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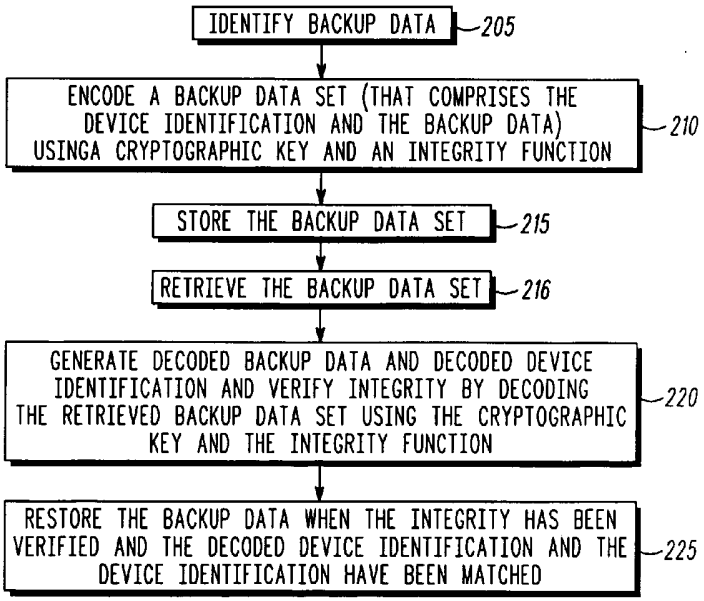
(54) **Title:** SECURE DATA BACKUP AND RECOVERY



(57) **Abstract:** A technology provides secure data backup and recovery for an electronic device (100) having a device identification (115) that is unique and unalterable. A method of the technology includes identifying (205) backup data (405, 805, 1205) to be backed up, encoding (210) a backup data set by coding the device identification (115) and the backup data (405, 805, 1205) for integrity and authentication using a cryptographic key (110) and an integrity function, generating (220) decoded backup data (635, 1015, 1435) and decoded device identification (640, 1020, 1440) by decoding a retrieved backup data set (605, 1005, 1405) using the the cryptographic key (115) and the integrity function, and restoring (225) the backup data with the decoded backup data only when the integrity has been verified and the decoded device identification and the device identification match. Three methods of encoding and decoding are described.

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SECURE DATA BACKUP AND RECOVERY

Field of the Invention

This invention is in the general technology area of data storage methods and more specifically, in the area of secure data backup.

Background

As electronic devices become more sophisticated, they are more likely to operate from program instructions that are downloaded and resident in read/write memory such as random access memory or disk drive memory. Information acquired or generated by a user of such devices may also be kept in such memory. Cellular telephones are one example of such electronic devices. Games and other applications can be downloaded. The read/write memory devices are fallible, so it would be desirable for a user to be able to back up the information stored in such devices.

In the case of games and applications that are downloaded, the entity that provides the software has typically licensed the software for use only in the device to which it has been downloaded, and would therefore prefer some assurance that it is only copied and only used for backup purposes for the device to which it has been licensed. This is a digital rights issue. A user may also desire that backup information that the user has generated be securely backed up such that it can only be restored to the user's device by which it was generated. For example, a backup service may be provided by a third party in whom the user does not have absolute trust. Thus there is need for a secure backup technology that allows restoration only in the device which performs the backup. The user may also be concerned about privacy of his backup data. For example, the user may desire that credit card information or medical records be encrypted (for privacy). Furthermore, the user may only trust the device in which the data resides and from which the backup will be made, and would want assurance that the data can be recovered only by the device in which the user created the backup.

Brief Description of the Drawings

The present invention is illustrated by way of example and not limitation in the accompanying figures, in which like references indicate similar elements, and in which:

Referring to **FIG. 1**, a functional block diagram shows portions of an electronic device and a backup memory, in accordance with some embodiments of the present invention;

Referring to **FIG. 2**, a flow chart of a method for secure data backup and recovery is shown, in accordance with some embodiments of the present invention;

Referring to **FIGS. 3**, **4**, **5**, and **6**, flow charts of methods and data flow diagrams for the encoding and decoding of the backup data set are shown, in accordance with embodiments of the present invention of a first type; and

Referring to **FIGS. 7**, **8**, **9**, and **10**, flow charts of methods and data flow diagrams for the encoding and decoding of the backup data set are shown, in accordance with embodiments of the present invention of a second type; and

Referring to **FIGS. 11**, **12**, **13**, and **14**, flow charts of methods and data flow diagrams for the encoding and decoding of the backup data set are shown, in accordance with embodiments of the present invention of a third type.

Skilled artisans will appreciate that elements in the figures are illustrated for simplicity and clarity and have not necessarily been drawn to scale. For example, the dimensions of some of the elements in the figures may be exaggerated relative to other elements to help to improve understanding of embodiments of the present invention.

Detailed Description of the Drawings

Before describing in detail the particular secure data backup and recovery technique in accordance with the present invention, it should be observed that the present invention resides primarily in combinations of method steps and apparatus components related to data backup and recovery. Accordingly, the apparatus components and method steps have been represented where appropriate by conventional symbols in the drawings, showing only those specific details that are pertinent to understanding the present invention so as not to obscure the disclosure

with details that will be readily apparent to those of ordinary skill in the art having the benefit of the description herein.

Referring to **FIG. 1**, a functional block diagram shows portions of an electronic device **100** and a backup memory **180**, in accordance with some embodiments of the present invention. The electronic device **100** comprises a read/write memory **120** that is coupled to a trusted backup and recovery function **125** that can encode a portion of the data in the read/write memory **120** that has been identified as backup data, and send the encoded backup data to be stored in a backup memory **180**, which may also be read/write memory. Each of the read/write memory **120** and the backup memory **180** is a logical set of memory that may be a portion of one, or may be one or more, of many types of physical memory, such as integrated circuit, hard disk, floppy disk, memory card, memory stick, etc.

In some embodiments the electronic device **100** is a wireless communication device such as a telephone handset, and the backup memory **180** is located in another electronic device that is accessed by a wireless link **170** that is established in response to the trusted backup and recovery function **125** sending the encoded data. In other embodiments, the electronic device **100** may be a wireless handset or one of many other types of electronic device (such as a desktop computer, gaming set, TV set top box, etc.) and the backup memory **180** is coupled to the electronic device **100** either temporarily or permanently. For example, the backup memory **180** could be a memory stick that plugs into the electronic device **100**, or an external hard drive. In these instances, the link **170** may be a wired link. It will also be appreciated that the electronic device **100** could be any electronic apparatus or an integrated circuit or similar apparatus that is capable of performing the functions described herein, when properly powered and coupled to input-output circuits and functions.

The trusted backup and recovery function **125** is coupled to a data backup user interface function **105** to provide means for a user to select some data for backup and determine when and where the selected data is backed up. In some applications of the present invention, the user may be allowed to select which data stored in the read/write memory **120** is backup data. For example, such backup data may include any data that the user has generated, or acquired, which may include software applications that the user has purchased. Backing up such data becomes practical because the unique design of the present invention assures that although the backup data may be received and stored by any electronic device, it is usable only in the electronic device **100** from which it has been backed up. This can be very

helpful for users who purchase rights to use software applications and wish to restore the application and related configuration data in the event of corruption of the application or configuration data in the read/write memory **120**. In other applications of the present invention, however, the backup data may be pre-defined so that the user has no control over data selection. For instance, the trusted backup and recovery function **125** may backup the entire image of the data in the read/write memory **120**, which could include data that is related to operating system functions of the electronic device **100**.

