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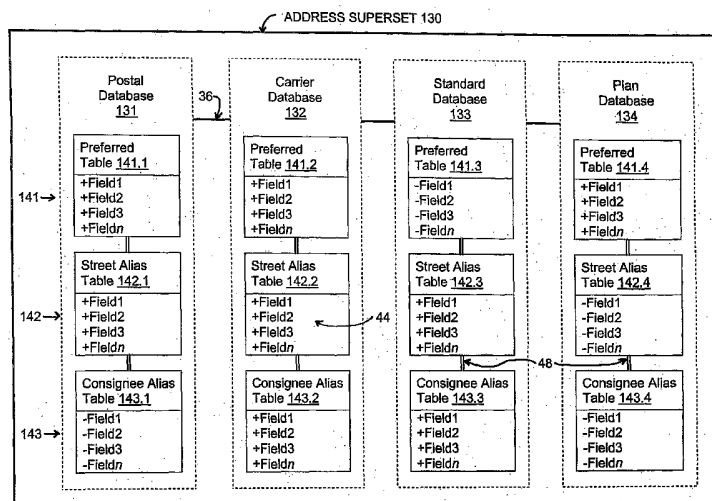
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(54) Title: DATA STRUCTURE AND MANAGEMENT SYSTEM FOR A SUPERSET OF RELATIONAL DATABASES



(57) Abstract: A data structure, database management system, and methods of validating data are disclosed. A data structure is described that includes a superset of interconnected relational databases containing multiple tables having a common data structure. The tables may be stored as a sparse matrix linked list. A method is disclosed for ordering records in hierarchical order, in a series of levels from general to specific. An example use with address databases is described, including a method for converting an input address having a subject representation into an output address having a preferred representation. Preferred artifacts may be marked with a token. Alias tables may be included. This abstract is provided to comply with the rules, which require an abstract to quickly inform a searcher or other reader about the subject matter of the application. This abstract is submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims.

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5 **DATA STRUCTURE AND MANAGEMENT SYSTEM
FOR A SUPERSET OF RELATIONAL DATABASES**

BACKGROUND

Technical Field. The following disclosure relates in general to relational
10 database management systems and more particularly, to a method and apparatus for
processing hierarchical data across multiple relational databases using sparse
matrix linked lists in a computer network environment.

Description of Related Art. The database has been a staple of computing
since the beginning of the digital era. A database refers generally to one or more
15 large, structured sets of persistent data, usually associated with a software system
to create, update, and query the data. In a database, each data value is stored in a
field; a set of fields together form a record; and a group of records may be stored
together in a file.

The first databases were flat; meaning all the data was stored in a single line
20 of text called a delimited file. In a delimited file, each field is separated by a
special character such as a comma. Each record is separated by a different
character, such as a caret (^) or a tab character. A simple delimited file may look
like this:

Last, First, Age^Doe, John, 26^Smith, Jane, 43^Jones, David, 34

25 Each field may be assigned a name or category called an attribute. In the
sample file above, the attributes are Last, First, and Age. The attribute indicates
the type of data to be stored in each field. For large amounts of data, the delimited
text file can grow very long. Accessing specific data generally requires searching
sequentially through the entire list. As the capacity of computers and databases
30 increased, the need for more efficient access and faster searching techniques led to
the development of new data structures.

The relational database model was described in the early 1970s. In a
relational database, the data is stored in a table. A table organizes the data into
rows and columns, providing a specific location (such as row x , column y) for each

field. Each row contains a single record. The columns are arranged in order, by attribute, so all the fields in each column contain the same type of data. The delimited file above may be represented in table format like this:

| Last | First | Age |
|-------|-------|-----|
| Doe | John | 26 |
| Smith | Jane | 43 |
| Jones | David | 34 |

The set of attributes or column headings is sometimes referred to as the schema of a table. The table above, for example, may be described as a table having the schema (Last, First, Age).

The table format for a database file makes searching and accessing data faster and more efficient. The records (rows) can also be sorted into a new order, based on any one or more of the columns (fields). Sorting is often used to order the records such that the most desired data appears earlier in the file, thereby making searching faster.

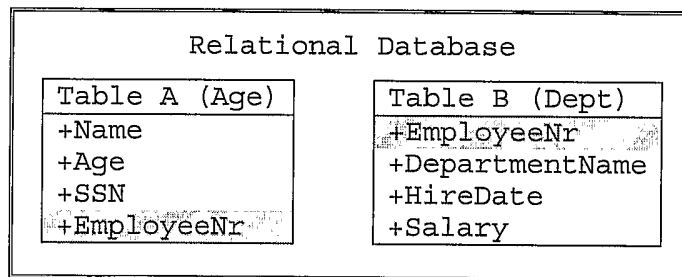
As computing speed and capacity increased, database tables were able to store larger amounts of data. Additional records (rows) may be added to describe additional instances. Additional attributes (columns) may be added to accommodate more types of data about each instance. As the number of fields increases, the task of changing the table structure (adding or deleting rows and columns) becomes more complex and increases the likelihood of error. Also, for large tables, the task of sorting the data based on one or more columns becomes more complex and time-consuming. Adding diverse types of data in a single, large, two-dimensional table eventually creates problems such as redundancy, inconsistency, increased storage requirements, and slower sorting and computing speeds.

Relational Databases with Multiple Tables. To accommodate diverse types of fields containing related data, a relational database model may include multiple tables. Multiple tables containing related data may be linked together using a key field. A key field contains a unique identifier for each record (or row of data). The key field can contain actual data, such as a part number or a Social Security Number, as long as it is unique to that record. This is sometimes called a logical key. The key field may also be a surrogate key, such as a record number, which is

a unique identifier not related to the actual data. Also, a key can be defined using a single field or a set of fields. A simple key is based on a single field, whereas a composite key is based on multiple fields.

In a relational database, related data may be stored in multiple tables. A key field called a “primary key” acts as a unique reference point for finding a particular record in a table. For example, the attributes (or column headings) in a sample “Table A” may be (Name, Age, Social Security Number, Employee Number). The primary key for Table A is the Social Security Number field.

In a relational database where data is stored in multiple tables, another key field called a “foreign key” is used as a reference point for connecting the tables. For example, consider another sample table: “Table B” having the schema (Employee Number, Department Name, Date of Hire, Salary). The primary key for Table B is the unique Employee Number field. Referring back to the attributes in Table A, the foreign key for Table A is the Employee Number field, because it links the records in Table A to the records in Table B. This relationship between tables can be illustrated using Entity Relationship Diagrams, where each table contains the data for a unique entity or category, such as “Age” or “Department.”



The shaded “EmployeeNr” field is common to both tables, and it provides a link between the data in the two Tables. The “EmployeeNr” field is the foreign key in Table A, but it is the primary key in Table B.

Table A and Table B need not include the same number of records. For example, the records in Table A may include the names, ages, Social Security Numbers, and Employee Numbers of everyone in an organization; and the records in Table B may be limited to only those in a particular department or division.

By including discrete sets of data in separate tables, a relational database can access selected tables for a variety of purposes. A single relational database may include any number of tables, from just a few to several thousand tables.

Query language allows users to interact with a database and analyze the data in the tables. A query is a collection of instructions used to extract a set of data from a database. Queries do not change the information in the tables; they merely display the information to the user. The result of a query is sometimes called a view.

The best known query language is Structured Query Language (SQL), pronounced "sequel." SQL is the standard language for database interoperability. Queries are probably the most frequently used aspect of SQL, but SQL commands may also be used as a programming tool, to create and maintain a database.

Database Management Systems. A database management system (sometimes abbreviated DBMS) refers generally to an interface and one or more computer software programs specifically designed to manage and manipulate the information in a database. The DBMS may include a complex suite of software programs that control the organization, storage, and retrieval of data, as well as the security and integrity of the database. The DBMS may also include an interface, for accepting requests for data from external applications.

An interface is a computer program designed to provide an operative connection or interface between a user and an application, such as a DBMS. An interface for a DBMS may provide a series of commands that allow a user to create, read, update, and delete the data values stored in the database tables. These functions (create, read, update, delete) are sometimes referred using the acronym CRUD, so an interface with those commands may be called a CRUD interface. A database interface that includes a query function may be called a CRUDQ interface.

A COM-based interface refers to software that is based upon the Component Object Model. Component Object Model is an open software architecture developed by Digital Equipment Corporation and Microsoft which allows for interoperability between various components of a database system.

In a relational database including multiple tables, the database management system (DBMS) is generally responsible for maintaining all the links between and among key fields in the various tables. This is referred to as maintaining the “referential integrity” of the database.

5 Maintaining referential integrity is often a challenge in a relational database that includes a very large number of tables. The linked nature of relational database tables has many advantages, but it may also allow an error to propagate across tables and throughout the entire database, especially when records or key fields are changed or deleted. The potential for error is compounded for systems
10 where a variety of users have access to the database through a CRUD interface.

 In a computer network environment, a large database may be housed on a central server, with many users or subscribers accessing the data from remote locations using a communication link. The speed of access is often limited by the type and capacity of the communication link. Distributing a duplicate of the entire
15 database to the remote location is generally impractical, especially for applications where the data must be current to be useful. Also, a large database stored locally would create a substantial burden on local users because remote systems are typically smaller than central servers. Storing a large database on a local system without sufficient capacity often causes an unacceptable increase in computing
20 time. The cost of upgrading all the hardware for every remote location may be too expensive, especially for very large user networks.

 Updating the data in large relational databases can be technically challenging and time-consuming, especially in a network environment where the data must be updated frequently. Transmitting an updated copy of the entire
25 database is often impractical and cost-prohibitive. Also, the cost and delay of distribution may present a barrier to the frequency of updates.

 Thus, there is a need in the art for an improved database management system capable of maintaining and protecting a large volume of data, distributing frequent updates in a cost-effective manner, and processing requests for data
30 quickly and efficiently at all locations within a network.

Address Databases. The United States includes more than 145 million deliverable addresses. A database containing information about all those street

addresses is an example of a very large database. Address databases are available from private sources or from government sources, such as the U.S. Postal Service (USPS).

5 The USPS offers a variety of address databases to the public, including a City-State file, a Five-Digit ZIP file, and a ZIP+4 file. The City-State file is a comprehensive list of ZIP codes with corresponding city and county names. The Five-Digit ZIP file, when used in conjunction with the City-State file, allows users to validate existing five-digit ZIP code assignments. The ZIP+4 file provides a comprehensive list of ZIP+4 codes.

10 The Delivery Sequence File (DSF) is a computerized database developed by the USPS which includes a complete, standardized address, stored in a discrete record, for every delivery point serviced by the USPS. Each separate record contains the street address, the ZIP+4 code, the carrier route code, the delivery sequence number (walk sequence number), a delivery type code, and a seasonal
15 delivery indicator. DSF includes sufficient data to accomplish address validation and standardization. DSF is offered to licensees who develop certified address hygiene software. The USPS recently developed a new Delivery Point Validation (DPV) database to replace DSF. The DPV database is available in its basic format or in its enhanced format, called DSF², which includes additional address
20 attributes.

