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Jajodia

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(54) **PROTECTING SENSITIVE DATA ASSOCIATIONS**

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(51) **Int. Cl.**
G06F 11/30 (2006.01)

(52) **U.S. Cl.** **713/193**; 726/26; 707/655

(58) **Field of Classification Search** 380/277–286; 726/2–3, 16, 26; 713/193; 707/600, 609–610, 707/640, 644–647, 655–656, 687, 690, 694, 707/696, 790, 802, 809, 899

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,268,962	A *	12/1993	Abadi et al.	713/161
6,367,010	B1 *	4/2002	Venkatram et al.	713/171
7,093,137	B1 *	8/2006	Sato et al.	713/193
2002/0046286	A1 *	4/2002	Caldwell et al.	709/229
2005/0166263	A1 *	7/2005	Nanopoulos et al.	726/7
2006/0041533	A1 *	2/2006	Koyfman	707/3
2006/0288232	A1 *	12/2006	Ho et al.	713/185
2007/0079386	A1 *	4/2007	Metzger et al.	726/29
2008/0123843	A1 *	5/2008	Machani	380/44

* cited by examiner

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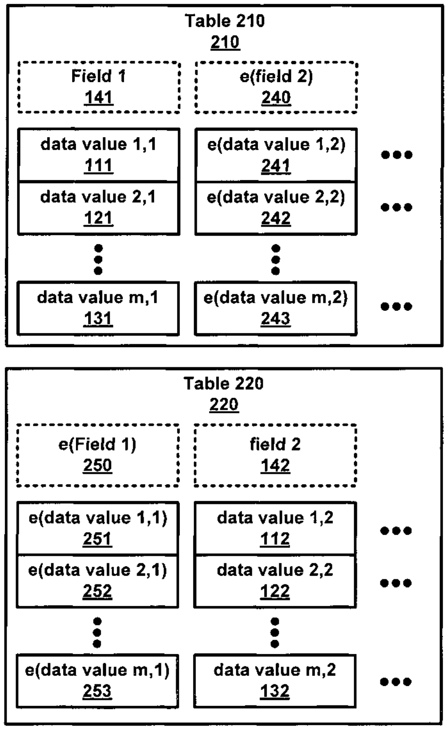
(57) **ABSTRACT**

Sensitive data associations for related data values are protected. A set of related data values is received. The set of related data values include at least a first data value and a second data value. The first data value is associated with a first data field and the second data value is associated to a second data field. First encrypted data is created by encrypting the first data value using a first encryption key and a second encrypted data is created by encrypting the second data value using a second encryption key. The first data value is stored in a first data table, the second data value is stored in a second data table, the first encrypted data is stored in the second table, and the second encrypted data is stored in the first table.

21 Claims, 10 Drawing Sheets



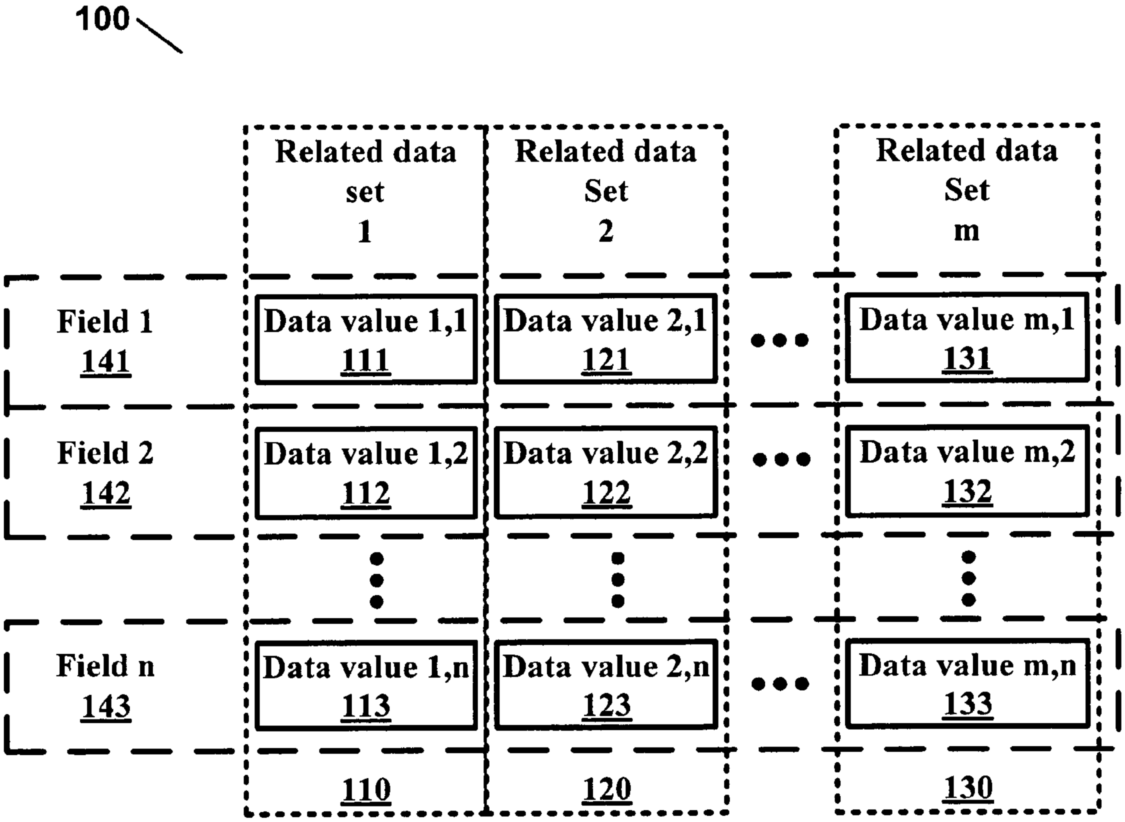

100
Related data set 1
Related data Set 2
Related data Set m
Field 1
141
Data value 1,1
111
Data value 2,1
121
Data value m,1
131
Field 2
142
Data value 1,2
112
Data value 2,2
122
Data value m,2
132
Field n
143
Data value 1,n
113
Data value 2,n
123
Data value m,n
133
110
120
130