In order to accomplish these unique aspects of the present invention, the electronic device **100** has a unique and unalterable identification (ID) **115** and a cryptographic key **110** that are coupled to the trusted backup and recovery function **125**. The trusted backup and recovery function **125** is incorporated with the electronic device **100** in such a way that an entity whose data (such as a software program) is being backed up by it has adequate assurance that the necessary functions of the trusted backup and recovery function **125** are essentially unalterable. "Essentially unalterable" means that the task of accomplishing alterations is impractical – for example, the functions may be performed by program code that resides in read-only memory implemented within the same integrated circuit (IC) as the processor used for executing the code.

The characteristics of the unique and unalterable ID **115** are described by its name: the unique and unalterable ID **115** should be essentially unique to the electronic device **100** (within a set of all electronic devices that could also use the data that is backed up), and should be essentially unalterable. "Essentially unique" simply means that the odds of another electronic device that is capable of receiving the backup data set having the same unique and unalterable ID **115** are appropriately small. This can be accomplished by techniques known in the art, such as large random numbers, or assigned numbers, or some combination thereof. The length and complexity of the unique and unalterable ID **115** are therefore related to the number of electronic devices that might be able to operate on, or otherwise use, the data in the backup data set. "Essentially unalterable" for the ID may be an ID stored in a read-only, laser-trimmed integrated circuit ID. Alternatively, the ID may, for example, be stored in one-time programmable memory or electronically programmable fuses implemented within the same IC that has a processor and a random access memory that are used for executing the functions of the trusted backup and recovery function **125**. The unique and unalterable ID **115** may not need

to be kept secret; in some embodiments it may be desirable for the unique and unalterable ID **115** to be displayable.

The cryptographic key **110** is a set of data that is used in the electronic device **100** during generation of the encoded backup data set and during restoration of the backup data from the encoded backup data set. The cryptographic key **110** may be a symmetric key or a public and private key pair. In a public/private key based system, the private key must be secret, whereas the public key need not be. A symmetric key must be secret. "Secret" may imply that the key cannot be known to the user. The symmetric key is unreadable by all but an authorized entity. Preferably, the trusted backup and recovery function **125** is an authorized entity. The length and complexity of the cryptographic key **110** are related to the type of security used in an embodiment of the electronic device **100** and the amount of resistance to cryptanalysis that is desired.

Referring to **FIG. 2**, a flow chart of a method for secure data backup and recovery is shown, in accordance with some embodiments of the present invention. At step **205**, the data to be backed up is identified. As described above with reference to **FIG. 1**, this may be done with input from the user, as restricted by the trusted backup and recovery function **125**. Alternatively, it could, for instance, be an automatic backup of all data that meets requirements stored in the trusted backup and recovery function **125**, or it could be prompted by a message received by the electronic device **100** (with any selection of data perhaps having to be authorized by the trusted backup and recovery function **125**). At step **210**, the backup data and the unique and unalterable ID **115** (hereafter called the device ID **115**) are encoded for integrity and authentication using the cryptographic key **110** and an integrity function, generating a backup data set. This step is performed by a trusted backup function of the trusted backup and recovery function **125** that includes the integrity function. "Integrity" in this context means that assurance can be obtained that the backup data and device ID have not been altered in a backup data set that is received by the electronic device **100**. "Authentication" in this context means that only the electronic device **100** that has the device ID **115** used to generate the backup data set can use a received backup data set to restore the backup data.

At step **215**, the backup data set is stored by the electronic device **110** in a backup memory **180**, which, as described above with reference to **FIG. 1**, may be one of a variety of types and which may be located locally or remotely. The storage is initiated by the trusted backup and recovery function **125** and may be completed

by other functions within and outside the electronic device **100** (e.g., message formatters, radio frequency transmitter and receiver, etc.). At step **216**, a retrieved backup data set is presented to the trusted backup and recovery function **125**, which generates decoded backup data and decoded device identification and an integrity value by decoding the retrieved backup data set at step **220** using the integrity function of the trusted backup and recovery function **125** and the cryptographic key **110**. At step **225**, the decoded backup data is used to restore the backup data only when the integrity of the backup data set has been verified at step **220** and the decoded device identification and the device ID **115** match.

Referring to **FIGS. 3** and **4**, a flow chart of a method and a data flow diagram for the encoding **210** of the backup data set are shown, in accordance with embodiments of the present invention of a first type. At step **305** (**FIG. 3**), a keyed hash **420** (**FIG. 4**) of the backup data **405** and the device ID **115** is generated, using the cryptographic key **110** and a keyed hash function **415**. By this is meant that a keyed hash function is performed on a set of data that comprises both the backup data **405** and the device ID **115**. The keyed hash **420** may be generated by a well known function such as HMAC (hash-based message authentication code), using a well known hash function such as SHA-1 (secure hash algorithm – version 1). At step **310** (**FIG. 3**), the encoded backup data set **410** is formed from the backup data **405**, the device ID **115** and the keyed hash **420**.

Referring to **FIGS. 5** and **6**, a flow chart of a method and a data flow diagram for the decoding **220** of the retrieved backup data set are shown, in accordance with the embodiments of the present invention of the first type. At step **505** (**FIG. 5**), the backup data **610** (**FIG. 6**), the device identification **615**, and the keyed hash **620** in the retrieved backup data set **605** are identified, respectively, to be the decoded backup data **635**, the decoded device identification **640**, and the decoded keyed hash **625**. The respective decoded data sets **635**, **640**, **625** are identical to the data sets **405**, **115**, **420** (**FIG. 4**) that formed the encoded backup data set **410** that was stored only when no data errors have occurred in, and no intentional data changes have been made to, the encoded backup data set **410** during the steps of storage **215** and retrieval **216**. The same keyed hash function **415** used at step **305** is used at step **510** (**FIG. 5**) to encode the decoded backup data **635** and decoded device ID **640**, which involves the use of the cryptographic key **110**, thus generating a verifying keyed hash **630**. When the verifying keyed hash **630** matches the decoded keyed hash **625** using the comparison function **655** at step **515**, integrity of the data is

established; otherwise integrity has failed. When the integrity has failed, the backup data **610** from the retrieved backup data set **605** cannot be used to restore the original backup data **405**. In these embodiments of the first type, the integrity function includes the keyed hash function **415** and the matching **515** of the decoded **625** and verifying **630** keyed hashes. The cryptographic key **110** is a symmetric key.

As described above with reference to **FIG. 2**, the decoded device ID **640** recovered from the retrieved backup data set **605** is compared to the device ID **115** at step **225** using comparison function **650**, and when they match and the integrity has been established, the decoded backup data **635** from the retrieved backup data set **605** may be used to restore the original backup data **405**. The matching of the device IDs at step **225** may be done in any order with reference to steps **510** and **515**.