Address Standardization. The need to standardize mailing addresses is a relatively modern development. A tremendous increase in the volume of mail, mostly business mail, caused a serious crisis for the postal service in the early 1960s. The computer was the single greatest force behind the dramatic increase in
25 mail volume. The computer allowed businesses to automate a variety of mailing functions, but the postal service was not prepared for the explosion in mail volume. In response to the crisis, the Zone Improvement Plan (ZIP) was instituted. By July 1963, a five-digit ZIP code had been assigned to every deliverable address in the United States. The ZIP code marked the beginning of the modern era of address
30 standardization.


Two decades later, the ZIP+4 code was introduced, adding a hyphen and four more digits to the ZIP code. Today, mail is often sorted using multi-line

optical character readers that scan the entire address, print an eleven-digit Delivery Point Bar Code (DPBC) on the envelope, and sort the mail into trays in the established walk sequence along each delivery route.

Address standardization transforms a given address into the best format for meeting governmental guidelines, such as those established by the USPS. Standardization affects all components of the delivery address, including the format, font, spacing, typeface, punctuation, and ZIP code or DPBC. For example, a non-standard address such as:

10 *John Doe*
 123 East Main Street, N.W.
 Oakland Center, Suite A-4
 Atlanta, Georgia 30030

may look quite different after standardization:

15 JOHN DOE
 123 E MAIN ST NW STE A4
 DECATUR GA 30030-1549
 

An address can be subdivided or parsed into its components, which are sometimes called artifacts. For example, the individual artifacts in the address above include a Resident or Consignee (John Doe), a Number (123), a Pre-directional (E), a Primary Name (Main), a Type (St), a Post-directional (NW), a Secondary Name (STE), a Secondary Number (A4), and a city, state and ZIP+4 code (Decatur GA 30030-1549). Dividing an address into its individual artifacts is useful in many contexts, including postal sorting and address validation.

25 Address Validation. Whereas standardization refers to the way an address is formatted, the process of address validation confirms whether a given address is valid and current. Address databases, from private or government sources, are often used to validate addresses. For example, the USPS databases discussed above may be used for comparison purposes to validate addresses.

30 In addition to governmental postal services, private businesses such as commercial parcel carriers often develop and maintain address databases for storing unique and valuable customer information. Private databases, developed independent of government postal service data, may represent the next generation

in addressing precision and data storage. In the future, a wider variety of governmental and private address databases will be available.

USPS address databases are regularly updated with new data. In addition to regular, periodic updates, the USPS has also developed a number of correction
5 databases including NCOA and LACS. The National Change of Address (NCOA) database contains address change records. The Locatable Address Conversion System (LACS) contains new addresses for regions that have undergone a conversion from rural route to city-type addresses.

Because of growth and changes in population, address databases generally
10 require frequent updating. As with any other large database, updating the data in very large address databases is often technically challenging and time-consuming. Thus, in the context of address databases, there is a need in the art for an improved database management system capable of maintaining and protecting large quantities of address data, distributing frequent updates to users or subscribers in a
15 cost-effective manner, and processing requests for address data quickly and efficiently.

SUMMARY

The following summary is not an extensive overview and is not intended to identify key or critical elements of the apparatuses, methods, systems, processes, and the like, or to delineate the scope of such elements. This Summary provides a conceptual introduction in a simplified form as a prelude to the more-detailed description that follows.

Certain illustrative example apparatuses, methods, systems, processes, and the like, are described herein in connection with the following description and the accompanying drawing figures. These examples represent but a few of the various ways in which the principles supporting the apparatuses, methods, systems, processes, and the like, may be employed and thus are intended to include equivalents. Other advantaged and novel features may become apparent from the detailed description which follows, when considered in conjunction with the drawing figures.

In view of the broad teachings of the present invention, a data structure, database management system, processing apparatus, and related methods are provided having an advantageous construction. The example apparatuses, methods, and systems described herein facilitate the prompt and efficient validation of input data presented in a subjective representation and produces output data having a preferred representation.

In one aspect of the present invention, a data structure may include a superset that includes a primary database operatively connected to one or more secondary databases, wherein each of the primary and one or more secondary databases comprises a first table operatively linked to one or more other tables, and each of the first and one or more other tables share a common data structure. The databases may be relational databases. The common data structure may include a sparse matrix linked list. The common data structure may also include data records arranged in hierarchical order, in a series of levels from general to specific, based upon the data.

In the data structure, the primary database may include source tables, a first secondary database may include alias tables, a second secondary database may include standardization tables, and a third secondary database may be configured to

accept and store input data. The source tables may include data records obtained from a public or private source, the alias tables may include one or more equivalent representations of a record, and the standardization tables may include one or more standardized representations of a record. In another aspect of the data structure, the
5 source tables may include address records obtained from a government postal service and a commercial source.

Within the data structure, the first table may include preferred records, a first other table may include primary alias records, and a second other table may include secondary alias records. The preferred records may include one or more
10 preferred representations, the primary alias records may include one or more equivalent representations of a primary artifact, and the secondary alias records may include one or more equivalent representations of a secondary artifact. In a related aspect, the preferred records may include one or more preferred representations of an address.

15 In another aspect of the present invention, a method is provided for preparing data for optimal searching, the data being stored in one or more databases comprising a plurality of linked tables of records. The method may include arranging the records in each of the tables in hierarchical order, in a series of levels from general to specific, based upon the data; and transforming each of
20 the tables into one or more sparse matrix linked list tables. When the databases exist in a server-client network environment, the method may also include distributing a duplicate of the one or more sparse matrix linked list tables from a server to one or more clients. The databases may be relational databases interconnected to form a data superset. In one aspect, the data may include address
25 artifacts.

In another aspect of the present invention, an apparatus is provided for preparing data for optimal searching, the being data stored in one or more databases comprising a plurality of linked tables of records. The apparatus may include a central processing unit, a memory, a basic input/output system, and
30 program storage containing a program module executable by the central processing unit. The program module may include means for arranging the records in each of the tables in hierarchical order, in a series of levels from general to specific, based

upon the data; and means for transforming each of the tables into one or more sparse matrix linked list tables. The apparatus may also include one or more clients remote from the central processing unit. The program module may also include means for distributing a duplicate of the one or more sparse matrix linked
5 list tables from a server to one or more clients.

In another aspect of the present invention, a method is provided for using a database of linked tables to convert a subjective representation into a preferred representation. The method may include capturing the subjective representation and storing it in a first one of the linked tables; storing source data in a second one
10 of the linked tables; locating one or more candidate representations from among the source data by comparing the subjective representation to the source data; selecting a preferred representation from among the one or more candidate representations, the preferred representation having the closest resemblance to the subjective representation; and releasing the preferred representation.

15 The method may also include reviewing the source data to identify one or more select records containing preferred data; and adding a preferred token to the one or more select records.

The step of selecting a preferred representation may include identifying a preferred token associated with one of the one or more candidate representations.

20 The step of locating one or more candidate representations may also include: (a) parsing the subjective representation into one or more discrete artifacts; (b) selecting one of the one or more discrete artifacts: (1) locating one or more candidate artifacts from among the source data by comparing the one discrete artifact to the source data; (2) selecting a preferred artifact from among the one or
25 more candidate artifacts, the preferred artifact having the closest resemblance to the one discrete artifact; (3) storing the preferred artifact; (c) repeating step (b) for each of the one or more discrete artifacts; and (d) combining the preferred artifacts to form a preferred representation.

The step of locating one or more candidate representations may also include
30 storing alias data in a third one of the linked tables; reviewing the alias data to identify one or more select alias records containing a preferred alias representation; adding a preferred alias token to the one or more select alias records; locating one

or more candidate aliases from among the alias data by comparing the subjective representation to the alias data; selecting a preferred alias from among the one or more candidate aliases, the preferred alias being most closely associated with the preferred alias token; releasing the preferred alias as a candidate representation.

5 The step of locating one or more candidate aliases may also include (a) parsing the subjective representation into one or more discrete artifacts; (b) selecting one of the one or more discrete artifacts: (1) locating one or more candidate alias artifacts from among the source data by comparing the one discrete artifact to the alias data; (2) selecting a preferred alias artifact from among the one
10 or more candidate alias artifacts, the preferred alias artifact being most closely associated with the preferred alias token; (3) storing the preferred alias artifact; (c) repeating step (b) for each of the one or more discrete artifacts; and (d) adding the preferred alias artifact to the preferred alias.

 In another aspect of the present invention, an apparatus is provided for
15 executing the method steps described immediately above. The apparatus may include a central processing unit; a memory; a basic input/output system; program storage containing a program module executable by the central processing unit, in which the program module may include means for executing each step in the method described above.

20 In another aspect of the present invention, a method is provided for controlling access to a database by one or more external applications. The method may include establishing and storing a plurality of rule sets, each correlated to one of the one or more external applications; receiving a request from a first application; retrieving a first rule set correlated to the first application; applying the
25 first rule set to control the interaction between the first application and the database. In the method, the first rule set may include a list of data available for capture from the database for use by the first application.

 In another aspect of the present invention, a method is provided for
30 controlling the depth of data capture within a database in response to a request from one or more external applications. The method may include establishing and storing a plurality of rule sets, each correlated to one of the one or more external applications, each of the plurality of rule sets including a list of data to capture

from the database; receiving a request from a first application; retrieving a first rule set correlated to the first application; and applying the first rule set to limit the data available to the first application from the database.

5 In another aspect of the present invention, a data structure is provided which may include a database linking a primary table and one or more secondary tables, each of the tables sharing a common data structure; the database controlled by a database management system configured to transform one or more of the primary and one or more secondary tables into a sparse matrix linked list. The database may include one or more interconnected relational databases. The
10 database management system may include an interface and a validation module. The interface may controls access to the database by one or more external applications. The database management system may be configured to convert data from a subjective representation into a preferred representation.

15 These and other objects are accomplished by the apparatuses, methods, and systems disclosed and will become apparent from the following detailed description of a preferred embodiment in conjunction with the accompanying drawings in which like numerals designate like elements.

BRIEF DESCRIPTION OF THE DRAWING

The invention may be more readily understood by reference to the following description, taken with the accompanying drawing figures, in which:

Figure 1 is a block diagram of an address superset according to one
5 embodiment of the present invention.

Figure 2 is a block diagram of a generic dataset according to one
embodiment of the present invention.

Figure 3 is an illustration of a system architecture according to one
embodiment of the present invention.

10 **Figure 4** is a block diagram of a stand-alone service mode according to one
embodiment of the present invention.

Figure 5 is a graphical illustration of a data table according to one
embodiment of the present invention.

15 **Figure 6** is a graphical illustration of values in a table, according to one
embodiment of the present invention.

Figure 7 is a block diagram of a link according to one embodiment of the
present invention.

Figure 8 is a block diagram of a linked list according to one embodiment of
the present invention.