FIGURE 1

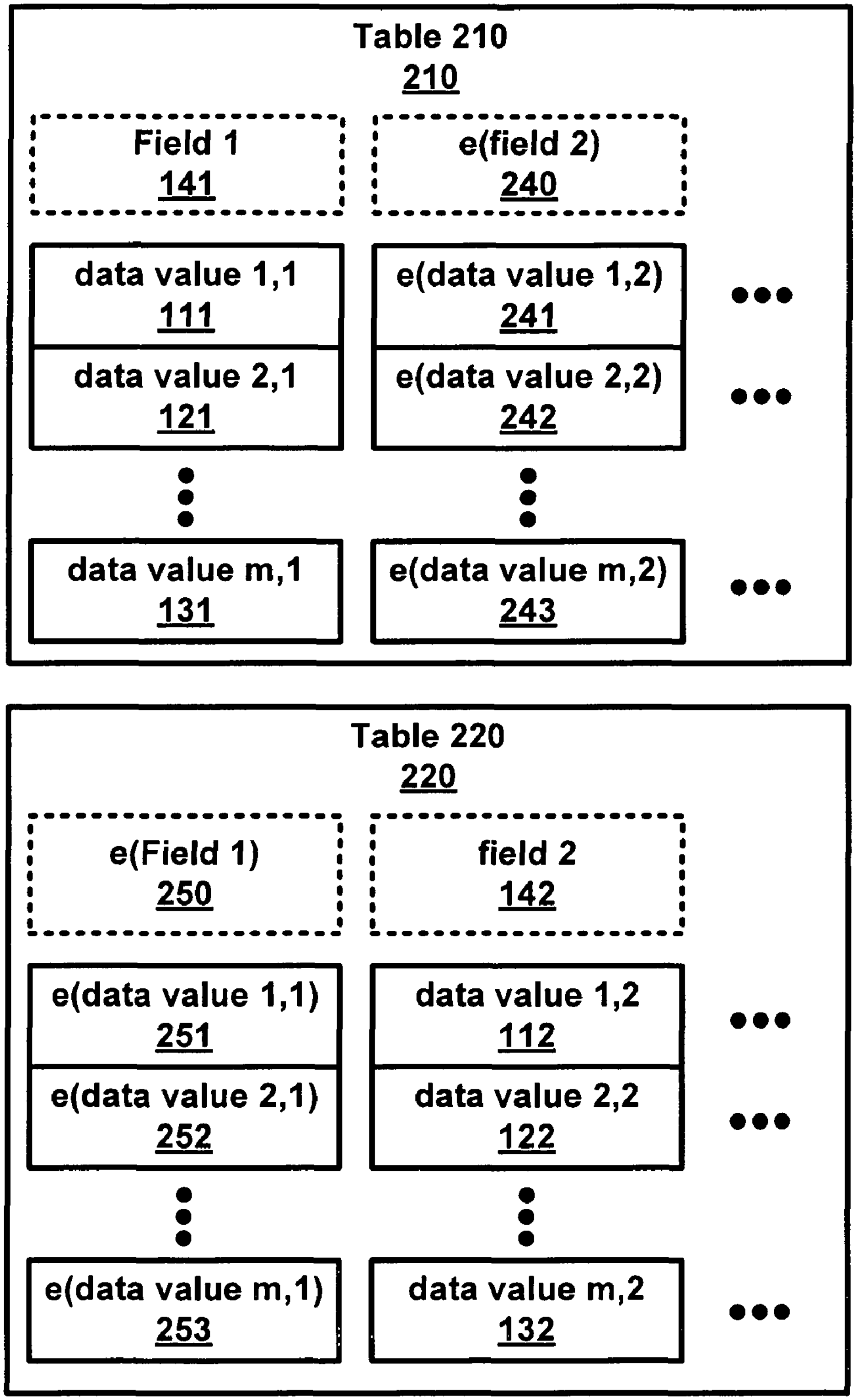
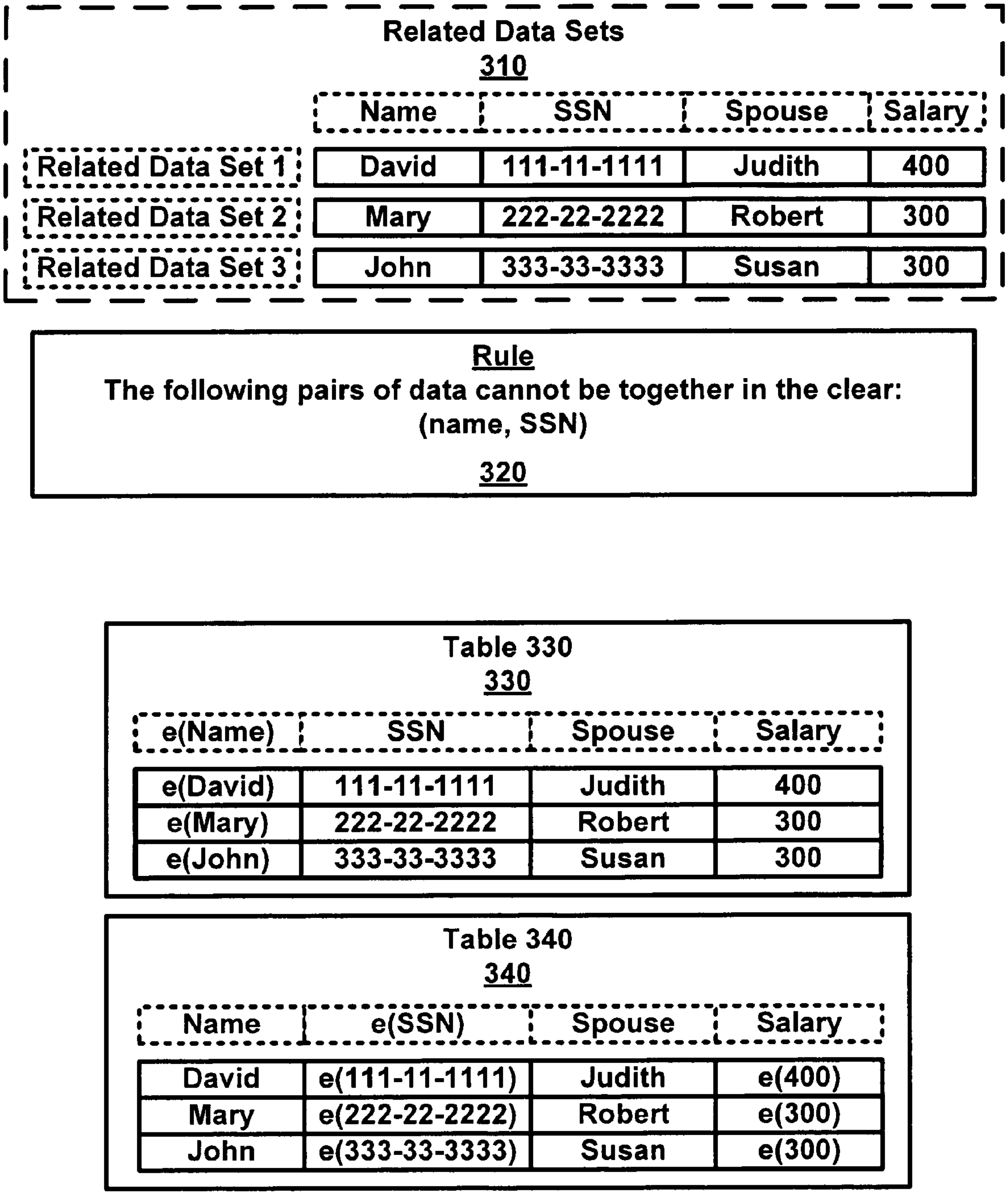


Table 210
210
Field 1
141
e(field 2)
240
data value 1,1
111
e(data value 1,2)
241
data value 2,1
121
e(data value 2,2)
242
data value m,1
131
e(data value m,2)
243
Table 220
220
e(Field 1)
250
field 2
142
e(data value 1,1)
251
data value 1,2
112
e(data value 2,1)
252
data value 2,2
122
e(data value m,1)
253
data value m,2
132

FIGURE 2



Related Data Sets
310

	Name	SSN	Spouse	Salary
Related Data Set 1	David	111-11-1111	Judith	400
Related Data Set 2	Mary	222-22-2222	Robert	300
Related Data Set 3	John	333-33-3333	Susan	300

Rule
The following pairs of data cannot be together in the clear:
(name, SSN)
320

Table 330
330

e(Name)	SSN	Spouse	Salary
e(David)	111-11-1111	Judith	400
e(Mary)	222-22-2222	Robert	300
e(John)	333-33-3333	Susan	300

Table 340
340

Name	e(SSN)	Spouse	Salary
David	e(111-11-1111)	Judith	e(400)
Mary	e(222-22-2222)	Robert	e(300)
John	e(333-33-3333)	Susan	e(300)

FIGURE 3

Rules:
The following pairs of data cannot be together in the clear:
(name, SSN)
(name, salary)
(SSN, Salary)
(Spouse, Salary)