Referring to **FIGS. 7** and **8**, a flow chart of a method and a data flow diagram for the encoding **210** of the backup data set are shown, in accordance with embodiments of the present invention of a second type. At step **705** (**FIG. 7**), a (non-keyed) hash **820** (**FIG. 8**) of the backup data **805** and the device ID **115** is generated using a hash function **815**. By this is meant that a hash function is performed on a set of data that comprises both the backup data **805** and the device ID **115**. The hash **820** may be generated by a well known function such as SHA-1 (secure hash algorithm – version 1). At step **710**, an encoded backup data set **830** is formed by encrypting the backup data **805**, the device ID **115**, and the hash **820** for privacy using the cryptographic key **110** and an encryption function **825**.

Referring to **FIGS. 9** and **10**, a flow chart of a method and a data flow diagram for the decoding **220** of the retrieved backup data set are shown, in accordance with the embodiments of the present invention of the second type. A decryption function **1010** (**FIG. 10**) that is reciprocal to the encryption function **825** (**FIG. 8**) that was used to encrypt the backup data **805**, device ID **115**, and hash **820** at step **710** is performed at step **905** (**FIG. 9**), using the cryptographic key **110**. This generates decoded backup data **1015**, a decoded device ID **1020**, and a decoded hash **1025**. These respective decoded data sets **1015**, **1020**, **1025** are identical to the data sets **805**, **115**, **820** that formed the encoded backup data set **830** that was stored only when no data errors have occurred in, and no intentional data changes have been made to, the encoded backup data set **830** during the steps of storage **215** and retrieval **216**. At step **910**, the same hash function **815** used at step **705** is used on the set of data comprising the decoded backup data **1015** and the decoded device ID

1020, generating a verifying hash **1030**. When the verifying hash **1030** matches the decoded hash **1025** using the comparison function **1055** at step **915**, integrity of the data is established; otherwise integrity has failed. When the integrity has failed, the decoded backup data **1015** from the retrieved backup data set **1005** cannot be used to restore the original backup data **805**. In these embodiments of the second type, the integrity function includes the encryption/decryption functions **825**, **1010**, the hash function **815**, and the matching **915** of the decoded **1025** and verifying **1030** hashes. The cryptographic key **110** is a symmetric key.

As described above with reference to **FIG. 2**, the decoded device ID **1020** recovered from the retrieved backup data set **1005** is compared to the device ID **115** at step **225** using the comparison function **1050**, and when they match and the integrity has been established, the decoded backup data **1015** from the retrieved backup data set **1005** may be used to restore the original backup data **805**. The matching of the device IDs at step **225** may be done in any order with reference to steps **910** and **915**.

Referring to **FIGS. 11** and **12**, a flow chart of a method and a data flow diagram for the encoding **210** of the backup data set are shown, in accordance with embodiments of the present invention of a third type. At step **1105** (**FIG. 11**), a digital signature **1220** (**FIG. 12**) of the backup data **1205** and the device ID **115** is generated, using a digital signature generation and verfication function **1215** and private key portion of the cryptographic key **110**, which comprises a public key and a private key. By this is meant that a digital signature generation function of the digital signature generation and verification function **1215** is performed on a set of data that comprises both the backup data **1205** and the device ID **115**. The digital signature **1220** may be generated by a well known function such as RSA (Rivest-Shamir-Adleman algorithm). At step **1110**, the encoded backup data set **1230** is formed from the backup data **1205**, the device ID **115** and the digital signature **1220**.

Referring to **FIGS. 13** and **14**, a flow chart of a method and a data flow diagram for the decoding **220** of the retrieved backup data set are shown, in accordance with the embodiments of the present invention of the third type. At step **1305** (**FIG. 13**), the backup data **1410**, device identification **1415**, and digital signature **1420** in the retrieved backup data set **1405** are identified, respectively, to be the decoded backup data **1435**, the decoded device identification **1440**, and a decoded digital signature **1425**. These respective decoded data sets **1435**, **1440**, **1425** are identical to the data sets **1205**, **115**, **1220** (**FIG. 12**) that formed the

encoded backup data set **1230** that was stored only when no data errors have occurred in, and no intentional data changes have been made to, the encoded backup data set **1230** during the steps of storage **215** and retrieval **216**. The decoded digital signature **1425** is verified at step **1310** by the digital signature verification function of the digital signature generation and verification function **1215**, using the decoded backup data **1435**, the decoded device ID **1440**, and the public key portion of the cryptographic key **110**. When the verification result **1445** of the decoded digital signature **1425** is positive, the integrity of the data is established; otherwise integrity has failed. When the integrity has failed, the decoded backup data **1435** from the retrieved backup data set **1405** cannot be used to restore the original backup data **1205**. In these embodiments of the third type, the integrity function includes the digital signature generation and verification function **1215**. The cryptographic key **110** is a public and private key pair.

As described above with reference to **FIG. 2**, the decoded device ID **1440** recovered from the retrieved backup data set **1405** is compared to the device ID **115** at step **225** using comparison function **1450**, and when they match and the integrity has been established, the decoded backup data **1435** from the retrieved backup data set **1405** may be used to restore the original backup data **1205**. The matching of the device IDs at step **225** may be done in any order with reference to step **1310**.

It will be appreciated that the secure data backup and recovery technology described herein may be comprised of one or more conventional processors and unique, stored program instructions that control the one or more processors to implement some, most, or all of the functions of secure data backup and recovery described herein; as such, these functions may be interpreted as steps of a method to perform secure data backup and recovery. Alternatively, some or all of these functions could be implemented by a state machine that has no stored program instructions, in which each function or some combinations of certain of the functions are implemented as custom logic. Of course, a combination of the two approaches could be used. Thus, methods and means for these, or some of these, functions may have been described herein. In the foregoing specification, the invention and its benefits and advantages have been described with reference to specific embodiments. However, one of ordinary skill in the art appreciates that various modifications and changes can be made without departing from the scope of the present invention as set forth in the claims below. Accordingly, the specification and figures are to be regarded in an illustrative rather than a restrictive sense, and all

such modifications are intended to be included within the scope of present invention. The benefits, advantages, solutions to problems, and any element(s) that may cause any benefit, advantage, or solution to occur or become more pronounced are not to be construed as a critical, required, or essential features or elements of any or all the claims.

As used herein, the terms "comprises," "comprising," or any other variation thereof, are intended to cover a non-exclusive inclusion, such that a process, method, article, or apparatus that comprises a list of elements does not include only those elements but may include other elements not expressly listed or inherent to such process, method, article, or apparatus.

A "set" as used herein, means a non-empty set (i.e., for the sets defined herein, comprising at least one member). The term "another", as used herein, is defined as at least a second or more. The terms "including" and/or "having", as used herein, are defined as comprising. The term "coupled", as used herein with reference to electro-optical technology, is defined as connected, although not necessarily directly, and not necessarily mechanically. The term "program", as used herein, is defined as a sequence of instructions designed for execution on a computer system. A "program", or "computer program", may include a subroutine, a function, a procedure, an object method, an object implementation, an executable application, an applet, a servlet, a source code, an object code, a shared library/dynamic load library and/or other sequence of instructions designed for execution on a computer system. It is further understood that the use of relational terms, if any, such as first and second, top and bottom, and the like are used solely to distinguish one entity or action from another entity or action without necessarily requiring or implying any actual such relationship or order between such entities or actions.