20 **Figure 9** is a table of address data according to one embodiment of the
present invention.

Figure 10 is a graphical illustration of containment levels and nodes,
according to one embodiment of the present invention.

25 **Figure 11** is a table of address data with tokens, according to one
embodiment of the present invention.

Figure 12 is a flow chart of a matching module according to one
embodiment of the present invention.

Figure 13 is a table of alias data according to one embodiment of the
present invention.

30

DETAILED DESCRIPTION OF THE INVENTION

Reference is now made to the figures, in which like numerals indicate like elements throughout the several views.

5 1. INTRODUCTION

As used in this application, the term “computer component” refers to a computer-related entity, either hardware, firmware, software, a combination thereof, or software in execution. For example, a computer component can be, but is not limited to being, a process running on a processor, a processor itself, an
10 object, an executable, a thread of execution, a program, a server, and a computer. By way of illustration, both an application running on a server and the server itself can be referred to as a computer component. One or more computer components cans reside within a process and/or thread of execution and a computer component can be localized on a single computer and/or distributed between and among two or
15 more computers.

“Computer communications,” as used herein, refers to a communication between two or more computer components and can be, for example, a network transfer, a file transfer, an applet transfer, an e-mail, a Hyper-Text Transfer Protocol (HTTP) message, a datagram, an object transfer, a binary large object
20 (BLOB) transfer, and so on. A computer communication can occur across, for example, a wireless system (*e.g.*, IEEE 802.11), an Ethernet system (*e.g.*, IEEE 802.3), a token ring system (*e.g.*, IEEE 802.5), a local area network (LAN), a wide area network (WAN), a point-to-point system, a circuit switching system, a packet switching system, and so on.

25 “Logic,” as used herein, includes but is not limited to hardware, firmware, software and/or combinations of each to perform one or more functions or actions. For example, based upon a desired application or needs, logic may include a software controlled microprocessor, discrete logic such as an Application-Specific Integrated Circuit (ASIC), or other programmed logic device. Logic may also be
30 fully embodied as software.

“Signal,” as used herein, includes but is not limited to one or more electrical or optical signals, analog or digital, one or more computer instructions, a bit or bit stream, or the like.

“Software,” as used herein, includes but is not limited to, one or more
5 computer readable and/or executable instructions that cause a computer, computer component and/or other electronic device to perform functions, actions and/or behave in a desired manner. The instructions may be embodied in various forms like routines, algorithms, stored procedures, modules, methods, threads, and/or programs. Software may also be implemented in a variety of executable and/or
10 loadable forms including, but not limited to, a stand-alone program, a function call (local and/or remote), a servlet, an applet, instructions stored in a memory, part of an operating system or browser, and the like. It is to be appreciated that the computer readable and/or executable instructions can be located in one computer component and/or distributed between two or more communicating, co-operating,
15 and/or parallel-processing computer components and thus can be loaded and/or executed in serial, parallel, massively parallel and other manners. It will be appreciated by one of ordinary skill in the art that the form of software may be dependent on, for example, requirements of a desired application, the environment in which it runs, and/or the desires of a designer or programmer or the like.

20 An “operable connection” (or a connection by which entities are “operably connected”) is one in which signals, physical communication flow and/or logical communication flow may be sent and/or received. Usually, an operable connection includes a physical interface, an electrical interface, and/or a data interface, but it is to be noted that an operable connection may consist of differing combinations of
25 these or other types of connections sufficient to allow operable control.

“Database,” as used herein, refers to a physical and/or logical entity that can store data. A database, for example, may be one or more of the following: a data store, a relational database, a table, a file, a list, a queue, a heap, and so on. A database may reside in one logical and/or physical entity and/or may be distributed
30 between two or more logical and/or physical entities.

The terms “fuzzy” or “blurry” refer to a superset of Boolean logic dealing with the concept of partial truth; in other words, truth values between “completely

true” and “completely false.” Any specific theory or system may be generalized from a discrete or crisp form into a continuous or fuzzy form. A system based on fuzzy logic or fuzzy matching may use truth values that have various degrees similar to probabilities except the degrees of truth do not necessarily need to sum
5 to one. In terms of applying fuzzy matching to a string of alpha-numeric characters, the truth value may be expressed as the number of matching characters in the string, for example.

The systems, methods, and objects described herein may be stored, for example, on a computer readable media. Media may include, but are not limited
10 to, an ASIC, a CD, a DVD, a RAM, a ROM, a PROM, a disk, a carrier wave, a memory stick, and the like. Thus, an example computer readable medium can store computer executable instructions for a method for managing transportation assets. The method includes computing a route for a transportation asset based on analysis data retrieved from an experience based travel database. The method also includes
15 receiving real-time data from the transportation asset and updating the route for the transportation asset based on integrating the real-time data with the analysis data.

It will be appreciated that some or all of the processes and methods of the system involve electronic and/or software applications that may be dynamic and flexible processes so that they may be performed in other sequences different than
20 those described herein. It will also be appreciated by one of ordinary skill in the art that elements embodied as software may be implemented using various programming approaches such as machine language, procedural, object oriented, and/or artificial intelligence techniques.

The processing, analyses, and/or other functions described herein may also
25 be implemented by functionally equivalent circuits like a digital signal processor circuit, a software controlled microprocessor, or an application specific integrated circuit. Components implemented as software are not limited to any particular programming language. Rather, the description herein provides the information one skilled in the art may use to fabricate circuits or to generate computer software
30 to perform the processing of the system. It will be appreciated that some or all of the functions and/or behaviors of the present system and method may be implemented as logic as defined above.

Furthermore, to the extent that the term “includes” is employed in the detailed description or the claims, it is intended to be inclusive in a manner similar to the term “comprising” as that term is interpreted when employed as a transitional word in a claim. Further still, to the extent that the term “or” is employed in the claims (for example, A or B) it is intended to mean “A or B or both.” When the author intends to indicate “only A or B but not both,” the author will employ the phrase “A or B but not both.” Thus, use of the term “or” herein is the inclusive use, not the exclusive use. *See* Bryan A. Garner, *A Dictionary Of Modern Legal Usage* 624 (2d ed. 1995).

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2. EXEMPLARY EMBODIMENT

The system of the present invention is often described herein, by way of example, in the context of its usefulness as an address management system. Although the address-related example may be described in considerable detail, it is not the intention of the applicants to restrict or in any way limit the scope of the invention to such detail. Additional uses, applications, advantages, and modifications of the inventive system will be readily apparent to those skilled in the art. Therefore, the invention, in its broader aspects, is not limited to the specific details, the representative apparatus, and illustrative examples shown and described. Accordingly, departures may be made from such details without departing from the spirit or scope of the general inventive concept.

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Example apparatuses, methods, systems, processes, and the like, are now described with reference to the drawings, where like reference numerals are used to refer to like elements throughout. In the following description, for purposes of explanation, numerous specific details are set forth in order to facilitate a thorough understanding of the apparatuses, methods, systems, processes, and the like. It may be evident, however, that the apparatuses, methods, systems, processes, and the like, can be practiced without these specific details. In other instances, well-known structures and devices are shown in block diagram form in order to simplify the description.

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3. DATA STRUCTURE: THE SUPERSET

3.1. A Data Superset

In one embodiment, as illustrated in **Figure 2**, the system of the present invention may include a data superset **30**. The data superset **30** may include four or more discrete, relational databases **31-35** (including Databases One, Two, Three, Four, . . . *N*, as shown). The databases **31-35** may be connected to the others in a network of database links **36**. In one embodiment, one of the databases **31-35** may be designated as primary and the others as secondary. Together, the several relational databases **31-35** may be controlled by a database management system in order to create a single data superset **30** that is capable of storing large amounts of data and executing complex queries in an ordered way across all the relational database tables.

The relational databases **31-35** may contain a set of tables **40** (including Tables A, B, C, . . . *N*, as shown). The tables **40** may contain a set of data fields **44** (including Field1, Field2, Field3, . . . Field*n*, as shown). The tables **40** may be linked together using one or more keys **48** in a manner known in the art of relational databases.

In one embodiment, each database **31-35** may have a common data structure. In this aspect, each relational database **31-35** may include the same number of tables **40**, and each table may include the same number of fields **44**. The common data structure among the various tables **40** in the data superset **30** may provide a degree of flexibility that allows the storage and processing of any type of data.

The common data structure in one embodiment may include arranging the records in one or more tables **40** in hierarchical order, in a series of levels from general to specific, based upon the value of the stored data, as described in more detail below. The common data structure may also include storing the tables **40** as a sparse matrix linked list.

3.2. An Address Superset

One exemplary embodiment of the data superset is illustrated in **Figure 1**. An address superset **130** may include several discrete, relational databases,

including in one embodiment a postal database 131, a carrier database 132, a standard database 133, and a plan database 134. The databases 131-134 may be connected to the others in a network of database links 36, as shown, to form an address superset 130. The relational databases 131-134 may be controlled by an
5 address database management system.

The relational databases 131-134 may contain a set of data tables 140, including in one embodiment a Preferred Table 141, a Street Alias Table 142, and a Consignee Alias Table 143, as described in more detail below. The Preferred Tables 141 may also include one or more fields for storing a token to act as a
10 unique identifier for a particular record. The tables 141, 142, 143 may contain a set of data fields 44 (including Field1, Field2, Field3, . . . Field n , as shown). The tables 141, 142, 143 may be linked together using one or more keys 48 in a manner known in the art of relational databases.

In one embodiment, each database 131-134 may have a common data
15 structure. In this aspect, each relational database 131-134 may include the same number of tables 141-143, and each table may include the same number of fields 44. The common data structure among the various tables in the address data superset 130 may provide a degree of flexibility that allows the storage and processing of any type of data. The common data structure in one embodiment
20 may include arranging the records in one or more tables in hierarchical order, in a series of levels from general to specific, based upon the value of the stored address data, as described in more detail below. The common data structure may also include storing or re-formatting the tables as a sparse matrix linked list.

25 4. SYSTEM ARCHITECTURE

Figure 3 is a representational diagram of a system 10 according to one embodiment of the present invention. The system 10 may include an infrastructure server 25, one or more computer networks, an application server 200, and one or more clients 655 distributed in a multi-tiered server-client relationship. The one or
30 more computer networks facilitate communications between the infrastructure server 25, the application server 200, and the one or more clients 255. The one or more computer networks may include a variety of types of computer networks such

as the internet, a private intranet, a private extranet, a public switch telephone network (PSTN), a wide area network (WAN), a local area network (LAN), or any other type of network known in the art.

As shown in **Figure 3**, a primary AMS server **510** may reside on an infrastructure server **25**. A graphical user interface such as an AMS GUI **324** may communicate with the primary AMS server **510** as shown.

The next tier in the system **10** in one embodiment may include several AMS clients **655** and a secondary AMS server **520**. Some of the AMS clients **655** may include a data capture workstation **155** and a GUI **26** for one or more users **28**. In one embodiment, an application server **200** may reside on an AMS client **655**.