420

Table 430
430

Name	Spouse	e(SSN)
David	Judith	e(111-11-1111)
Mary	Robert	e(222-22-2222)
John	Susan	e(333-33-3333)

Table 440
440

Name	Spouse	e(Salary)
David	Judith	e(400)
Mary	Robert	e(300)
John	Susan	e(300)

Table 450
450

Name	e_1(SSN)	Spouse	e_2(Salary)
David	e_1(111-11-1111)	Judith	e_2(400)
Mary	e_1(222-22-2222)	Robert	e_2(300)
John	e_1(333-33-3333)	Susan	e_2(300)

FIGURE 4

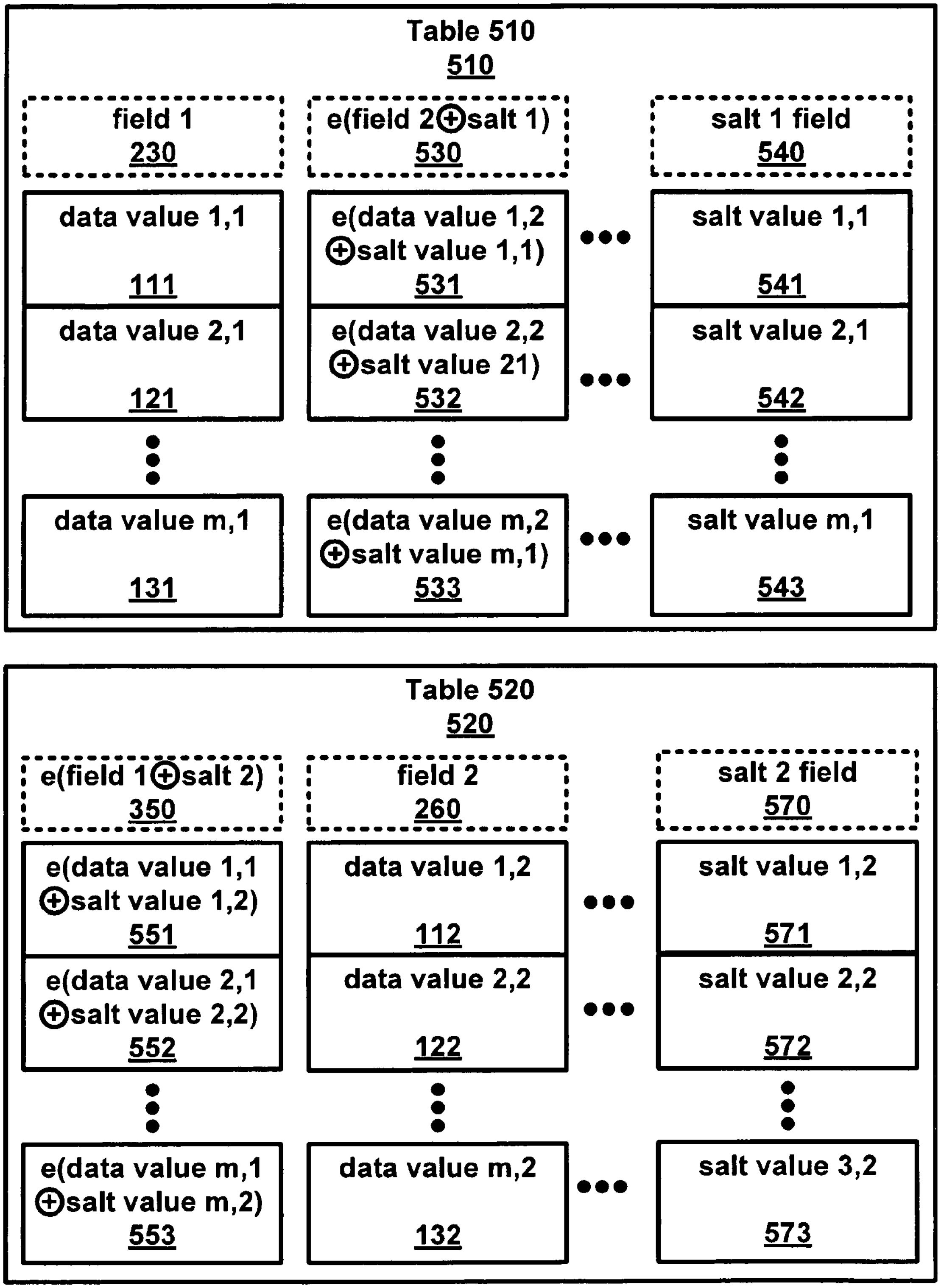


Table 510
510
field 1
230
e(field 2⊕salt 1)
530
salt 1 field
540
data value 1,1
111
e(data value 1,2 ⊕salt value 1,1)
531
salt value 1,1
541
data value 2,1
121
e(data value 2,2 ⊕salt value 21)
532
salt value 2,1
542
data value m,1
131
e(data value m,2 ⊕salt value m,1)
533
salt value m,1
543
Table 520
520
e(field 1⊕salt 2)
350
field 2
260
salt 2 field
570
e(data value 1,1 ⊕salt value 1,2)
551
data value 1,2
112
salt value 1,2
571
e(data value 2,1 ⊕salt value 2,2)
552
data value 2,2
122
salt value 2,2
572
e(data value m,1 ⊕salt value m,2)
553
data value m,2
132
salt value 3,2
573

FIGURE 5

Rule
The following pairs of data cannot be together in the clear:
(name, Salary)
620