What is claimed is:

CLAIMS

1. A method for secure data backup and recovery of an electronic device having a device identification that is unique and unalterable, comprising:

identifying backup data;

encoding a backup data set that comprises the backup data and the device identification for integrity and authentication using a cryptographic key and an integrity function;

generating decoded backup data and a decoded device identification and verifying integrity by decoding a retrieved backup data set using the cryptographic key and the integrity function;

verifying authenticity by matching the decoded device identification to the device identification; and

restoring the backup data with the decoded backup data only when the integrity and authenticity have been verified.

2. The method according to claim 1, wherein the integrity function uses a hash function on the backup data and the device identification.

3. The method according to claim 1, wherein the cryptographic key is one of a symmetric key and a public/private key pair.

4. The method according to claim 1, wherein the cryptographic key is a symmetric key and wherein the encoding comprises:

generating a keyed hash of the backup data and the device identification using the cryptographic key and a keyed hash function; and

forming the backup data set from the backup data, the device identification, and the keyed hash.

5. The method according to claim 1, wherein the cryptographic key is a symmetric key and wherein the encoding comprises:

generating a hash of the backup data and the device identification using a hash function; and

forming the backup data set by encrypting the backup data, the device identification, and the hash for privacy using an encryption/decryption function and the cryptographic key.

6. The method according to claim 1, wherein the cryptographic key is a public key and private key pair and wherein the encoding comprises:

generating a digital signature of the backup data and the device identification using a digital signature generation function and the private key; and

forming the backup data set from the backup data, the device identification, and the digital signature.

7. The method according to claim 1, wherein the identifying of the backup data is done under control of a trusted backup function that restricts the backup data to be from a defined set of data.

8. The method according to claim 1, further comprising storing and retrieving the encoded backup data set.

9. The method according to claim 1, wherein the encoding, decoding, and restoring are done under control of a trusted backup function.

10. An apparatus for secure data backup and recovery, comprising:

a memory for at least one of application and user data;

a trusted backup and recovery function that identifies backup data in the memory for secure backup that is a member of a defined set of authorized backup data;

a cryptographic key function that provides a cryptographic key; and

a unique and unalterable device identification, wherein the trusted backup and recovery function

encodes a backup data set that comprises the device identification and the backup data for integrity and authentication using the cryptographic key and an integrity function;

generates decoded backup data and a decoded device identification and verifying integrity by decoding a retrieved backup data set using the cryptographic key and the integrity function;

verifies authenticity by matching the decoded device identification to the device identification; and

restores the backup data with the decoded backup data only when the integrity and authenticity have been verified.

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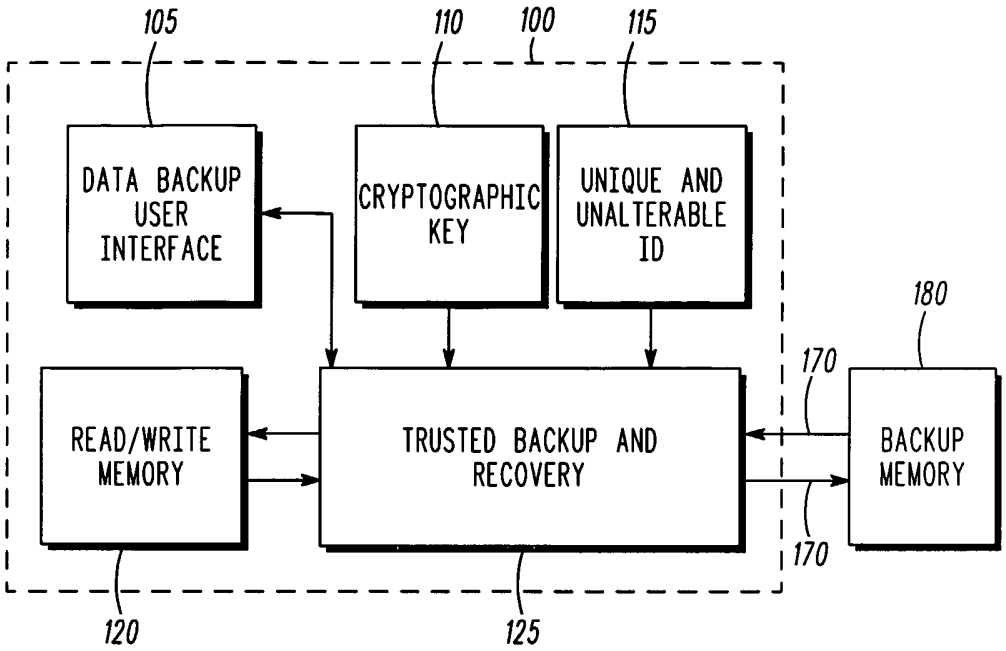

105
110
100
115
DATA BACKUP USER INTERFACE
CRYPTOGRAPHIC KEY
UNIQUE AND UNALTERABLE ID
180
170
READ/WRITE MEMORY
TRUSTED BACKUP AND RECOVERY
BACKUP MEMORY
170
120
125