Descending from the secondary AMS server **520**, in one embodiment, the next tier may include several AMS clients **655**, each including a data capture workstation **155** and a GUI **26** for one or more users **28**.

The infrastructure server **25** in an exemplary embodiment, may include a central processor that communicates with other elements within the infrastructure server **25** over a system interface or bus. Also included in the infrastructure server **25** may be an input and display device for receiving and displaying data. The input and display device may be, for example, a keyboard or pointing device used in combination with a monitor. The infrastructure server **25** may further include a memory, which may include both read only memory (ROM) and random access memory (RAM). The ROM may be used to store a basic input/output system (BIOS), which contains the basic routines that help transfer information between and among elements of the infrastructure server **25**.

In addition, the infrastructure server **25** may include at least one storage device, such as a hard disk drive, a floppy disk drive, a CD-ROM drive, or an optical disk drive, for storing information on various computer-readable media, such as a hard disk, a removable magnetic disk, or a CD-ROM disk. Each of these types of storage devices may be connected to the system bus by an appropriate interface. The storage devices and their associated computer readable media may provide non-volatile storage. It is important to note that the computer readable media described above may be replaced by any other type of computer readable

media known in the art. Such media include, for example, magnetic cassettes, flash memory cards, digital video disks, and Bernoulli cartridges.

A number of program modules may be stored by the various storage devices within the RAM. Such program modules include an operating system and one or more applications. Also located within the infrastructure server **25** may be a network interface, for interfacing and communicating with other elements of a computer network. One or more components of the infrastructure server **25** may be geographically remote from other processing components. Also, one or more of the components may be combined. The infrastructure server **25** may include additional components for performing the functions described herein.

4.1. A Database Management System (DBMS)

According to one embodiment of the present invention, a database management system (DBMS), referring again to **Figure 3**, may reside on a primary AMS server **510** (the infrastructure server **25**), an Application Server **200**, or a secondary AMS server **520**. The DBMS may include an interface **600** and a suite of programs **500**, similar to the AMS **110** shown in **Figure 4**.

By way of example, a database management system (DBMS) of the present invention may be described in the context of its usefulness as an address management system (AMS) **110**. Like the DBMS, the AMS **110** may reside on a primary AMS server **510** (the infrastructure server **25**), an Application Server **200**, or a secondary AMS server **520**. In one embodiment, the AMS **110** may include an interface **600** and a suite of programs **500**, as shown in **Figure 4**.

Figure 4 is a block diagram of a system **10** according to one embodiment of the present invention that depicts an AMS **110** operating in Stand-Alone Service Mode **640**. The system **10** as shown includes a computer **15** that provides access to one or more users **28** through an AMS GUI **324**.

4.2. An Address Management System (AMS)

The address management system (AMS) **110** may be specifically designed to control the organization, storage, and retrieval of data in an address data superset **130**, and to control the security and integrity of the address superset **130** and its

component databases. The interface 600 may be configured to accept and process requests for data received from external applications (not shown). In one embodiment, the interface 600 may be a COM-based interface with the capacity to create, read, update, and delete records. The interface 600 may also include a query function for performing operations on the data stored in the address superset 130.

5. FINDING A PREFERRED REPRESENTATION

In one embodiment, the system 10 of the present invention may include a database management system (DBMS) for a data superset 30. The DBMS may also be useful as a database management system for any type of data, including address data. In the context of address data, the DBMS may be referred to as an address management system (AMS) 110. In any capacity, the management system 110 may include an interface 600 and a suite of programs 500.

In one embodiment, the suite of programs 500 may include one or more computer software programs for receiving raw data in a “subjective representation,” analyzing values stored in a database by using an interface 600 to execute one or more queries, and producing output data in a “preferred representation.”

The term “subjective representation” is used herein to indicate raw data entered or submitted by someone whose understanding of the data may be personal to that individual. Subjective representations tend to be ambiguous or incomplete, which may be problematic when the raw data is needed to perform computing steps. For example, a person may enter a date of birth using the subjective representation “12-4-63.” In the United States, this date may indicate “December 4th,” whereas in Europe it may signify “12th April.” A computer component may interpret the year as 1963 or 63. These ambiguities have a serious impact on the accuracy of the raw data. To remove the ambiguities and incompleteness, a suite of programs 500 may be designed to convert the subjective representation into a “preferred representation.” Such a suite of programs 500, for example, may include a system or query for determining whether the user is entering the date in U.S. format or in European format. A suite of programs 500 may also include a

rule or logic routine setting the 0s as the default century for all years entered, unless the user enters a four-digit year. Designing and building a suite of programs 500 requires forethought and planning about the types and formats of raw data to expect in a particular system.

5 A subjective representation may be processed by a suite of programs 500 into a preferred representation that is generally unrelated to the raw data. For example, a customer may order a printer cartridge using the subjective representation "Acme LX-709 Color" where Acme is the printer manufacturer, LX-709 is the model number of the printer, and color ink is desired. In a system for
10 processing printer cartridge orders, for example, the cartridges may be catalogued and stored using a ten-digit cartridge serial number. The serial number is not directly related to the text and digits in the raw data; however, the serial number is the "preferred representation" to be printed on a purchase order, so the seller can locate and ship the desired cartridge. To match the subjective raw data to the
15 correct serial number, a suite of programs 500 may be written to interpret any variety of potential indicators submitted by a customer. Suppose the first four digits of every cartridge serial number corresponds to a list of printer manufacturers who build machines capable of using that type of cartridge. A suite of programs 500 may include a stored procedure for comparing the printer
20 manufacturer name entered to the names in the list, and finding the corresponding first four digits of the cartridge serial number. This represents a first step toward finding the ten-digit serial number to print on the purchase order.

 Another example of a subjective representation is a common street address. On a mail piece, a person may write the subjective representation "Doe, 123 East
25 Main Street N.W., Suite A-4, Atl 30030." Several parts of the address are ambiguous or incomplete, including the addressee "Doe," the abbreviation "Atl," and the missing State name. If this data were destined for processing by a computer or sorting equipment, these ambiguities may result in the loss, delay, or incorrect delivery of the mail piece. To remove the ambiguities and
30 incompleteness, a suite of programs 500 may be designed to convert the subjective representation into a preferred representation. Such a suite of programs 500, for example, may include a program or a stored procedure for comparing the written

address to a commercially available computer database of street addresses and ZIP codes.

The examples described above refer to an attribute or parameter – a date, a part number, an address. A parameter may be characterized in a variety of formats, including the subjective representations shown above and other representations depending on the context of use. The system of the present invention, in one embodiment, uses tabulated data to manipulate and modify the way a parameter is characterized, as described in more detail below.

In one embodiment, the a database management system (DBMS) of the present invention, my include a suite of programs **500**, which may include one or more of the following general procedures: (1) an Enhancement module; (2) a Publish & Subscribe module; and (3) a Matching module. The suite of programs **500** may include additional components and procedures, of course, for performing the other functions described in this application.

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5.1. An Enhancement Module

In one embodiment, the suite of programs **500** of the present invention may include an Enhancement module suitable for use in optimizing the structure and order of the data stored in the relational databases **31-35** of a data superset **30**. Each database **31-35** in a data superset **30** may include millions of records. The tasks of reading, updating, and searching through all or most of the records in each database **31-35** may be improved and expedited, in one embodiment, by optimizing the structure of the data.

Database tables including a large number of records consume large amounts of memory and require lengthy computing times for performing sorting, searching and other analytical operations. A simple example of enhancing or optimizing data is to sort the records based upon one or more attributes (columns), to place the records in order, increasing or decreasing. For large tables with multiple attributes, however, a simple record sort does not yield significant time savings or searching efficiency.

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In one embodiment, one kind of Enhancement module in the suite of programs **500** includes a procedure for transforming a database into a sparse matrix

linked list. A linked list includes a link designed to direct a query from one field to the next, sometimes using the link to bypass or skip irrelevant fields. A sparse matrix includes no repeated field values in subsequent records. Instead of repeating a first value, the subsequent fields are left blank and subsequent values are presumed to be equal to the first value unless and until a different value appears.

For example, in **Figure 9**, the ZIP code field includes a repetitive entry (the ZIP code 20001) in each of the thirteen records. In one aspect, the system **10** of the present invention uses the concept of a sparse matrix to eliminate repetitive entries and thereby save memory and shorten computing times. In **Figure 9**, for example, the ZIP code for Node 1 may be populated by the five digit ZIP code 20001. In the system **10** of the present invention, where a table may be transformed into a sparse matrix, the subsequent ZIP code fields would be made empty or zeroed. In **Figure 9**, the ZIP code field for Node 2 through Node 13 would be empty or zero; and the value in those fields would be presumed to be 20001.

In a sparse matrix the value encountered in the sequence of records is presumed to remain the same until a different value appears. Because many repeated values may be eliminated in this way, the table or matrix is described as being sparse. Any attribute in a table may be made sparse by applying the rules for creating a sparse matrix.

A small portion of a model database table **40** is shown in **Figure 5**. Each row contains a single record **42**. Each field **44** may be located by referring to the row and column numbers. The field located in Row 3 of Column 2, for example, may be described as Field (3,2) or simply (3,2). This field-naming convention is of value in many database operations where pointing to a particular field is desired.

The table **40** of **Figure 6** is an example of a sparse matrix. Column 2, for example, begins with the value "Smith" in Row 1 and is followed in subsequent records (row) by a zero value. Accordingly, the value of Column 2 is understood to be "Smith" in subsequent rows 2, 3, and 4.

The row-and-column naming convention for fields is helpful when a table is organized as a linked list. In one type of linked list, a link **340** may include a field **44**, a value **46**, and one or more pointers, as shown in **Figure 7** and **Figure 8**.

In one type of link **340**, shown in **Figure 7**, a next-in-column pointer **344** is included, along with a next-in-row pointer **342**. The pointers **344**, **342** include instructions to the next field containing a non-zero value. Because they point to the next field (as opposed to the last field) these pointers **344**, **342** are referred to as forward pointers. Some types of linked lists also include backward pointers, with instructions directed toward the last or previous non-zero field value. In one aspect, the system **10** of the present invention may include only forward pointers.

Figure 8 is a representation of the links **340** between the sparse matrix values shown in **Figure 6**. The instructions in link **340** for Row 4, Column 1, for example, would quickly direct the analysis to the next non-zero value located in Row 4, Column 3. The instructions contained in link **340** allow an analytical process such as a search query to bypass or skip the empty fields in a sparse matrix. By skipping empty fields, the searching time is greatly reduced, producing faster results from the query.

In one embodiment, a suite of programs **500** including an Enhancement module may be used to transform any table in a data superset **30** into a sparse matrix linked list. A data superset **30** stored as a sparse matrix linked list may consume far less memory, and therefore may be more suitable for distribution as a duplicate superset **330** to subscriber clients **255**. When a data table has been transformed into a sparse matrix linked list (SMLL) table, the Enhancement module may finalize or otherwise “wrap” the SMLL table to prepare it for distribution and use by other system components and elsewhere.