Table 630
630

e(Name⊕salt)	Salary	Salt
e(David⊕S1)	400	S1
e(Mary⊕S2)	300	S2
e(John⊕S3)	300	S3

Table 640
640

Name	e(Salary⊕salt)	Salt
David	e(400⊕S4)	S4
Mary	e(300⊕S5)	S5
John	e(300⊕S6)	S6

To retrieve Name:
Name = d(e(Name⊕salt))⊕salt
650

To retrieve Salary:
Salary = d(e(Salary⊕salt))⊕salt
660

FIGURE 6

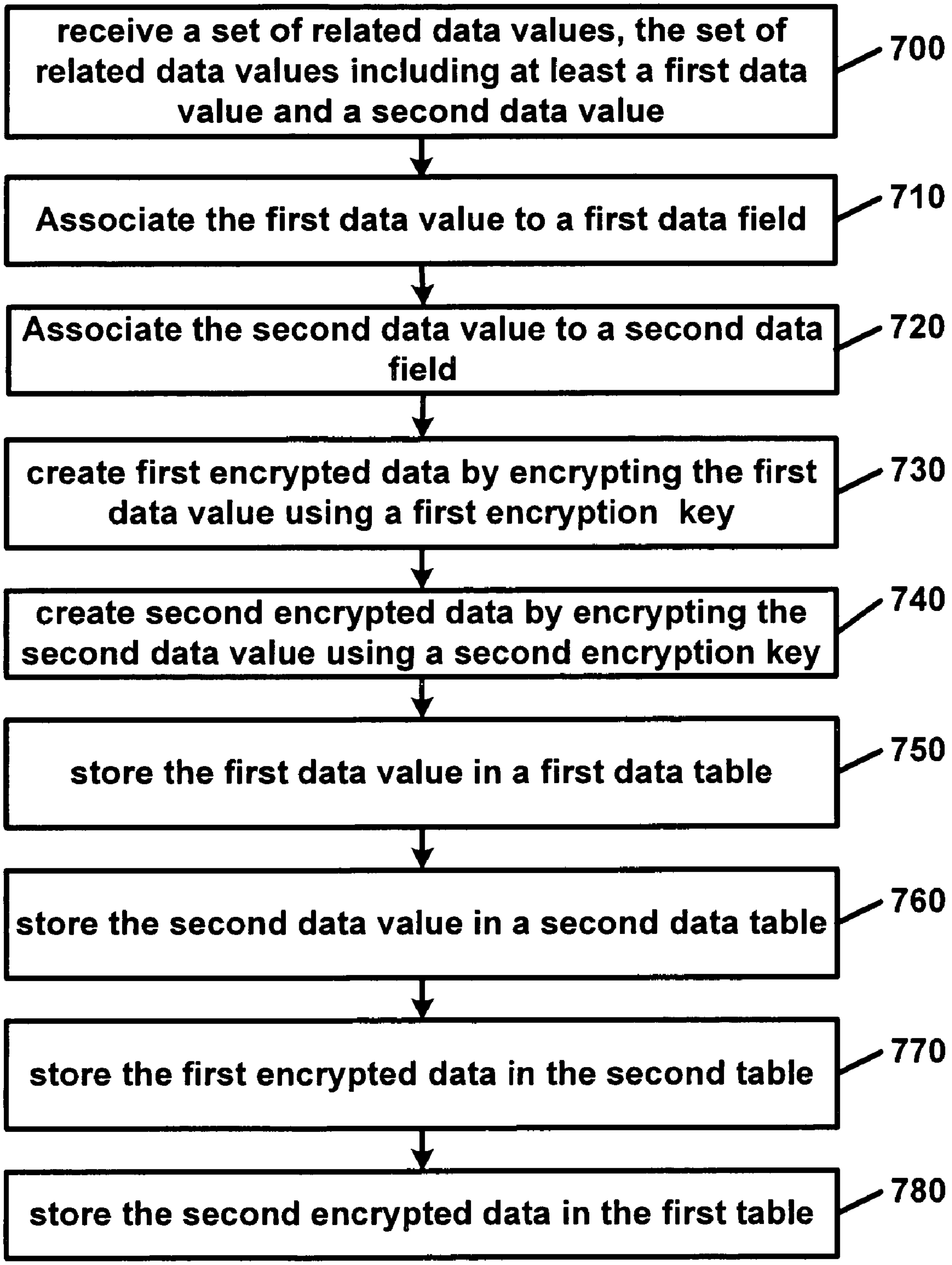

receive a set of related data values, the set of related data values including at least a first data value and a second data value
700
Associate the first data value to a first data field
710
Associate the second data value to a second data field
720
create first encrypted data by encrypting the first data value using a first encryption key
730
create second encrypted data by encrypting the second data value using a second encryption key
740
store the first data value in a first data table
750
store the second data value in a second data table
760
store the first encrypted data in the second table
770
store the second encrypted data in the first table
780

FIGURE 7

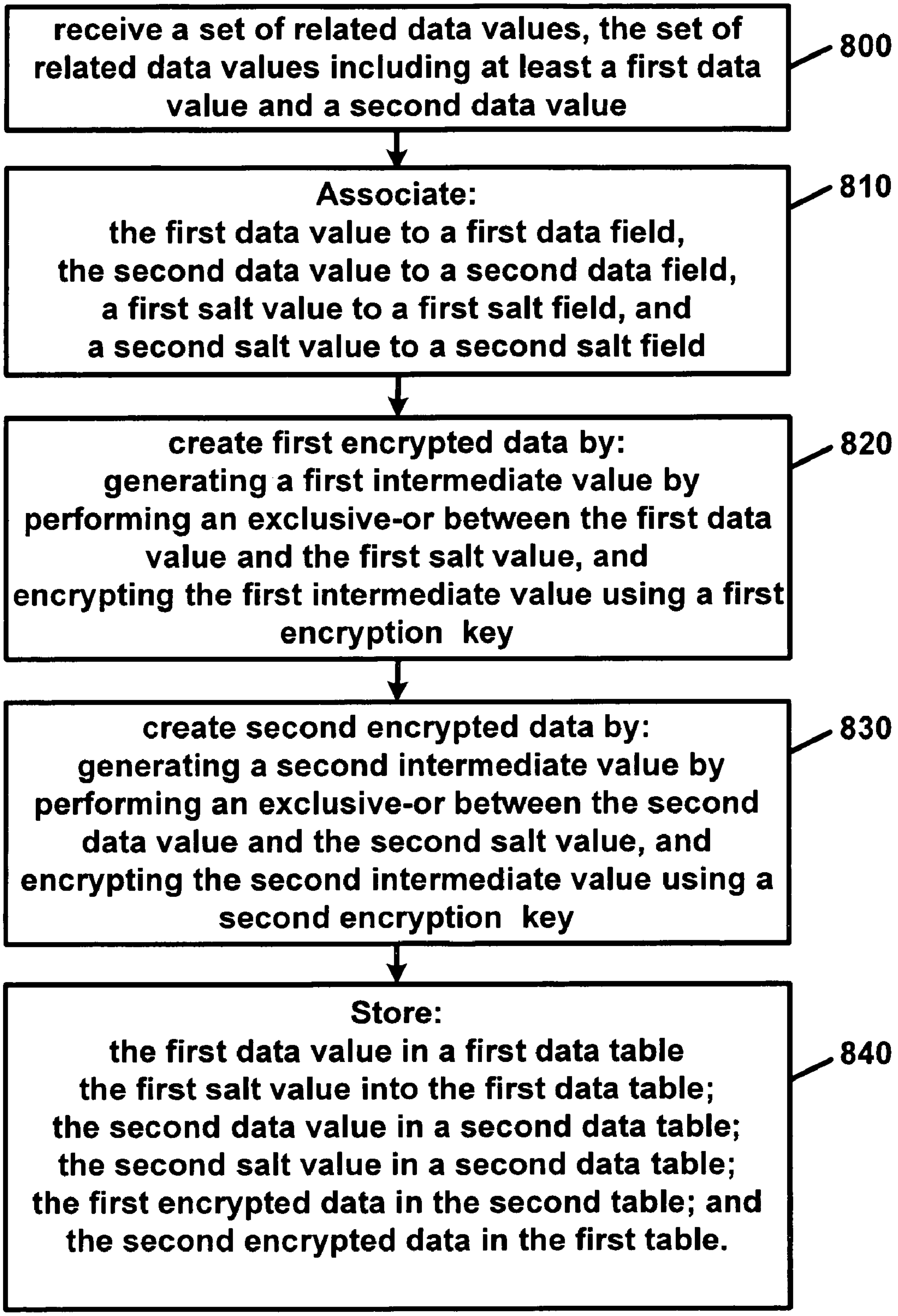

receive a set of related data values, the set of related data values including at least a first data value and a second data value
800
Associate:
the first data value to a first data field,
the second data value to a second data field,
a first salt value to a first salt field, and
a second salt value to a second salt field
810
create first encrypted data by:
generating a first intermediate value by performing an exclusive-or between the first data value and the first salt value, and
encrypting the first intermediate value using a first encryption key
820
create second encrypted data by:
generating a second intermediate value by performing an exclusive-or between the second data value and the second salt value, and
encrypting the second intermediate value using a second encryption key
830
Store:
the first data value in a first data table
the first salt value into the first data table;
the second data value in a second data table;
the second salt value in a second data table;
the first encrypted data in the second table; and
the second encrypted data in the first table.
840