FIG. 1

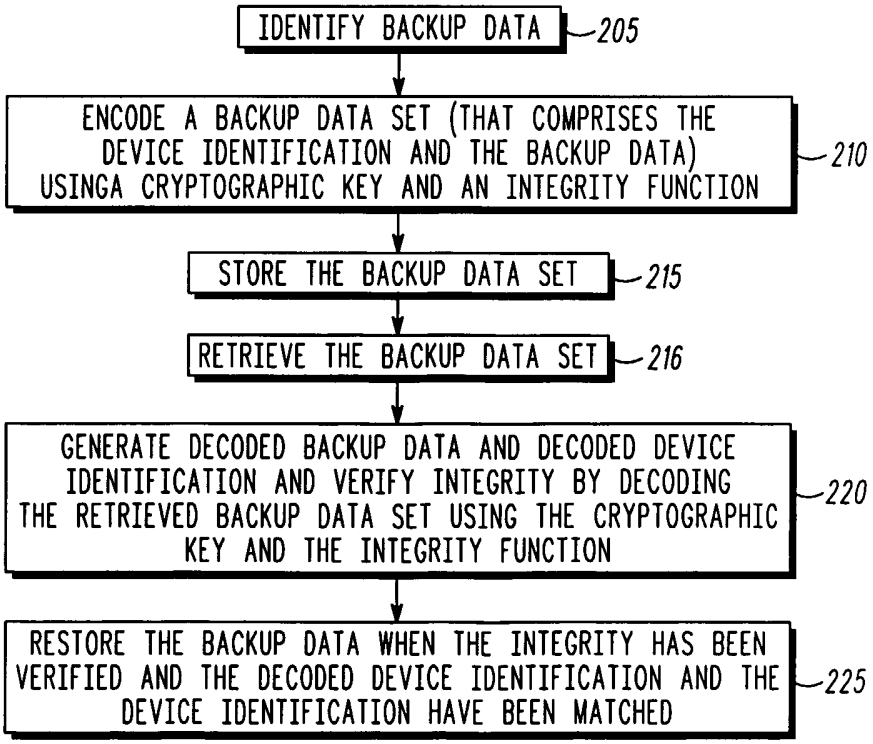

IDENTIFY BACKUP DATA
205
ENCODE A BACKUP DATA SET (THAT COMPRISES THE DEVICE IDENTIFICATION AND THE BACKUP DATA) USINGA CRYPTOGRAPHIC KEY AND AN INTEGRITY FUNCTION
210
STORE THE BACKUP DATA SET
215
RETRIEVE THE BACKUP DATA SET
216
GENERATE DECODED BACKUP DATA AND DECODED DEVICE IDENTIFICATION AND VERIFY INTEGRITY BY DECODING THE RETRIEVED BACKUP DATA SET USING THE CRYPTOGRAPHIC KEY AND THE INTEGRITY FUNCTION
220
RESTORE THE BACKUP DATA WHEN THE INTEGRITY HAS BEEN VERIFIED AND THE DECODED DEVICE IDENTIFICATION AND THE DEVICE IDENTIFICATION HAVE BEEN MATCHED
