block of information during compression.

21. A system for updating compressed information, the system comprising:

at least one electronic device comprising compressed information; and

an update generator remote from the electronic device for generating updates for updating the compressed information resident in the at least one electronic device in a fault tolerant manner, the generated updates comprising information identifying an amount of updated decompressed information to be compressed to form each block of updated compressed information, and information that enables the at least one electronic device to resume updating the compressed information at a point of interruption of the updating.

22. The system according to claim **21**, wherein the electronic device comprises a compressed section of non-volatile memory comprising compressed code.

23. The system according to claim **21**, wherein the electronic device comprises one of a unitary decompression/compression engine and a separate decompression engine and a separate compression engine.

24. The system according to claim **21**, wherein the electronic device comprises a hack-up non-volatile storage for ensuring continuity of an update procedure and preventing loss of information, wherein at least one duplicate block of information is stored in the hack-up non-volatile storage only during the update procedure.

25. The system according to claim **21**, wherein the electronic device comprises random access memory for performing an update on decompressed blocks of information.

26. The system according to claim **21**, wherein the electronic device comprises a non-volatile memory adapted to contain blocks of information comprising one of a uniform size and a uniform length.

27. The system according to claim **21**, wherein the electronic device comprises a random access memory adapted to contain blocks of information comprising one of a variable size and a variable length.

28. The system according to claim **21**, wherein the electronic device comprises one of a unitary ciphering/deciphering engine and a separate ciphering engine and a separate deciphering engine.

29. The method according to claim **1**, wherein the compressed information comprises executable code installed in the electronic device and the updating comprises reprogramming the electronic device.

30. The method according to claim **5**, wherein the compressed version is the one of the at least one block of information before the updating.

31. The method according to claim **5**, wherein the compressed version is the one of the at least one block of information after the updating.

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