FIGURE 8

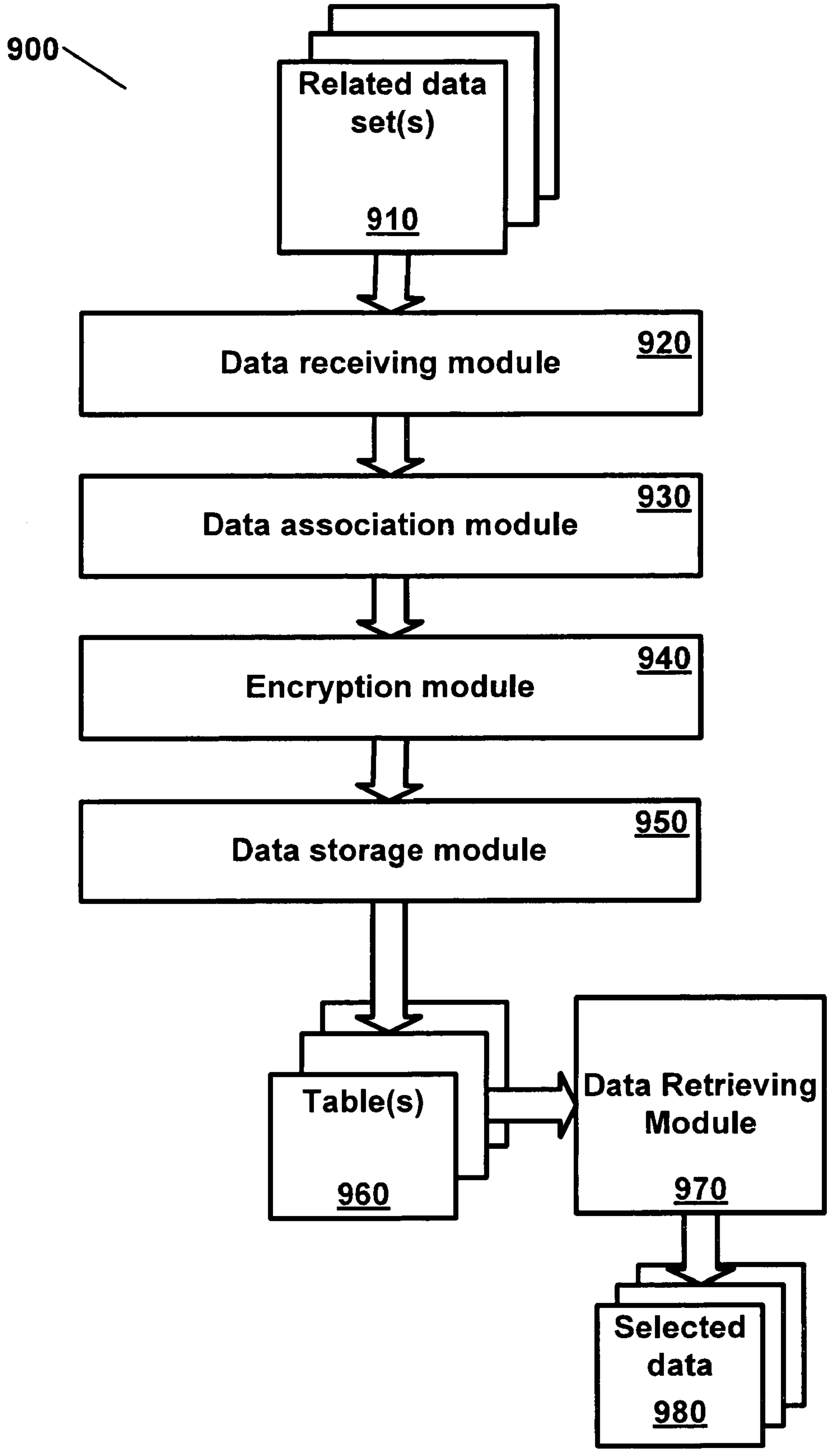

900
Related data set(s)
910
Data receiving module
920
Data association module
930
Encryption module
940
Data storage module
950
Table(s)
960
Data Retrieving Module
970
Selected data
980

FIGURE 9

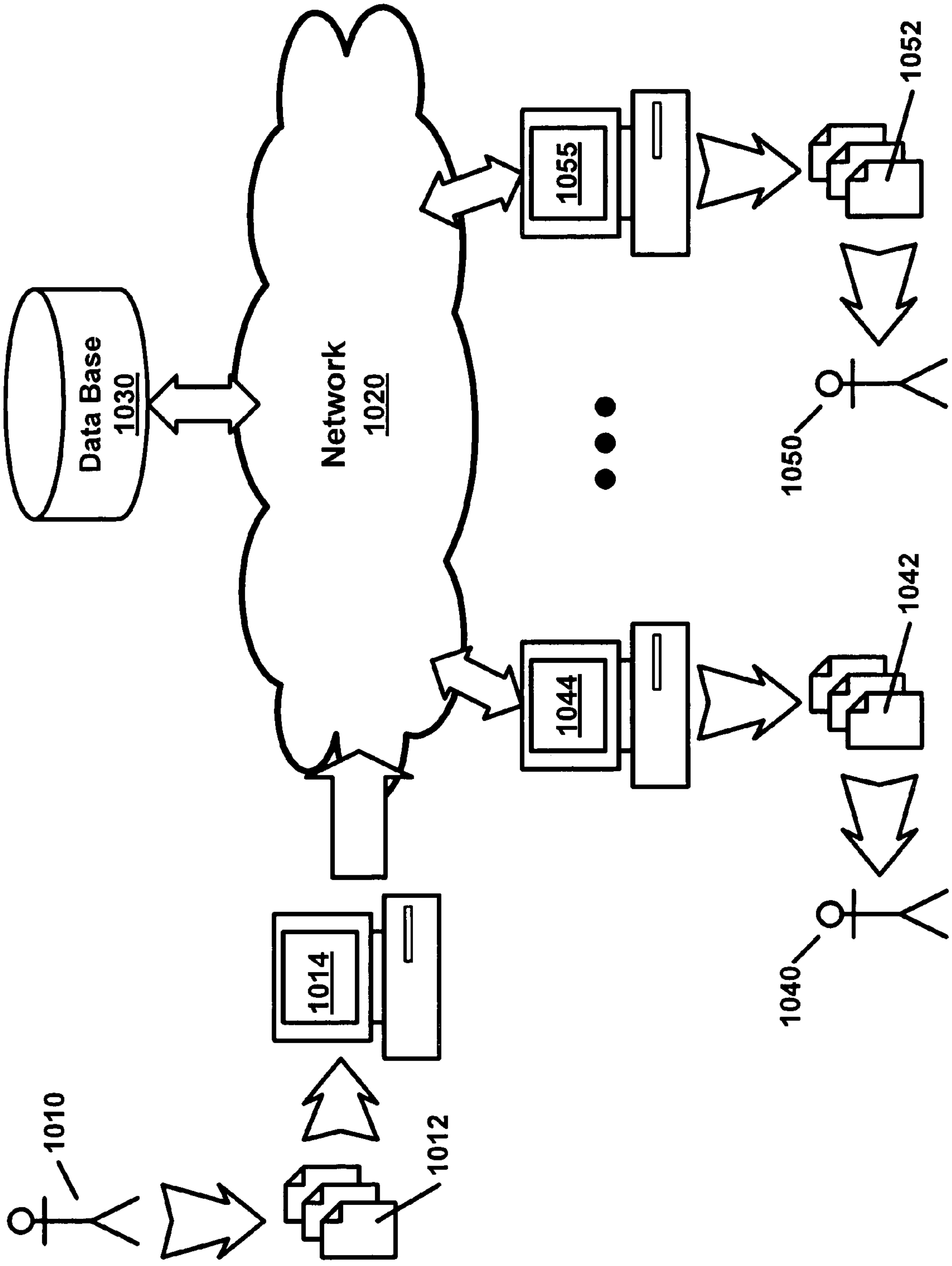

1010
1012
1014
Data Base
1030
Network
1020
1044
1055
1042
1052
1040
1050

FIGURE 10

PROTECTING SENSITIVE DATA ASSOCIATIONS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of U.S. Provisional Application No. 60/868,765, filed Dec. 6, 2006, entitled "Protecting Sensitive Data Associations," and U.S. Provisional Application No. 60/910,608, filed Apr. 6, 2007, entitled "Protecting Sensitive Data Associations" which are hereby incorporated by reference in its entirety.