225

FIG. 2

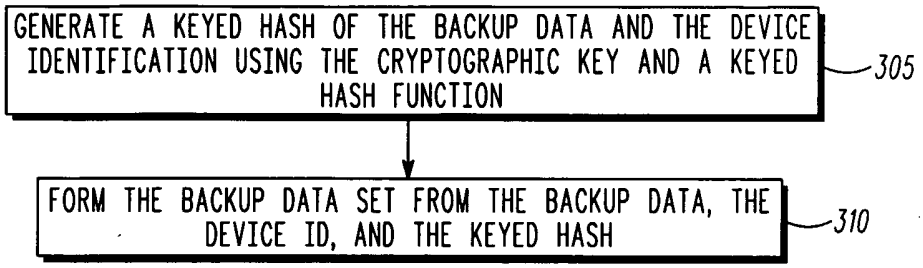

GENERATE A KEYED HASH OF THE BACKUP DATA AND THE DEVICE IDENTIFICATION USING THE CRYPTOGRAPHIC KEY AND A KEYED HASH FUNCTION
305
FORM THE BACKUP DATA SET FROM THE BACKUP DATA, THE DEVICE ID, AND THE KEYED HASH
310

FIG. 3

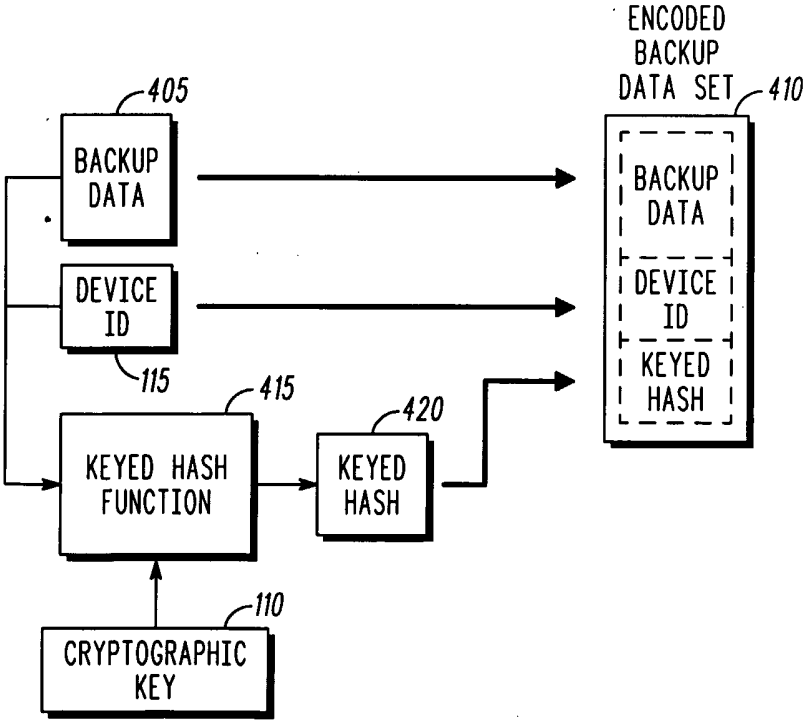

ENCODED BACKUP DATA SET
410
405
BACKUP DATA
DEVICE ID
115
415
KEYED HASH FUNCTION
420
KEYED HASH
110
CRYPTOGRAPHIC KEY
BACKUP DATA
DEVICE ID
KEYED HASH

FIG. 4

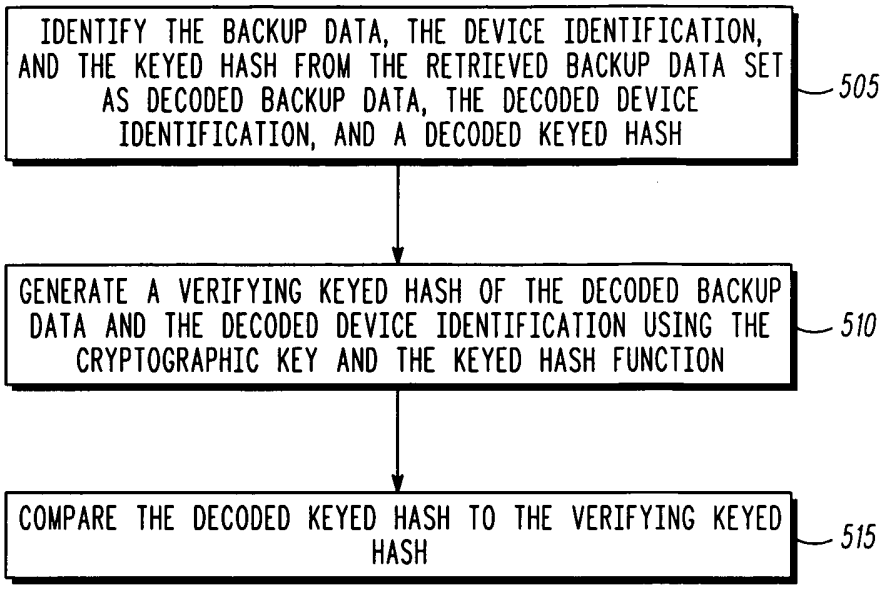
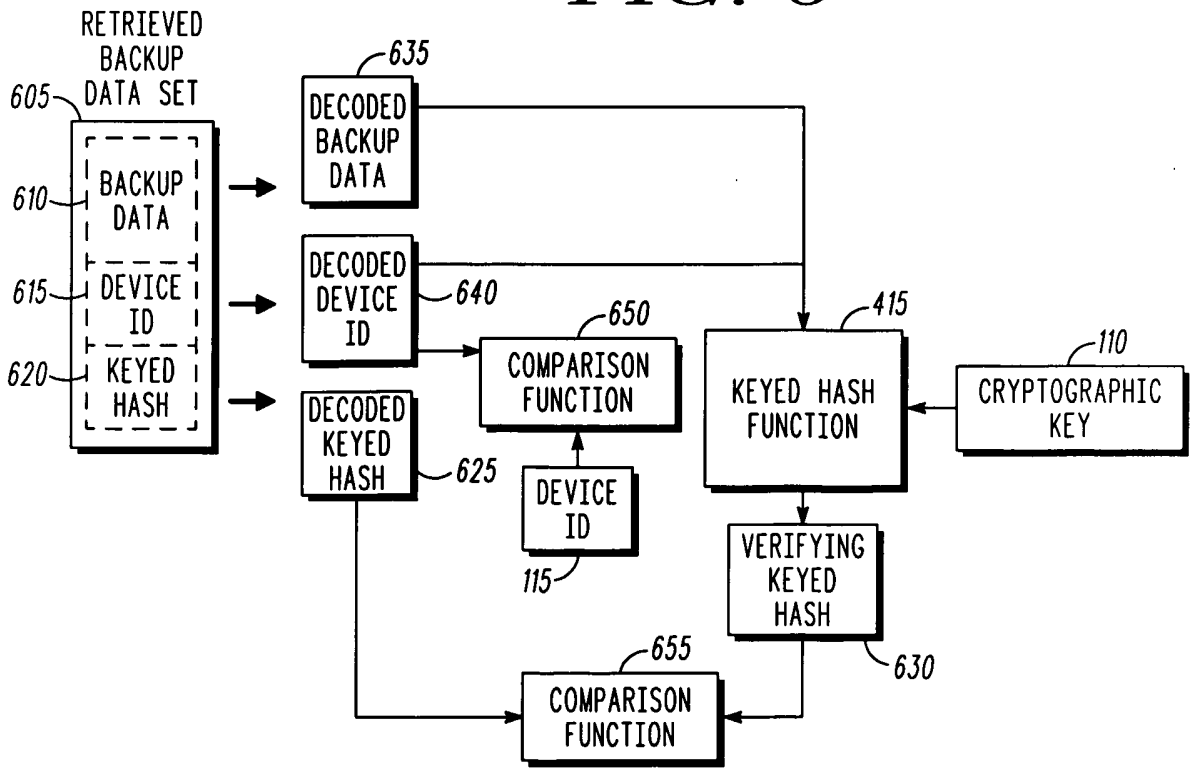