As shown in **Figures 5-8**, a duplicate superset **330** may reside on the one or more clients **255** in the system **10**. The transmission or “publication” of a duplicate superset **330** throughout the system **10** may be accomplished using a Publish & Subscribe module, as discussed below.

The Enhancement module in one embodiment may also monitor the condition of tables as new data is added, maintain the tables in optimal condition by repeating the transformation procedure as necessary, and communicating with other system components regarding the condition of tables and their availability to be shared or distributed to subscriber clients **255**. In this aspect, the Enhancement portion of the suite of programs **500** may be configured to interact and

communicate with other system components to maintain data tables in optimal condition for fast and efficient searching.

5.2. A Publish & Subscribe Module

5 In one embodiment, the suite of programs **500** of the present invention may include a publication and subscription program or procedure to control and facilitate the transfer of data between components of the system **10** of the present invention. As illustrated in **Figure 3**, the system **10** may include an infrastructure server **25**, one or more computer networks **230**, an application server **200**, and one
10 or more clients **255** distributed in a server-client relationship.

In a server-client network environment, such as the ones illustrated in **Figure 5-9** for example, a duplicate superset **330** may reside on the one or more subscriber clients **255** in the system **10**. A Publish & Subscribe module may be configured to monitor and control the publication of a duplicate superset **330**
15 throughout the system **10** to clients **255** who are subscribers.

5.3. A Matching Module

In one embodiment, the suite of programs **500** of the present invention may include a Matching module **85** configured to receive raw data in a subjective
20 representation **80**, analyze the values stored in a data superset **30** using an interface **600** to execute one or more queries, and produce output data in a preferred representation **90**. The general steps in an exemplary Matching module **85** are shown as a flow chart in **Figure 12**.

The steps of finding and displaying data in its preferred representation **90**,
25 based on a subjective representation **80**, in one embodiment may involving the following general functions: capture **300**, parse **305**, standardize **310**, validate **320**, update **380**, combine **390**, and release **395**. One skilled in the art may understand these general steps need not necessarily occur in this order, and some steps may be repeated as necessary, according to one or more specific algorithms.

30 **5.3.1. Capture.** The step referred to as capture **300** in one embodiment may involve capturing or otherwise receiving the subjective representation **80** (input data).

5.3.2. Parse. The step referred to as parse **305** in one embodiment may involve parsing the subjective representation **80** into its component parts. The task of parsing generally involves dividing a sentence or character string into its component parts. In the context of a street address, for example, the address
5 written on an envelope represents a subjective representation **80** that may be divided into many different components or artifacts through the process of parsing. A parsing algorithm or program generally receives the input as a sequence or string of characters and then applies a set of rules to accomplish the division by category.

One example of a subjective representation **80** is a street address. For
10 example, a U.S. street address such as "123 East Main Street N.W., Suite A-4" may include a number of discrete artifacts, including a Number (123), a Pre-directional (East), a Primary Name (Main), a Type (Street), a Post-directional (NW), a Secondary Name (Suite), and a Secondary Number (A-4). A street address may also be parsed into components based upon political subdivisions such
15 as cities, counties and states, or it may be parsed to a finer level of detail or granularity, based upon the ZIP+4 code, for example.

By parsing a subjective representation **80** and storing its component parts in separate fields of a table, for example, the Matching module **85** of the present invention may allow users to access and summarize (or "abstract") the data in a
20 variety of ways, depending upon the need and the application. For example, a user may request a summary or abstract of address data based upon the five-digit ZIP code in a particular state. If address data has been parsed and the ZIP code is stored in a discrete field, the step of abstracting the data based upon ZIP code involves a relatively simple search and retrieval. Storage of the artifacts in separate
25 fields may allow the user to search and retrieve data using any level of abstraction. In this aspect, the invention provides a great deal of flexibility to various users with various needs.

5.3.3. Standardize. The step referred to as standardize **310** in one embodiment may generally involve re-formatting a subjective representation **80**
30 according to a set of standardization rules. Standardization in general may involve many characteristics of a subjective representation **80**, including the font, spacing,

format. In one embodiment, the standardize step 310 may be performed on each separate artifact after parsing, while in another the parse step 305 may take place first. As with the other general steps in the Matching module 85, the standardize 310 and parse 305 steps may take place in any order, and may be repeated.

5 **5.3.4. Validation Module.** The step referred to as validate 320 in one embodiment may involve a complex series of steps undertaken to validate a subjective representation 80, as described in more detail below. Validation 320 generally involves checking the accuracy and recency of a subjective representation 80. Validation 320 may also include comparing a subjective representation 80 to
10 the values stored in tables in the superset 30 and thereby searching for a preferred representation 90.

5.3.5. Update. The step referred to as update 380 in one embodiment may involve adding newly acquired data to one of the relational databases in the superset 30. In this aspect, the superset 30 by and through the operation of the
15 suite of programs 500 may be updated continually based upon new data. The update step 380 may occur at any time during the procedures executed by the Matching module 85.

 In one embodiment, the update step 380 may add new data to one of the tables in the superset. The data may be placed in records located near the end of a
20 table. In one aspect of the invention, the table may or may not be recompiled before the tasks of the enhancement module are next executed. The tables as designed do not require frequent compiling.

5.3.6. Combine. The step referred to as combine 390 in one embodiment may involve the reversal of the parse step 305, in that the separate artifacts of a
25 subjective representation 80 are re-assembled. In one embodiment, the combine step 390 is executed after the validate step 320 has produced the artifacts of a preferred representation 90.

5.3.7. Release and Display. The step referred to as release 395 in one embodiment may involve the transmission or sending of the preferred
30 representation 90 (or a preferred token) to one or more components of the system 10 of the present invention. In this aspect, the release step 395 may be described as returning or publishing the results of the search query. The release step 395 may

also include or be followed by a display step, in which the preferred representation **90** may be displayed on a monitor or other type of user display. The release step **395** may further include or be followed by a printing step, in which the preferred representation **90** may be printed onto a label, in a list, as part of a report, or
5 otherwise sent in readable text format as directed by the system.

5.4. Validation Module

The validation step **320** in one embodiment may generally include comparing a subjective representation **80** to the values stored in tables in the
10 superset **30** and thereby searching for a preferred representation **90**. In the context of an address management system **110**, address validation **320** generally involves comparing the subjective representation **80** of an input address to the values stored in address databases **131**, **132**, **133** in an address superset **130** (as shown in **Figure 1**), and identifying the preferred representation **90** for the address.

15 As illustrated in **Figure 1**, the address superset **130** may include in one embodiment a postal database **131**, a carrier database **132**, a standard database **133**, and a plan database **134**. Each relational database **131-134** may include in one embodiment a preferred table **141**, a street alias table **142**, and a consignee alias table **143**. The preferred tables **141** may also include one or more fields for storing
20 a token to act as a unique identifier for a particular record.

Postal Database 131 in one embodiment may include address data from a postal service, such as the U.S. Postal Service (USPS). The United States includes more than 145 million deliverable addresses. The USPS offers a variety of address databases to the public which are updated regularly, including the Delivery
25 Sequence File (DSF). DSF is a computerized database developed by the USPS which includes a complete, standardized address, stored in a discrete record, for every delivery point serviced by the USPS. Each separate record contains the street address, the ZIP+4 code, the carrier route code, the delivery sequence number (walk sequence number), a delivery type code, and a seasonal delivery indicator.
30 The USPS recently developed a new Delivery Point Validation (DPV) database to replace DSF. The DPV database is available in its basic format or in its enhanced format called DSF² (which includes additional address attributes). Many foreign

countries and regions offer similar databases of postal address records, including addresses standardized according to the particular needs and rules of the country. The postal database 131 of the present invention may be configured to receive and store any of a variety of databases containing postal addresses.

5 Within the postal database 131, the preferred table 141.1 may be configured to accept and store the preferred representation for the delivery points served by a postal authority. The preferred representation may be stored as a whole, or as separate artifacts, or both. The postal preferred table 141.1 may be one of the primary sources of preferred representations 90 of addresses.

10 A postal authority may also provide street alias data that may be accepted and stored in street alias table 142.1. An alias, as the name implies, refers to the situation where several different identifiers refer to the same object. A common example of a street alias occurs when a road has multiple names: a local street name, a state route number, and a federal highway number. For example, U.S.
15 Highway 1 may be referred to as State Route 16 in a particular state, and also as Maple Street when it passes through a particular town. In the region where all three names apply, the street names Maple Street, State Route 16, and U.S. Highway 1 are street aliases. In addition, a list of street aliases may also include S.R. 16, Route 16, U.S. 1, Route 1, or Maple Drive, for example, if those names
20 are in use. The USPS databases often include street alias data. The street alias table 142.1 may be configured to accept and store the street alias data provided by a postal authority.

Other features and artifacts are also subject to aliasing. For example, a formal company name may include terms that are not typically included by the
25 public. For example, the Acme Shoe Corporation may be referred to in everyday parlance as Acme Shoes or simply Acme. The problem created by different names or aliases for a value to be stored in a database arises when a user of the database wants to retrieve that value specifically. A search for Acme Shoe Corporation, for example, may not find records that simply say Acme Shoes.

30 The consignee alias table 143.1 may be configured to accept and store the consignee alias data provided by a postal authority, when it is available. A postal authority may or may not provide consignee alias data. In some jurisdictions, like

the United States, the postal service may not distribute data revealing the identity of residents (consignees) in connection with a street address. The data fields shown for the consignee alias table **143.1** (Field1, Field2, Field3, . . . Field n) are preceded by a hyphen instead of a + sign, to indicate these fields may be blank.

5 The tables **141.1**, **142.1**, **143.1** of the postal database **131** may be linked or otherwise interconnected using one or more key fields, in a manner known in the art of relational databases.

Carrier Database 132 in one embodiment may include address data from a private source, such as a commercial freight carrier, parcel service, or private
10 database provider. Some delivery companies and other service providers develop and maintain address databases, some of which may be made available. The carrier database **132** of the present invention may be configured to receive and store any of a variety of private databases containing address information.

 Within the carrier database **132**, the preferred table **141.2** may be
15 configured to accept and store the preferred representation for the delivery points contained in a private-source database. The preferred representation may be stored as a whole, as separate artifacts, or both.

 A private source may also provide street alias data that may be accepted and stored in street alias table **142.2**. Some delivery companies and other service
20 providers develop and maintain lists of street aliases for the territories they serve. The street alias table **142.2** may be configured to accept and store the street alias data provided by any private source.

 The consignee alias table **143.2** may be configured to accept and store the consignee alias data provided by a private source. In addition to street aliases,
25 many delivery companies and other service providers develop and maintain lists of users or customers (consignees) that may include aliases. The consignee alias table **143.2** may be configured to accept and store the consignee alias data provided by any private source.