BACKGROUND OF THE EMBODIMENTS OF THE INVENTION

Federal and state governments are passing laws that define what constitutes personal information of individuals and mandating that there be procedures for protecting that personal information. An example of such a law is the California Security Breach Information Act (SB-1386) (enacted). This bill is a California state law requiring organizations that maintain personal information about individuals to inform those individuals if the security of their information is compromised. The Act stipulates that if there's a security breach of a database containing personal data, the responsible organization must notify each individual for whom it maintained information. The Act, which went into effect Jul. 1, 2003, was created to help stem the increasing incidence of identity theft. According to the Federal Trade Commission, the organization received 214,905 complaints of identity theft in 2003, up 40% from 2002. Accordingly, there is a need for a simple but useful technique that can be incorporated in commercial databases to protect personal data from theft without seriously affecting the availability of the personal data to those that have a need to use it.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

FIG. **1** is a block diagram of example related data sets as per an aspect of an embodiment of the present invention.

FIG. **2** is a block diagram of example tables containing some of the data from the related data sets of FIG. **1** with the data associations hidden as per an aspect of an embodiment of the present invention.

FIG. **3** shows an example related data sets, an example rule, and tables containing some of the data from the related data set with the data associations hidden according to the rule as per an aspect of an embodiment of the present invention.

FIG. **4** shows other example rules, and two sets of tables containing some of the data from the related data set with the data associations hidden according to the rule as per an aspect of an embodiment of the present invention.

FIG. **5** is a block diagram of example tables containing some of the data from the related data sets of FIG. **1** with the data associations hidden using salt values as per an aspect of an embodiment of the present invention.

FIG. **6** shows another example rule, tables containing some of the data from the related data set with the data associations hidden according to the rule using salt values, and formulas for retrieving data of interest as per an aspect of an embodiment of the present invention.

FIG. **7** is a flow diagram of an aspect of an embodiment of the present invention.

FIG. **8** is a flow diagram of an aspect of another embodiment of the present invention.

FIG. **9** is a block diagram of an aspect of an embodiment of the present invention.

FIG. **10** is a block diagram showing how an aspect of an embodiment of the present invention may be used.

DETAILED DESCRIPTION OF EMBODIMENTS

Embodiments of the present invention provide a simple but useful technique that can be incorporated in commercial databases to protect personal data from theft without seriously affecting the availability of the personal data to those that have a need to use it.

FIG. **1** is a block diagram of example related data sets **100** as per an aspect of an embodiment of the present invention. As shown related data sets **1** thru m are shown (**110**, **120**, and **130**). Each of these related data sets have data values associated with data fields (shown as field **1 141**, field **2 142** and field n **143**).

FIG. **2** is a block diagram of example tables **210** and **220** containing some of the data from the related data sets of FIG. **1** with the data associations hidden as per an aspect of an embodiment of the present invention. A first table **210** is populated with clear data (**111**, **121**, . . . **131**) for a first field **141** and encrypted data (**241**, **242**, . . . **243**) for a second field (**240**). A second table **220** is populated with clear data (**112**, **122**, . . . **132**) for the second field **142** and encrypted data (**251**, **252**, **253**) for the first field (**250**). This combination allows a user to retrieve data for a particular field without being able to correlate the data to the other fields, thus hiding the association between the data values.

FIG. **3** shows example related data sets **310**, an example rule **320**, and tables **330** and **340** containing some of the data from the related data set(s) **310** with the data associations hidden according to rule **320** as per an aspect of an embodiment of the present invention. Rule **320** states that the data values for the name and SSN fields cannot be in the clear together. The solution is to break the data into two tables **330** and **340**. Table **330** has encrypted the data values associated with the name field but leaves the other data available for analysis, reports, etc. Table **340** has encrypted the data values associated with the SSN field, but leaves the data values associated with the other fields in the clear. Therefore, neither table alone allows the data associations between the name and SSN fields to be made between the values even though the other data is available in the clear for other legitimate uses.

FIG. **4** shows other example rules **420**, and two sets of tables **430**, **440** and **450** containing some of the data from the related data set **310** with the data associations hidden according to rule **420** as per an aspect of an embodiment of the present invention. This figure shows that there can be more than one way to satisfy rules such as rules **420**. Tables **430** and **440** together satisfy the rules. Similarly, table **450** satisfies rules **420** by itself.

Table **430** and table **440** satisfy the rules by breaking up the data so that name and spouse data are available in the clear in table **430** along with an encrypted copy of the SSN data and name and spouse data are available in the clear in table **440** along with encrypted copies of the salary data. Therefore, neither name and SSN, name and salary, SSN and salary, or spouse and salary are together in the clear in the same table.

Table **450** shows another solution that also satisfies rule **420** with only one table. This is done by using more than one encryption key. In this table, data associated with the SSN field and data associated with the salary field are encrypted using separate keys. Therefore, the rules are satisfied and authorized users of either the SSN or the salary data may get access to that data without exposing the data.

FIG. **5** is a block diagram of example tables containing some of the data from the related data sets of FIG. **1** with the data associations hidden using salt values as per an aspect of an embodiment of the present invention. Data (**541**, **542**, . . . **543**) associated with the salt **1** field **540** are stored in table **510**. These salt values salt values (**541**, **542**, . . . **543**) may then be used to fill and extract data values (**531**, **532**, . . . **533**) from the encrypted field data **2** field **530**. Note that the data values (**111**, **121**, . . . **131**) associated with field **1 230** are in the clear.

Similarly, data (**571**, **572**, . . . **573**) associated with the salt **2** field **570** are stored in table **520**. These salt values salt values (**571**, **572**, . . . **573**) may then be used to fill and extract data values (**551**, **552**, . . . **553**) from the encrypted field data **1** field **550**. Note that the data values (**112**, **122**, . . . **132**) associated with field **2 260** are in the clear.

FIG. **6** shows another example rule, tables containing some of the data from the related data set with the data associations hidden according to the rule using salt values, and formulas for retrieving data of interest as per an aspect of an embodiment of the present invention. Rule **620** states that name and salary information cannot be together in the clear. To accomplish this, the name values are exclusive OR'ed with the data associated with salt field, encrypted and then stored in the table **630**. The salary and salt data may be in the clear. The data associated with the salary field are exclusive OR'ed with the data associated with the salt field, encrypted and then stored in the table **640**. Therefore, neither the name or salary data is available in the clear in the same table.

To retrieve the name data, the encrypted name values in table **630** need to be decrypted and then exclusive OR'ed with the appropriate salt value as shown in **650**. Similarly, to retrieve the salary data, the encrypted salary values in table **640** need to be decrypted and then exclusive OR'ed with the appropriate salt value as shown in **660**. Using this technique, separate records with the same name or salary data values will have different encrypted values, making it difficult, if at all possible to correlate records with known values with records that have unknown values.

Some embodiments of the present invention protect sensitive data associations through the use of a method. FIG. **7** is a flow diagram of an example method as per an aspect of an embodiment of the present invention. The method includes receiving a set of related data values at **700**. The set of related data values should include at least a first data value and a second data value. The data values should be associated with appropriate data fields at **710**. For example, the first data value should be associated to a first data field and the second data value should be associated to a second data field. These associations may be performed for many data values and data fields, however, for clarity they are being described in the basic case of two data values and fields.