IDENTIFY THE BACKUP DATA, THE DEVICE IDENTIFICATION, AND THE KEYED HASH FROM THE RETRIEVED BACKUP DATA SET AS DECODED BACKUP DATA, THE DECODED DEVICE IDENTIFICATION, AND A DECODED KEYED HASH
505
GENERATE A VERIFYING KEYED HASH OF THE DECODED BACKUP DATA AND THE DECODED DEVICE IDENTIFICATION USING THE CRYPTOGRAPHIC KEY AND THE KEYED HASH FUNCTION
510
COMPARE THE DECODED KEYED HASH TO THE VERIFYING KEYED HASH
515

FIG. 5

FIG. 6


RETRIEVED BACKUP DATA SET
605
BACKUP DATA
610
DEVICE ID
615
KEYED HASH
620
635
DECODED BACKUP DATA
DECODED DEVICE ID
640
DECODED KEYED HASH
625
650
COMPARISON FUNCTION
DEVICE ID
115
415
KEYED HASH FUNCTION
110
CRYPTOGRAPHIC KEY
VERIFYING KEYED HASH
630
655
COMPARISON FUNCTION

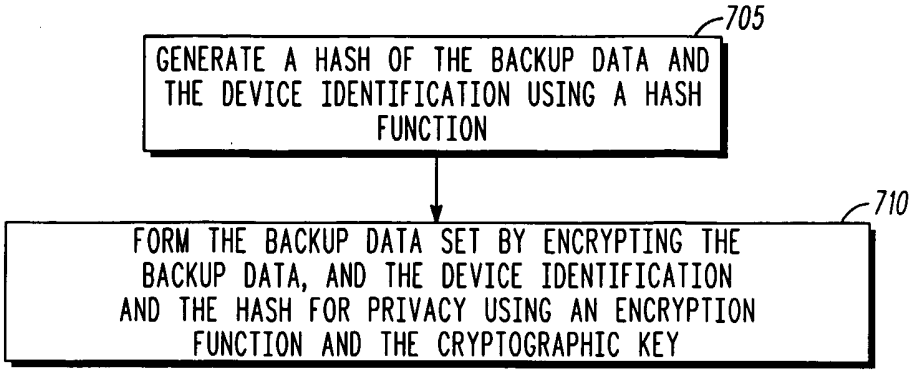


FIG. 7

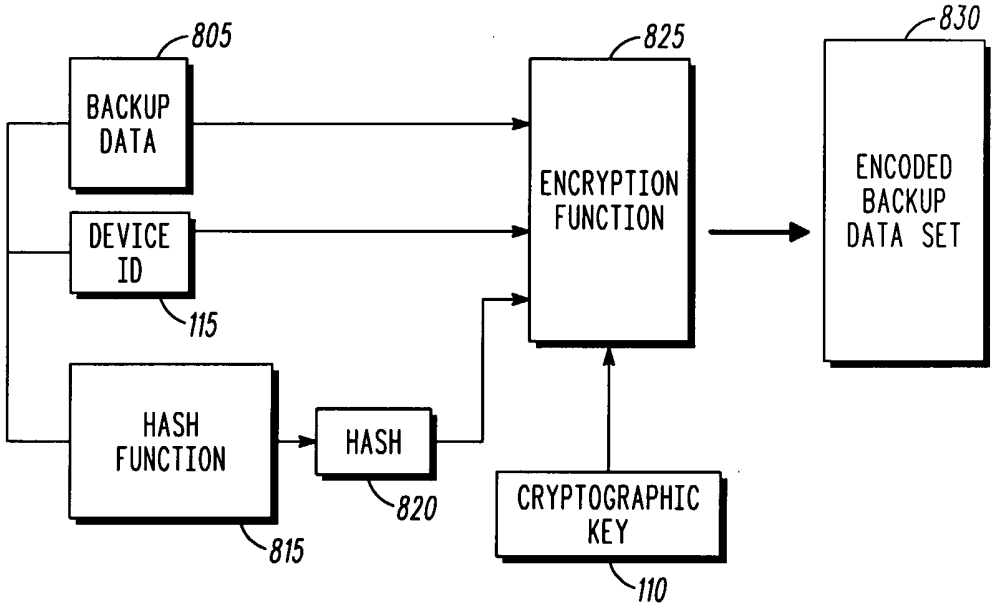


FIG. 8

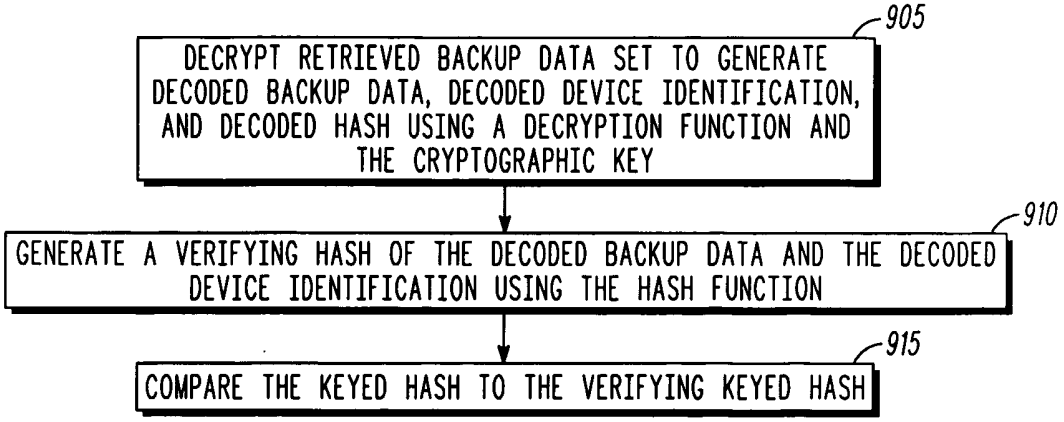


FIG. 9

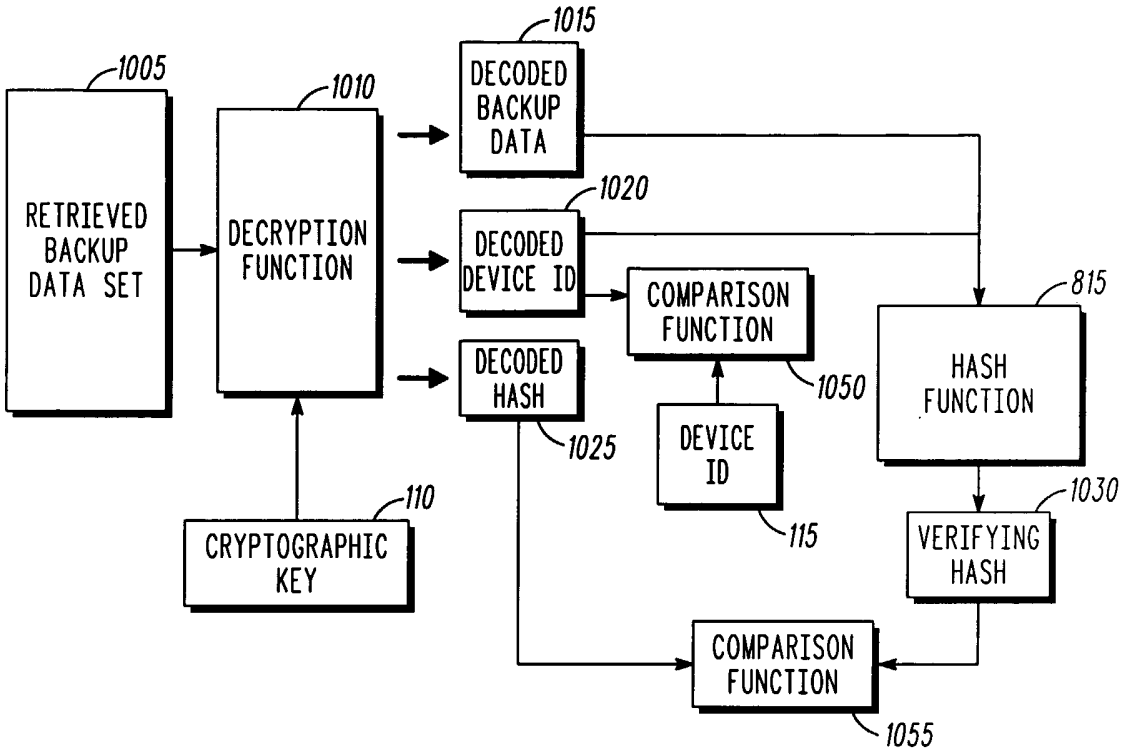

1005
RETRIEVED BACKUP DATA SET
1010
DECRYPTION FUNCTION
1015
DECODED BACKUP DATA
1020
DECODED DEVICE ID
DECODED HASH
1025
COMPARISON FUNCTION
1050
DEVICE ID
115
815
HASH FUNCTION
1030
VERIFYING HASH
110
CRYPTOGRAPHIC KEY
COMPARISON FUNCTION
1055

FIG. 10

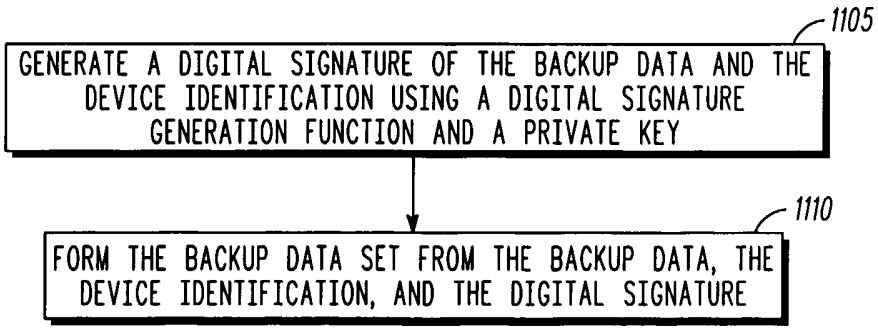

1105
GENERATE A DIGITAL SIGNATURE OF THE BACKUP DATA AND THE DEVICE IDENTIFICATION USING A DIGITAL SIGNATURE GENERATION FUNCTION AND A PRIVATE KEY
1110
FORM THE BACKUP DATA SET FROM THE BACKUP DATA, THE DEVICE IDENTIFICATION, AND THE DIGITAL SIGNATURE