 The tables **141.2**, **142.2**, **143.2** of the carrier database **132** may be linked or
30 otherwise interconnected using one or more key fields, in a manner known in the art of relational databases. Similarly, the carrier database **132** may be linked or otherwise interconnected with the postal database **131**.

Standard Database 133 in one embodiment may include alias data, generally. During the upload and installation of the postal database 131 and the carrier database 132, the system 10 of the present invention may include a tool to harvest street alias and consignee alias information and store it in the standard database 133. The standard street alias table 142.3 may be configured to accept and store street alias data. The standard consignee alias table 143.3 may be configured to accept and store consignee alias data. In this aspect, the standard database 133 in one embodiment may act as a repository for alias data.

Because the standard database 133 is generally for alias data, it may or may not include any preferred data in table 141.3. The data fields for the standard preferred table 141.3 (Field1, Field2, Field3, . . . Field n) are preceded by a hyphen instead of a + sign, to indicate these fields may be blank.

The tables 141.3, 142.3, 143.3 of the standard database 133 may be linked or otherwise interconnected using one or more key fields, in a manner known in the art of relational databases. Similarly, the standard database 133 may be linked or otherwise interconnected with the carrier database 132 and the postal database 131.

Data stored in the standard database 133 may be used in a process known as blurry or fuzzy matching. Literal matching requires an exact match, such as Acme and Acme. Fuzzy matching reveals partial matches, such as Acme, ACM, Acmed, and Ch2Acme. Alias data may be generally useful in a system where fuzzy matching is allowed or desired, because aliases by their very nature contain subtle differences yet represent the same object. The consignee aliases discussed above, for example, (Acme Shoe Corporation, Acme Shoes, Acme) also represent fuzzy matches of one another.

Fuzzy matching may be useful in the context of address standardization because the subjective representation 80 of an address may include one or more ambiguous or incorrect address artifacts. For example, the subjective representation 80 "Doe, 123 East Main Street N.W., Suite A-4, Atl 30030" is incomplete and includes several ambiguities. The addressee "Doe" may be matched with a preferred consignee "John W. Doe" through the process of fuzzy matching, using data stored in the consignee alias table 143.3 of the standard database 131. This example may illustrate how the databases 131-134 of the

address superset 130 work together, because the standard database 131 may not include any preferred data in table 141.3. Accordingly, to complete the address validation 320, the address management system 110 may be configured to access related data in tables stored in other databases 131, 132, 134 in order to find a preferred representation 90 for the address. Because the tables 141, 142, 143 are linked, the search for a match may use the ZIP code "30030" alone or together with the street primary "Main" in order to find records similar to the subjective representation 80. In this aspect, the address management system 110 of the present invention in one embodiment may be configured to include programs or structured query language for finding a match among any of the data stored in the address superset 130.

Another tool that may be useful in the context of address standardization and validation is known as Soundex. Soundex provides a method of finding words that sound alike. Soundex began as a filing system and it uses a simple phonetic algorithm to reduce proper names and other words into a four-character alphanumeric code. In one type of Soundex algorithm, the first letter of the code may correspond to the first letter of a word or proper name, and the remainder of the code may consist of three digits derived from the sound of the remaining syllables. In this way, the phonetic sound of a word or name is quantified. The Soundex function is useful because computers are generally better at comparing numbers than comparing letters. In one embodiment, the validation step 320 of the present invention may include a Soundex algorithm.

Plan Database 134 in one embodiment may include the input data, including one or more subjective representations 80. In this aspect, the process of adding the subjective representation data into the plan tables 141.4, 142.4, 143.4 may involve the steps of capturing, parsing, and standardizing described herein, so that the input data may be properly divided and standardized in preparation for validation.

In one embodiment, the input data may be stored primarily in plan preferred table 141.4. Because the plan database 134 is generally for input data, it may or may not include any data in the street alias and consignee alias tables 142.4, 143.4.

The data fields for these tables are preceded by a hyphen instead of a + sign, to indicate these fields may be blank.

5.4.1. Arranging Data by Hierarchy. In one aspect, the address management system **110** of the present invention takes advantage of the hierarchical nature of address data in order to quickly and efficiently locate records similar to the subjective representation **80**. In this aspect, the address management system **110** may include a method of preparing or arranging the stored data according to its inherent hierarchy. The data may be arranged in a series of levels, described below, from general to specific or in any order particularly suitable for the application. In use, the address management system **110** may be configured to include programs or stored query procedures capable of finding a match among any of the data stored in the address superset **130**.

In general, a query may be used to extract the desired data from a database, without changing or altering the data itself. Because queries generally find and display the desired data to a user, the result of a query is sometimes referred to as a view. Also, a query may be used to create a result (a view) without displaying it to the user. In this aspect, a query may be used to arrange data (usually temporarily) into a new structure that is different from the table structure. A query may be used to create a new data structure that has particular advantages, such as improved logic in the arrangement, faster sorting and searching, or moving a particular data field to a more primary position, for example. The validation step **320** of the present invention in one embodiment may include one or more queries to arrange data in the superset. One such arrangement involves a process called tokenization.

5.4.2. Tokenization. An example of a postal preferred table **141.1** is depicted in **Figure 9**. Each row represents a single record and includes multiple fields. Each separate field is stored in a separate column containing like attributes. The attributes of the table are shown across the top as the column names. Preferred Table **141.1** as shown in **Figure 9**, may be described as having the schema (ZIP, Token, Street, Type, Lo, Hi, Odd/Even, Consignee, Sec, Lo, Hi, +4).

The Token column as shown includes a postal token **71** as a unique identifier for each unique address. Notice, the two records containing the address "440 First Street, Suite 600" have been assigned postal token T6. The other street

address records in other rows of the table represent different addresses, and therefore have different tokens.

Address data by its very nature is hierarchical. The various artifacts of an address vary from the general to the specific. For example, the five-digit ZIP code by itself provides a general idea of an address location, whereas a complete address is normally understood as including the resident or consignee and all street data as well as a ZIP code or ZIP+4, provides a very specific address location.

In one embodiment, the validation step 320 of the present invention may include a query or algorithm for placing the City-State-ZIP combination at the top of an address data hierarchy. City-State combinations, of course, may include multiple ZIP codes. At the next level of specificity are the street artifacts, including a pre-directional, street name, street type, and post-directional. Such a street address may look like 100 East Main Street, SW. The street artifacts may be further subdivided by using one or more street address ranges which may be purely numeric as in the range 240-298 or may be alphanumeric depending upon the range field. Beyond the regular street artifacts are the secondary artifacts including a secondary and number, such as Suite 100 or Apartment1C. The additional four digits in a ZIP+4 code may provide yet another level of specificity. Some databases may also include an additional two-digit delivery sequence number.

The validation step 320 of the present invention, in one embodiment, may include a method of ordering the records in a table of a superset into a hierarchical structure, from general to specific. The resulting relationships and grouping of records may be defined within the validation step 320 in terms of the concepts known as containment and inclusion. A node number has been assigned to each record of the table 141.1, as shown in Figure 9. The node numbers may help demonstrate the concepts of containment and inclusion among the address records.

5.4.3. Containment Levels. After the validation step 320 has re-ordered the records of table 141.1, the new hierarchical arrangement of the records may be illustrated as shown in Figure 10. The Node numbers in Figure 10 are distributed according to the level of specificity displayed in the data. For example, Level 1 in Figure 10 includes Node 1, which represents the record including the address range "440 - 498 First Street." Of all the records shown in Figure 9, the record

located at Node 1 is the most general and thus is placed in Level 1. The next level of specificity, Level 2, includes Node 2. The record at Node 2 includes a single street address (440 First Street) but no secondary artifacts (no suite number).

Level 3 in **Figure 10** includes those addresses with suite numbers or ranges, but no consignee name. These records include Nodes 3, 11, 4, 12, 5, and 13. The nodes in Level 3 are arranged from left to right in order of the increasing suite number. In this aspect, the system 10 may be configured to order the address data from left to right in addition to placing them in different levels of specificity.

Level 4 includes those records having a name in the consignee field.

The concepts of containment and inclusion are demonstrated by the connections between the various nodes in **Figure 10**. Node 10 is connected to Node 3 because "Suite 310" is a subset of the range "Suite 100 - 400." Similarly, Nodes 6, 7, and 8 are connected to Node 5 because their suite numbers "500 and 600" are a subset of the range in Node 5 (Suite 500 – 600). Finally, Node 9 is a subset of Node 13 because the address is the same, but Node 9 includes a consignee name.

The nodes as shown in **Figure 10** illustrate the containment and inclusion concepts that may be enforced in one embodiment of the validation step 320 of the present invention. Node 1 on Level 1 "contains" all the nodes below it, because all the other address records fall within the range stated for Node 1. Conversely, all the nodes below Level 1 are "included" within (or contained by) Node 1. Similarly, Node 2 on Level 2 contains all the nodes below it, and Node 3 contains Node 10. Node 5 contains Nodes 8, 6, and 7 because they are subsets of the range stated in Node 4. Node 13 contains Node 9.

In one embodiment, the validation step 320 of the present invention may assign a token to each unique record. The tokens also demonstrate the concepts of containment and inclusion. **Figure 11** is a tabular representation of the hierarchy table illustrated in **Figure 10**. The table in **Figure 11** shows all the nodes and tokens at each level, beginning with Level 1. The token T1 can be described as containing all the other tokens in the hierarchy table. Notice, however, the token numbers may be different from the node numbers. Token T3 contains token T9.

Token T5 contains tokens T6 and T7. Notice that token T6 is used for both Nodes 6 and 7 because the addresses are equivalent.

The concepts of inclusion and containment can be readily seen in **Figure 11**. For example, comparing the data at Node 3 and Node 10, the reader will notice that “Suite 310” in Node 10 lies between the range of suite numbers (100 – 400) stored in Node 3. This relationship demonstrates the inclusion and containment concepts that are also illustrated in **Figure 10**.

In one embodiment, there is no limit on the number of containment levels that may be applied during the validation step **320** of the present invention. An address records may contain a large number of artifacts. A table may include a large number of records. Considering the vast number of records that may be included in a table, the hierarchical organization of records may be used to greatly increase the speed of accessing and analyzing the data. The containment levels and token numbers described for the thirteen nodes illustrated in **Figures 14, 15, and 16** may be applied to millions of address records and ranges, in any one of the tables of an address superset **130**. In the same way that preferred table **141.1** in **Figure 9** may be ordered according to hierarchy, the other tables **141, 142, 143** in the address superset **130** may also be organized using nodes and containment levels.

In addition to the re-arrangement of data using containment levels, each table may be transformed into a sparse matrix linked list, as described herein, to further increase the speed of processing.

5.4.3. Preferred Tokens. Referring again to the table **141.1** in **Figure 9**, Nodes 6 and 7 were both given the identical token T6 because they represent the same physical location. Notice, the consignee names in Nodes 6 and 7 are “APC” and “AM POLLING CMTE,” respectively. These alternative names for the addressee are consignee aliases. In other words, APC is an alias for AM POLLING CMTE. As discussed herein, such a consignee alias may be stored in one or more consignee alias tables **143** in address superset **130**.