A rule may be used to indicate which associations are to be kept secret. For example, in this case of two data values and fields, the rule may state that that the association of the first data value and the second data value needs to be kept secret. To enforce this rule, data values may be encrypted that will be stored in separate tables. As shown, first encrypted data may be created at **730** by encrypting the first data value using a first encryption key. Similarly, second encrypted data may be created at **740** by encrypting the second data value using a second encryption key.

To hide the associations, the data values and encrypted data may be stored in separate tables, thus allowing access to particular fields of data to a user in one table without exposing the data from other fields in the related data set. In the current example this is done by storing the first data value in a first data table at **750**, storing the second data value in a second data table at **760**, storing the first encrypted data in the second table at **770**, and storing the second encrypted data in the first table at **780**.

The actions above may be repeated for additional sets of related data values.

After the data values have been stored, they may be retrieved from the proper table by an authorized user who possesses the decryption proper key. For example, the first data value may be obtained by: retrieving the first encrypted data from the second table; and then decrypting the first encrypted data using a first decryption key. Similarly, the second data value may be obtained by: retrieving the second encrypted data from the first table; and then decrypting the second encrypted data using a second decryption key.

Many combinations of keys may be used. The encryption key and the decryption key may be the same symmetric key. The first encryption key and the second encryption key may be the same or different. The decryption keys for any particular data value will need to work with the encryption key used to encrypt that data value. When the first encryption key and the second encryption key are the same, the first decryption key and the second decryption key may also need to be the same.

FIG. **8** is a flow diagram of an aspect of another embodiment of the present invention for protecting sensitive data associations where salt values are utilized to ensure that identical data from different related data sets do not inadvertently disclose associations by having identically encrypted values. A set of related data values is received at **800**. The set of related data values preferably includes at least a first data value and a second data value. At **810** data values and salt values are associated with their appropriate data fields. As shown in the illustrated example, the first data value is associated to a first data field, the second data value is associated to a second data field, a first salt value is associated to a first salt field, and a second salt value is associated to a second salt field. The first salt value and the second salt value may be random or pseudo-random values. Although some embodiments, the first salt value and the second salt value are the same, it may be necessary to protect inadvertent disclosure of data to have the first salt value and the second salt value be different.

Associated data values may be encrypted at **820** and **830**. First encrypted data is created at **820**. To do this, a first intermediate value is generated by performing an exclusive-or between the first data value and the first salt value. Then the first intermediate value may be encrypted using a first encryption key. Similarly, second encrypted data is created at **830** by generating a second intermediate value by performing an exclusive-or between the second data value and the second salt value and then encrypting the second intermediate value associated with the second field using a second encryption key.

At **840**, the data and salt values are stored in tables such that the association between the values in the related data set are protected according to the rule(s). In the present example, a rule indicates that the association of the first data value and the second data value needs to be kept secret. Consequently, the first data value is stored in a first data table, the first salt value is stored in the second data table, the second data value is stored in a first data table, the second salt value is stored in a second data table, the first encrypted data is stored in the second table, and the second encrypted data is stored in the first table.

The first data value may be retrieved by: retrieving the first encrypted data from the second table; generating a third intermediate value by decrypting the first encrypted data using a first decryption key; and performing an exclusive-or between the third intermediate value and the first salt value. Similarly, the second data value may be retrieved by: retrieving the second encrypted data from the first table; generating a fourth intermediate value by decrypting the second encrypted data using a second decryption key; and performing an exclusive-or between the fourth intermediate value and the second salt value.

Embodiments of the present invention may be built as a system. FIG. **9** is a block diagram of a system **900** for protecting sensitive data associations according to an aspect of an embodiment of the present invention. The block diagram shows a multitude of modules. The modules may use software, firmware, hardware, either by themselves or in combination. For example, some of the modules may be software modules that run on general purpose computer. However, in some embodiments, the modules could be configured as firmware that runs on customized microprocessor. In some cases, some of the processing may be performed using programmable logic such as FPGA or ASIC logic. On example of a hardware implementation may be a USB memory device that has customized logic to selectively hold table data created using embodiments of aspects of the present invention for access by authorized users only.

As shown, the system includes a data receiving module **920** configured to receive a set(s) of related data values **910**. The set(s) of related data values **910** preferably include at least a first data value and a second data value. The system normally operates against rule(s) that indicates which data value associations need to be kept secret. In the absence of such a rule, a default rule may be used such as the association of the first data value and the second data value needs to be kept secret.

A data association module **930** may be configured to associate the first data value to a first data field; and the second data value to a second data field. An encryption module **940** may then create first encrypted data by encrypting the first data value using a first encryption key; and create second encrypted data by encrypting the second data value using a second encryption key. A data storage module **950** is configured to store: the first data value in a first data table; the second data value in a second data table; the first encrypted data in the second table; and the second encrypted data in the first table.

A data retrieving module(s) **970** may be used to retrieve: the first data value by decrypting the first encrypted data using a first decryption key and/or the second first data value by decrypting the second encrypted data using a second decryption key. As with the method embodiments, there are many possibilities for the encryption and decryption keys. The encryption key and the decryption key may be the same symmetric key. The encryption keys may be different or the same. Similarly the decryption keys may be the same or different. The choice of keys should be made carefully to ensure that the data relationships in the rule(s) be kept secret. In some embodiments, the rule may bee received from an external source. In the absence of an external rule, and internal rule or a default rule may be used.

The system of FIG. **9** may also apply salt values to prevent identical data from encrypting to an identical value. The salt values may be stored in salt fields. Generally, the salt values are either random or pseudo-random values. The data may then be encrypted by generating an intermediate value by performing an exclusive-or between the data value and the salt value and then encrypting the intermediate value using an encryption key. This technique may be applied to as many data values as necessary.

The storage module can then store the salt values in the appropriate tables to be used in retrieving the encrypted data.

The data values may be retrieved by retrieving the encrypted data from the appropriate table, generating an intermediate value by decrypting the encrypted data using a decryption key, and then performing an exclusive-or between the intermediate value and the salt value.

FIG. **10** is an illustrative diagram showing how an embodiment of the present invention may be used. A first user **1010** may input personal data **1012** associated with an individual into a database **1030** through a network **1020** using a computer **1014**. The personal data may come from many sources such as a person directly or a tangible form filled out by a person. The data may be stored in database **1030** in tables that separate the data so as to protect the relationship between selected pieces of the private information. Users (**1040**, **1050** and the like) who have a need to access some of the private data may access data (**1042**, **1052** and the like) from selected tables in the database **1030** that correspond to their specific need for information through network **1020** using a local computer (**1044**, **1054** and the like). This figure only shows one possible scenario and should not be considered limiting. For example, users **1040** and **1050** in other embodiments may have bi-directional access to the database **1030**. In other embodiments, the database may be shared on an individual machines and not on a network.

While various embodiments have been described above, it should be understood that they have been presented by way of example, and not limitation. It will be apparent to persons skilled in the relevant art(s) that various changes in form and detail can be made therein without departing from the spirit and scope. In fact, after reading the above description, it will be apparent to one skilled in the relevant art(s) how to implement alternative embodiments. Thus, the present embodiments should not be limited by any of the above described exemplary embodiments. In particular, it should be noted that, for example purposes, the above explanation has focused on the example(s) of personal data. However, one skilled in the art will recognize that embodiments of the invention could be used to protect associations of other types of data such as research data where for validation purposes it is important to keep associations of some of the research data hidden.