FIG. 11

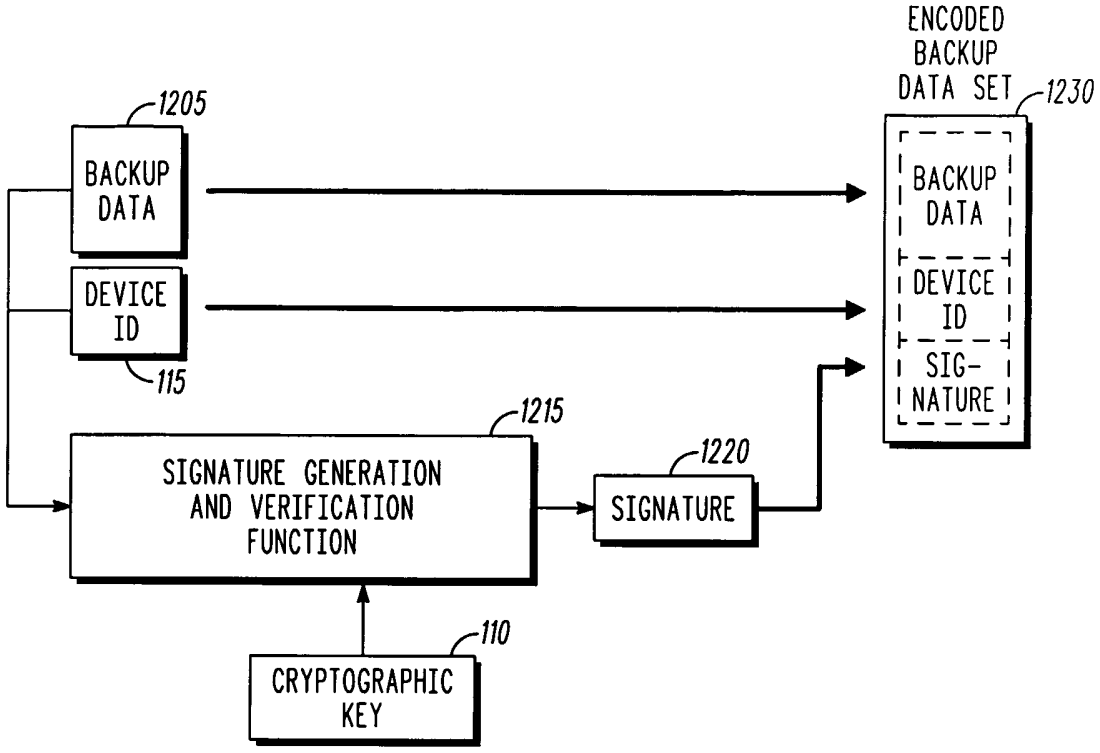

ENCODED BACKUP DATA SET
1230
1205
BACKUP DATA
DEVICE ID
115
BACKUP DATA
DEVICE ID
SIG-NATURE
1215
SIGNATURE GENERATION AND VERIFICATION FUNCTION
1220
SIGNATURE
110
CRYPTOGRAPHIC KEY

FIG. 12

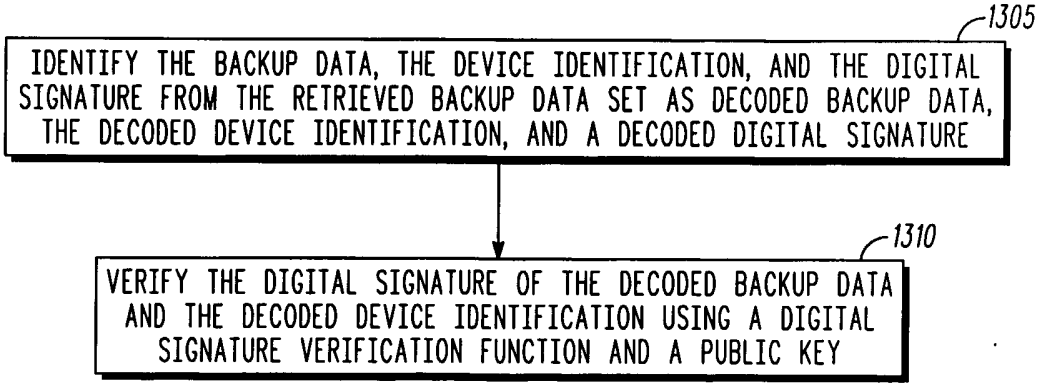

1305
IDENTIFY THE BACKUP DATA, THE DEVICE IDENTIFICATION, AND THE DIGITAL SIGNATURE FROM THE RETRIEVED BACKUP DATA SET AS DECODED BACKUP DATA, THE DECODED DEVICE IDENTIFICATION, AND A DECODED DIGITAL SIGNATURE
1310
VERIFY THE DIGITAL SIGNATURE OF THE DECODED BACKUP DATA AND THE DECODED DEVICE IDENTIFICATION USING A DIGITAL SIGNATURE VERIFICATION FUNCTION AND A PUBLIC KEY

FIG. 13

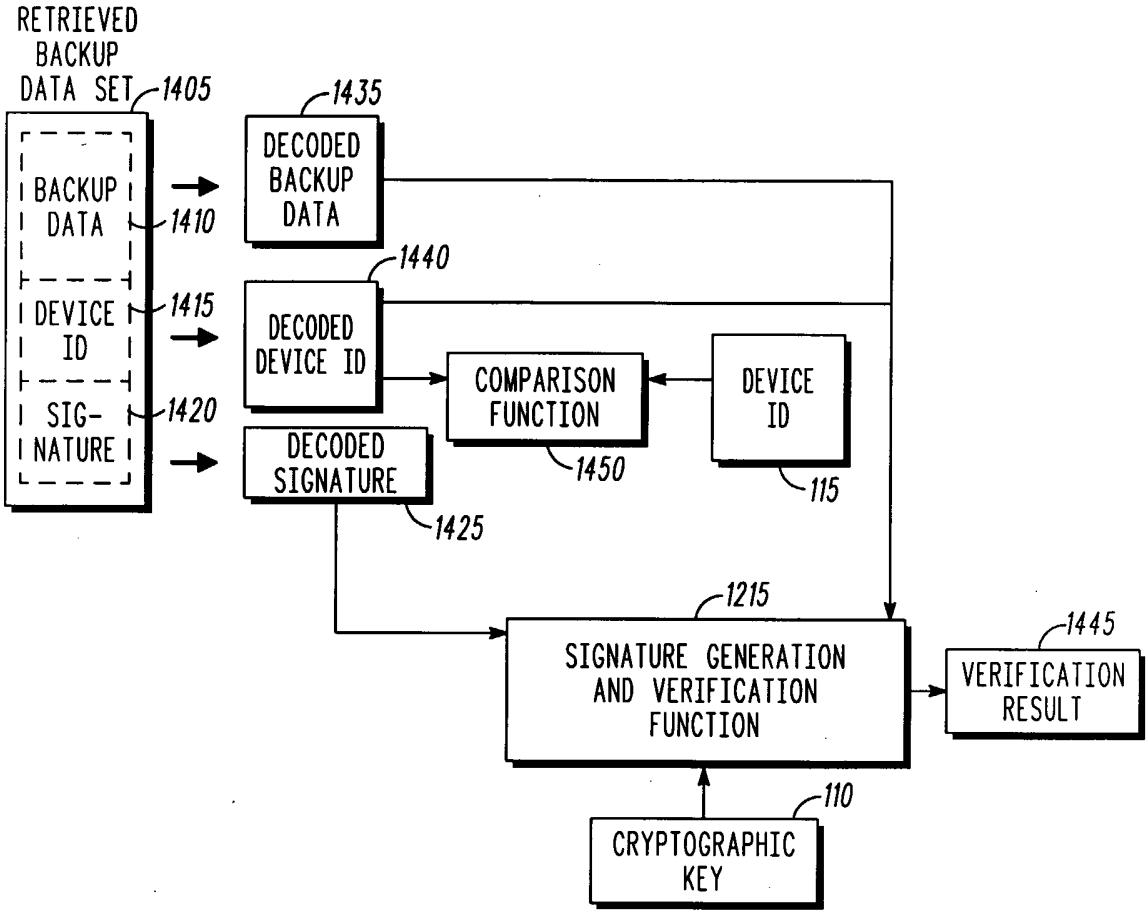

RETRIEVED BACKUP DATA SET
1405
BACKUP DATA
1410
DEVICE ID
1415
SIG-NATURE
1420
1435
DECODED BACKUP DATA
1440
DECODED DEVICE ID
DECODED SIGNATURE
1425
COMPARISON FUNCTION
1450
DEVICE ID
115
1215
SIGNATURE GENERATION AND VERIFICATION FUNCTION
1445
VERIFICATION RESULT
110
CRYPTOGRAPHIC KEY

FIG. 14