Similarly, street alias data may be stored in one or more street alias tables **142** of the address superset **130**. The fields in a street alias table **142**, for example, may be arranged as shown in **Figure 13**. The example street alias table **142** in **Figure 13** includes the several street aliases for Sixth Avenue in New York City,

which is also known as Avenue of the Americas. A street alias table **142** may include such a list in a format that is readily accessible when comparing street address records.

In one aspect of the present invention, the address database management system **10** may be instructed to mark one of the alias representations as the “preferred representation.” Applying the various street aliases and consignee aliases to the data stored in the address data superset **130**, one of the tokens T4081 (for example) may be marked as the preferred representation. As such the preferred token **70** may include a marker such as a “p” for preferred, such that the preferred token **70** may look like T4081p. The system **10** of the present invention may recognize that all address records with the token T4081 are equivalent. In one embodiment, identifying a preferred token **70** and marking it (T4081p, for example) may be helpful to ensure the preferred artifacts (marked T4081p) of a particular street address are always returned in response to a query.

In this aspect of the invention, a validation step **320** in one embodiment may be configured to arrange stored data into new hierarchical data structures using queries. One or more tokens may be marked or otherwise identified as a preferred token **70** in one embodiment in order to identify the preferred representation of an address or a particular artifact.

In a related aspect, the management system of the present invention may be configured to pass tokens (instead of text) among various components of the system **10** of the present invention. Exchanging tokens may be more efficient and less prone to errors than exchanging long strings of address text. In this aspect, the use of tokens as unique identifiers further speeds the processing of queries, reporting, and other types of analysis on data stored in a superset.

In one embodiment, the validation step **320** may be executed as part of a suite of programs **500** of the address management system **110** (see **Figure 7**, for example). The validation step **320** may be performed on a duplicate superset **330** and results released to the AMS client **655**. In an address management system **110** applying one or more of the techniques described herein, the elapsed time from the capture step **300** to the release step **395** may be in the range of one hundred to two hundred milliseconds.

5.4.5. Comparing. The validation step 320 in one embodiment generally includes comparing a subjective representation 80 to the values stored in tables in the superset 30 and thereby searching for a preferred representation 90. In the context of an address management system 110, address validation 320 generally involves comparing the subjective representation 80 of an input address to the values stored in address databases 131, 132, 133 in an address superset 130 (as shown in **Figure 1**), and identifying the preferred representation 90 for the address.

In the block diagram shown in **Figure 12**, the validation step 320 occupies a single block. As described herein, however, the validation step 320 may involve a large number of steps and procedures for validating an address. The preceding sections have outlined a number of data manipulation routines and searching methods, while the process of comparing the input data to the stored data is described generally. More specifically, the comparing process of the validation step 320 in one embodiment may include the numbered steps listed below.

- 15 (1) Store the input data (subjective representations 80) in the plan database 134, in preferred table 141.4 (refer to **Figure 1**).
- (2) Compare the input data stored in preferred table 141.4 to the data values stored in the other preferred tables 141.1, 141.2, and 141.3 (if any). Recall, in one embodiment, each table in the superset may have been transformed into a sparse matrix linked list, re-arranged using nodes and hierarchical containment levels, and/or tokenized as described above, to facilitate fast and efficient searching in each table. The process of comparing may including locating one or more candidate representations from among the data values stored in the other preferred tables 141.1, 141.2, 141.3. Finding a match may include, in general, selecting the candidate representation having the closest resemblance to the selective representation 80 being searched.
- 25 (a) If a match is found between the input data and the preferred table data, then locate the corresponding preferred token 70 and proceed to execute the update 380, combine 390, and release 395 steps shown in **Figure 12**.
- 30

- (b) If no match is found, proceed to step (3) below.
- (3) Compare the street name input data stored in preferred table 141.4 to the street alias data values stored in the street alias tables 142.1, 142.2, and 142.3. The process of comparing may including locating one or more candidate street aliases from among the data values stored in the street alias tables 141.2, 142.2, 142.3. Finding a match may include, in general, selecting the candidate street alias most closely associated with a preferred token.
- (a) If a match is found between the street name input data and the street alias table data, then locate the preferred token 70 identifying the preferred street alias, substitute the corresponding street alias for the street name in the preferred table 141.4, and using the street alias repeat step (1) above.
- (b) If no match is found, proceed to step (4) below.
- (4) Compare the consignee name input data stored in preferred table 141.4 to the consignee alias data values stored in the consignee alias tables 143.1 (if any), 143.2, and 143.3. The process of comparing may including locating one or more candidate consignee aliases from among the data values stored in the consignee alias tables 143.1, 143.2, 143.3. Finding a match may include, in general, selecting the candidate consignee alias most closely associated with a preferred token.
- (a) If a match is found between the consignee name input data and the consignee alias table data, then locate the preferred token 70 identifying the preferred consignee alias, substitute the corresponding consignee alias for the consignee name in the preferred table 141.4, and using the consignee alias repeat step (1) above.
- (b) If no match is found, proceed to step (5).
- (5) Return an exception code 400 to the user 28 or application.
- (6) In one embodiment, the validation step 320 may include the step of displaying a list of possible matches (addresses, street aliases,

consignee aliases) and permitting the user **28** to execute a visual comparison and manually select (if appropriate) one of the possible matches as the preferred representation.

- 5
- (a) If a manual selection is made, the comparing process would proceed to execute the update **380**, combine **390**, and release **395** steps shown in **Figure 12**.
 - (b) If no manual selection is made, the input data and the exception code **400** may be transferred out of the validation system for further processing.

10

The method described in Step (2) above, for finding a preferred address representation, may include the additional steps of

- (a) parsing the subjective representation into one or more discrete artifacts;
- 15 (b) selecting one of the one or more discrete artifacts:
 - (1) locating one or more candidate artifacts from among the source data by comparing the one discrete artifact to the source data;
 - (2) selecting a preferred artifact from among the one or more candidate artifacts, the preferred artifact having the closest resemblance to the one
 - 20 discrete artifact;
 - (3) storing the preferred artifact;
- (c) repeating step (b) for each of the one or more discrete artifacts;
- (d) combining the preferred artifacts to form a preferred representation.

25 Similarly, the method described in Steps (3) and (4) above, for finding a preferred alias representation, may include the additional steps of

- (a) parsing the subjective representation into one or more discrete artifacts;
- (b) selecting one of the one or more discrete artifacts:
 - 30 (1) locating one or more candidate alias artifacts from among the source data by comparing the one discrete artifact to the alias data;

- (2) selecting a preferred alias artifact from among the one or more candidate alias artifacts, the preferred alias artifact being most closely associated with the preferred alias token;
- (3) storing the preferred alias artifact;
- 5 (c) repeating step (b) for each of the one or more discrete artifacts;
- (d) adding the preferred alias artifact to the preferred alias.

The term “match” as used in the comparing steps described above, in one embodiment, may involve an analysis of one or more artifacts of an address in
10 order to determine whether the similarities between the data are sufficiently valid to constitute a “match.” For example, the following guidelines may apply:

1. A literal match is required on the primary address, which includes the street number and the street name.
2. A literal match is only required on the secondary (such as a suite
15 number) when the secondary exists in the Carrier Database **132** and it is associated with the primary address.
3. A literal match is only required on the consignee name when the consignee exists in the Plan Database **134** (the input data).

It should be understood that other matching guidelines may be established,
20 depending upon the application and processing goals.

5.5. Interface

In one embodiment, the database management system, 110 of the present invention may include an interface 600 and a suite of programs 500, as shown in **Figures 3 and 5-9**. An interface 600 in one embodiment may be a computer
5 program designed to provide an operative connection or interface between an application (such as a suite of programs 500) and a user (or another application). An interface 600 may provide a series of commands that allow a user to create, read, update, and delete the data values stored in the database tables. These functions (create, read, update, delete) are sometimes referred using the acronym
10 CRUD, so an interface providing those commands may be called a CRUD interface. A database interface that includes a query function may be called a CRUDQ interface.

In one embodiment, the interface 600 may be configured as a COM-based interface; meaning that it is based upon the Component Object Model. Component
15 Object Model is an open software architecture that may facilitate interoperability between an interface 600 and various other components of the system 10 of the present invention. Although a COM-based interface 600 may be provided, other software models may be used to accomplish a desired functionality.

A query function may be included in an interface 600 according to one
20 embodiment of the present invention. A query is a command or instruction used to extract a desired set of data from a database. The best known query language is Structured Query Language (SQL, pronounced "sequel"), although other query languages may be used. A query may include a single command or a complex series of commands. SQL includes a wide variety of query commands. Sets of
25 query commands that may be used again can be saved in SQL as a stored procedure. Like running a program, calling a stored procedure in SQL is more efficient than sending individual query commands one at a time. Also, stored procedures are generally compiled ahead of time and may also be cached by the database management system. In this aspect, query commands may be used as a
30 powerful programming tool.

5.5.1. Application Identifier. The interface 600 in one embodiment may be configured to operate and interact with a variety of different programs and

application, both internal and external to the database management system, **110** in use. The interface **600** may be configured to operate with each component of the internal suite of programs **500**. The interface **600** may also be configured to operate with one or more external programs or applications, outside the database management system, such as related database applications, auxiliary reporting applications, stand-alone business applications, or any of a variety of other programs that may have a desire or a business need to interact with the data stored in the superset **30**, **130**.

In one embodiment, the interface **600** of the present invention may include one or more application identifiers, each having a corresponding rule set. The application identifier may be used to identify the application seeking access to the database management system of the present invention. The application identifier may be a single command or a complex algorithm. In general, the application identifier operates to identify an application seeking to interact with the database.

Each application identifier may include a corresponding rule set that may be used to govern the interaction between a specific application **270** and the database management system. Such interactions may include query requests, subscription updates, data transfer or other communications, output format instructions, or any other conduct. The application identifiers and rule sets may be stored in a database or otherwise saved in an accessible format.

In the context of an address management system **110**, for example, a specific application **270** may seek access to the address superset **130** by sending a query. In response, an interface **600** may be configured to identify the application **270**, retrieve the appropriate application identifier, and in turn retrieve the corresponding rule set. The interface **600** may then pass the rule set to the address management system **110** for use in processing the query or other interaction with the application **270**. The address management system **110** may process queries or take other actions related to the application **270** which produce output data. The output data may be returned to the interface **600**, where the rule set may be used to confirm the output data is in a format accessible by the application **270**. In this aspect, the address management system **110** and its interface **600** may cooperate in processing requests from applications **270** by using the rule set.

In this aspect, the interface 600 of the present invention is generic; meaning the interface 600 may be configured to operate and interact with any application 270. By maintaining a rule set separate from the interface itself, the programming in the interface 600 need not include rules for all the various applications 270.

5 Instead, by using an application identifier, the interface 600 may include only relatively simple commands for finding and retrieving the corresponding rule set.