In addition, it should be understood that any figures which highlight the functionality and advantages, are presented for example purposes only. The disclosed architecture is sufficiently flexible and configurable, such that it may be utilized in ways other than that shown. For example, the steps listed in any flowchart may be re-ordered or only optionally used in some embodiments.

Further, the purpose of the Abstract of the Disclosure is to enable the U.S. Patent and Trademark Office and the public generally, and especially the scientists, engineers and practitioners in the art who are not familiar with patent or legal terms or phraseology, to determine quickly from a cursory inspection the nature and essence of the technical disclosure of the application. The Abstract of the Disclosure is not intended to be limiting as to the scope in any way.

Finally, it is the applicant's intent that only claims that include the express language "means for" or "step for" be interpreted under 35 U.S.C. 112, paragraph 6. Claims that do not expressly include the phrase "means for" or "step for" are not to be interpreted under 35 U.S.C. 112, paragraph 6.

What is claimed is:

1. A method for protecting sensitive data associations within a database, comprising:

(a) receiving a set of related data values, the set of related data values including at least a first unencrypted data value and a second unencrypted data value;

(b) associating:

(i) the first unencrypted data value to a first data field; and

(ii) the second unencrypted data value to a second data field;

(c) creating first encrypted data by encrypting the first unencrypted data value using a first encryption key;

(d) creating second encrypted data by encrypting the second unencrypted data value using a second encryption key; and

(e) a computer processor storing:

(i) the first unencrypted data value in a first data table;

(ii) the second unencrypted data value in a second data table;

(iii) the first encrypted data in the second data table; and

(iv) the second encrypted data in the first data table; and wherein:

a rule indicates that the association of the first unencrypted data value and the second unencrypted data value is secret; and

said database includes said first data table and said second data table.

2. The method according to claim **1**, further including repeating steps (a)-(e) for additional sets of related data values.

3. The method according to claim **1**, further including obtaining the first unencrypted data value by:

(a) retrieving the first encrypted data from the second table; and

(b) decrypting the first encrypted data using a first decryption key.

4. The method according to claim **1**, further including obtaining the second data value by:

(a) retrieving the second encrypted data from the first table; and

(b) decrypting the second encrypted data using a second decryption key.

5. A method for protecting sensitive data associations within a database, comprising:

(a) receiving a set of related data values, the set of related data values including at least a first unencrypted data value and a second unencrypted data value;

(b) associating:

(i) the first unencrypted data value to a first data field;

(ii) the second unencrypted data value to a second data field;

(iii) a first salt value to a first salt field; and

(iv) a second salt value to a second salt field;

(c) creating a first encrypted data by:

(i) generating a first intermediate value by performing an exclusive-or between the first unencrypted data value and the first salt value; and

(ii) encrypting the first intermediate value using a first encryption key;

(d) creating second encrypted data by:

(i) generating a second intermediate value by performing an exclusive-or between the second unencrypted data value and the second salt value; and

(ii) encrypting the second intermediate value associated with the second field using a second encryption key; and

(e) a computer processor storing:

(i) the first unencrypted data value in a first data table;

(ii) the first salt value into the second data table;

(iii) the second unencrypted data value in a first data table;

(iv) the second salt value in a second data table;

(v) the first encrypted data in the second table; and

(vi) the second encrypted data in the first table and wherein:

a rule indicates that the association of the first unencrypted data value and the second data value is secret; and

said database includes said first data table and said second data table.

6. The method according to claim **5**, wherein the first salt value and the second salt value are random values.

7. The method according to claim **5**, wherein the first salt value and the second salt value are pseudo-random values.

8. The method according to claim **5**, further including retrieving the first unencrypted data value by:

(a) retrieving the first encrypted data from the second table;

(b) generating a third intermediate value by decrypting the first encrypted data using a first decryption key; and

(c) performing an exclusive-or between the third intermediate value and the first salt value.

9. The method according to claim **5**, further including retrieving the second unencrypted data value by:

(a) retrieving the second encrypted data from the first table;

(b) generating a fourth intermediate value by decrypting the second encrypted data using a second decryption key; and

(c) performing an exclusive-or between the fourth intermediate value and the second salt value.

10. The method according to claim **5**, wherein the first salt value and the second salt value are the same.

11. A system for protecting sensitive data associations within a database, comprising:

(a) a data receiving module configured to receive a set of related data values, the set of related data values including at least a first data unencrypted value and a second unencrypted data value;

(b) a rule indicating that the association of the first unencrypted data value and the second unencrypted data value is secret;

(c) a data association module configured to associate:

(i) the first unencrypted data value to a first data field; and

(ii) the second unencrypted data value to a second data field;

(d) an encryption module configured to:

(i) create first encrypted data by encrypting the first unencrypted data value using a first encryption key; and

(ii) create second encrypted data by encrypting the second unencrypted data value using a second encryption key; and

(e) a data storage module configured to employ a computer processor to store:

(i) the first unencrypted data value in a first data table;

(ii) the second unencrypted data value in a second data table;

(iii) the first encrypted data in the second table; and

(iv) the second encrypted data in the first table; and wherein

said database includes said first data table and said second data table.

12. The system according to claim **11**, further including a first data retrieving module configured to retrieve the first unencrypted data value by decrypting the first encrypted data using a first decryption key.

13. The system according to claim **11**, further including a second data retrieving module configured to retrieve the second first unencrypted data value by decrypting the second encrypted data using a second decryption key.

14. The system according to claim **11**, wherein the rule is received from an external source.

15. A system for protecting sensitive data associations within a database, comprising:

(a) a data receiving module configured to receive a set of related data values, the set of related data values including at least a first unencrypted data value and a second unencrypted data value;

(b) a rule indicates that the association of the first unencrypted data value and the second unencrypted data value is secret;

(c) a data association module configured to associate:

(i) the first unencrypted data value to a first data field;

(ii) the second unencrypted data value to a second data field;

(iii) a first salt value to a first salt field; and

(iv) a second salt value to a second salt field;

(d) an encryption module configured to:

(i) to create a first encrypted data by:

(1) generating a first intermediate value by performing an exclusive-or between the first unencrypted data value and the first salt value; and

(2) encrypting the first intermediate value using a first encryption key; and

(ii) create a second encrypted data by:

(1) generating a second intermediate value by performing an exclusive-or between the second unencrypted data value and the second salt value; and

(2) encrypting the second intermediate value associated with the second field using a second encryption key; and

(e) a storage module configured to employ a computer processor to store:

(i) the first unencrypted data value in a first data table;

(ii) the first salt value into the second data table;

(iii) the second unencrypted data value in a second data table;

(iv) the second salt value in a first data table;

(v) the first encrypted data in the second table; and

(vi) the second encrypted data in the first table; and wherein

said database includes said first data table and said second data table.

16. The system according to claim **15**, wherein the first salt value and the second salt value are random values.

17. The system according to claim **15**, wherein the first salt value and the second salt value are pseudo-random values.

18. The system according to claim **15**, further including a first data retrieving module configured to retrieve the first unencrypted data value by:

(a) retrieving the first encrypted data from the second table;

(b) generating a third intermediate value by decrypting the first encrypted data using a first decryption key; and

(c) performing an exclusive-or between the third intermediate value and the first salt value.

19. A system according to claim **15**, further including a second data retrieving module configured to retrieve the second unencrypted data value by:

(a) retrieving the second encrypted data from the first table;

(b) generating a fourth intermediate value by decrypting the second encrypted data using a second decryption key; and

(c) performing an exclusive-or between the fourth intermediate value and the second salt value.

20. The system according to claim **15**, wherein the first salt value and the second salt value are the same.

21. The system according to claim **15**, wherein the rule is received from an external source.

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