When the management system 110 requires interaction with a new application 270, there may be no need to modify the interface 600. The only action required may be to add an application identifier and a corresponding rule set for the
10 new application 270. The interface 600 may provide a system for entering such new information.

5.5.2. Depth of Data Capture. The rule set for a particular application 270 in one embodiment may be configured to control which particular artifacts to capture from a data superset 30. In use, for example, a first application may
15 require only ZIP code data, while a second application may require ZIP+4, City, and State. The rule set of the present invention may include stored information about the data requirements for the particular application 270 in use. By controlling the extent or depth of the data capture, the rule set may increase the efficiency and speed at which the interface 600 accesses data within the system 10.

20

6. CONCLUSION

The described embodiments of the invention are intended to be merely exemplary. Numerous variations and modifications will be apparent to those skilled in the art. All such variations and modifications are intended to fall within
25 the scope of the present invention as defined in the appended claims.

What has been described above includes several examples. It is, of course, not possible to describe every conceivable combination of components or methodologies for purposes of describing the systems, methods, computer readable media and so on employed in database management systems. However, one of
30 ordinary skill in the art may recognize that further combinations and permutations are possible. Accordingly, this application is intended to embrace alterations, modifications, and variations that fall within the scope of the appended claims.

Furthermore, the preceding description is not meant to limit the scope of the invention. Rather, the scope of the invention is to be determined only by the appended claims and their equivalents.

5 While the systems, methods, and apparatuses herein have been illustrated by describing examples, and while the examples have been described in considerable detail, it is not the intention of the applicants to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will be readily apparent to those skilled in the art. Therefore, the invention, in its broader aspects, is not limited to the specific details, the
10 representative systems and methods, or illustrative examples shown and described. Accordingly, departures may be made from such details without departing from the spirit or scope of the applicant's general inventive concepts.

15

CLAIMS

What is claimed is:

- 5 1. A data structure comprising:
 a superset comprising a primary database operatively connected to
one or more secondary databases, wherein
 each of said primary and one or more secondary databases
comprises a first table operatively linked to one or more other tables, and
10 each of said first and one or more other tables share a common data
structure.
2. The data structure of claim 1, wherein each of said primary and one
or more secondary databases are relational databases.
- 15 3. The data structure of claim 1, wherein said common data structure
comprises a sparse matrix linked list.
4. The data structure of claim 1, wherein said common data structure
20 comprises a plurality of records containing data, said records arranged in
hierarchical order, in a series of levels from general to specific, based upon said
data.
5. The data structure of claim 1, wherein:
25 said primary database includes source tables,
 a first secondary database includes alias tables,
 a second secondary database includes standardization tables, and
 a third secondary database is configured to accept and store input
data.
- 30

6. The data structure of claim 5, wherein:
said source tables comprise data records obtained from a public or
private source,
said alias tables comprise one or more equivalent representations of
5 a record, and
said standardization tables comprise one or more standardized
representations of a record.

7. The data structure of claim 6, wherein said source tables comprise
10 address records obtained from a government postal service and a commercial
source.

8. The data structure of claim 1 for storing records comprising one or
more artifacts, wherein:
15 said first table includes preferred records,
a first other table includes primary alias records, and
a second other table includes secondary alias records.

9. The data structure of claim 8, wherein:
20 said preferred records comprise one or more preferred
representations,
said primary alias records comprise one or more equivalent
representations of a primary artifact, and
said secondary alias records comprising one or more equivalent
25 representations of a secondary artifact.

10. The data structure of claim 9, wherein said preferred records
comprise one or more preferred representations of an address.

30

11. A method of preparing data for optimal searching, said data stored in one or more databases comprising a plurality of linked tables of records, comprising:

arranging said records in each of said tables in hierarchical order, in
5 a series of levels from general to specific, based upon said data; and
transforming each of said tables into one or more sparse matrix
linked list tables.

12. The method of claim 11, wherein said one or more databases exist
10 in a server-client network environment, the method further comprising:

distributing a duplicate of said one or more sparse matrix linked list
tables from a server to one or more clients.

13. The method of claim 11, wherein said one or more databases are
15 relational databases interconnected to form a data superset.

14. The method of claim 11, wherein said data comprises address
artifacts.

20 15. An apparatus for preparing data for optimal searching, said data
stored in one or more databases comprising a plurality of linked tables of records,
comprising:

a central processing unit;
a memory;
25 a basic input/output system; and
program storage containing a program module executable by said
central processing unit, said program module comprising:
means for arranging said records in each of said tables in
hierarchical order, in a series of levels from general to specific, based upon said
30 data; and
means for transforming each of said tables into one or more
sparse matrix linked list tables.

16. The apparatus of claim 15, further comprising:
one or more clients remote from said central processing unit, said
program module further comprising:
means for distributing a duplicate of said one or more sparse
5 matrix linked list tables from a server to one or more clients.
17. A method of using a database of linked tables to convert a
subjective representation into a preferred representation, comprising:
capturing said subjective representation and storing it in a first one
10 of said linked tables;
storing source data in a second one of said linked tables;
locating one or more candidate representations from among said
source data by comparing said subjective representation to said source data;
selecting a preferred representation from among said one or more
15 candidate representations, said preferred representation having the closest
resemblance to said subjective representation; and
releasing said preferred representation.
18. The method of claim 17, further comprising:
20 reviewing said source data to identify one or more select records
containing preferred data; and
adding a preferred token to said one or more select records;
19. The method of claim 17, wherein said step of selecting a preferred
25 representation comprises identifying a preferred token associated with one of said
one or more candidate representations.

20. The method of claim 17, wherein said step of locating one or more candidate representations further comprises:

- (a) parsing said subjective representation into one or more discrete artifacts;
- 5 (b) selecting one of said one or more discrete artifacts:
 - (1) locating one or more candidate artifacts from among said source data by comparing said one discrete artifact to said source data;
 - (2) selecting a preferred artifact from among said one or more candidate artifacts, said preferred artifact having the closest resemblance to
10 said one discrete artifact;
 - (3) storing said preferred artifact;
- (c) repeating step (b) for each of said one or more discrete artifacts; and
- (d) combining said preferred artifacts to form a preferred
15 representation.

21. The method of claim 17, wherein said step of locating one or more candidate representations further comprises:

- storing alias data in a third one of said linked tables;
- 20 reviewing said alias data to identify one or more select alias records containing a preferred alias representation;
- adding a preferred alias token to said one or more select alias records;
- locating one or more candidate aliases from among said alias data
25 by comparing said subjective representation to said alias data;
- selecting a preferred alias from among said one or more candidate aliases, said preferred alias being most closely associated with said preferred alias token; and
- releasing said preferred alias as a candidate representation.

30

22. The method of claim 21, wherein said step of locating one or more candidate aliases further comprises:

- (a) parsing said subjective representation into one or more discrete artifacts;
- 5 (b) selecting one of said one or more discrete artifacts:
 - (1) locating one or more candidate alias artifacts from among said source data by comparing said one discrete artifact to said alias data;
 - (2) selecting a preferred alias artifact from among said one or more candidate alias artifacts, said preferred alias artifact being most closely
 - 10 associated with said preferred alias token;
 - (3) storing said preferred alias artifact;
- (c) repeating step (b) for each of said one or more discrete artifacts; and
- (d) adding said preferred alias artifact to said preferred alias.

15

23. An apparatus for using a database of linked tables to convert a subjective representation into a preferred representation, comprising:

- a central processing unit;
- a memory;
- 20 a basic input/output system; and
- program storage containing a program module executable by said central processing unit, said program module comprising:
 - means for capturing said subjective representation and storing it in a first one of said linked tables;
 - 25 means for storing source data in a second one of said linked tables;
 - means for locating one or more candidate representations from among said source data by comparing said subjective representation to said source data;
 - 30 means for selecting a preferred representation from among said one or more candidate representations, said preferred representation having the closest resemblance to said subjective representation; and

means for releasing said preferred representation.

24. The apparatus of claim 23, said program module further comprising:
means for reviewing said source data to identify one or more select
5 records containing preferred data; and
means for adding a preferred token to said one or more select
records;

25. The apparatus of claim 23, said program module further comprising:
10 means for identifying a preferred token associated with one of said
one or more candidate representations.

26. The apparatus of claim 23, wherein said means for locating one or
more candidate representations further comprises:
15 (a) means for parsing said subjective representation into one or
more discrete artifacts;
(b) means for selecting one of said one or more discrete
artifacts:
(1) means for locating one or more candidate artifacts
20 from among said source data by comparing said one discrete artifact to said source
data;
(2) means for selecting a preferred artifact from among
said one or more candidate artifacts, said preferred artifact having the closest
resemblance to said one discrete artifact;
25 (3) means for storing said preferred artifact;
(c) means for repeating step (b) for each of said one or more
discrete artifacts; and
(d) means for combining said preferred artifacts to form a
preferred representation.

30

27. The apparatus of claim 23, wherein said means for locating one or more candidate representations further comprises:

means for storing alias data in a third one of said linked tables;

5 means for reviewing said alias data to identify one or more select alias records containing a preferred alias representation;

means for adding a preferred alias token to said one or more select alias records;

means for locating one or more candidate aliases from among said alias data by comparing said subjective representation to said alias data;

10 means for selecting a preferred alias from among said one or more candidate aliases, said preferred alias being most closely associated with said preferred alias token; and

means for releasing said preferred alias as a candidate representation.

15

28. The apparatus of claim 27, wherein said means for locating one or more candidate aliases further comprises:

(a) means for parsing said subjective representation into one or more discrete artifacts;

20 (b) means for selecting one of said one or more discrete artifacts:

(1) means for locating one or more candidate alias artifacts from among said source data by comparing said one discrete artifact to said alias data;

25 (2) means for selecting a preferred alias artifact from among said one or more candidate alias artifacts, said preferred alias artifact being most closely associated with said preferred alias token;

(3) means for storing said preferred alias artifact;

30 (c) means for repeating step (b) for each of said one or more discrete artifacts; and

(d) means for adding said preferred alias artifact to said preferred alias.

29. A method of controlling access to a database by one or more external applications, comprising:
establishing and storing a plurality of rule sets, each correlated to one of said one or more external applications;
5 receiving a request from a first application;
retrieving a first rule set correlated to said first application; and
applying said first rule set to control the interaction between said first application and said database.

10 30. The method of claim 29, wherein said first rule set includes a list of data available for capture from said database for use by said first application.

31. A method of controlling the depth of data capture within a database in response to a request from one or more external applications, comprising:
15 establishing and storing a plurality of rule sets, each correlated to one of said one or more external applications,
each of said plurality of rule sets including a list of data to capture from said database;
receiving a request from a first application;
20 retrieving a first rule set correlated to said first application; and
applying said first rule set to limit the data available to said first application from said database.

32. A data structure comprising:
25 a database linking a primary table and one or more secondary tables, each of said tables sharing a common data structure;
said database controlled by a database management system configured to transform one or more of said tables into a sparse matrix linked list.

30 33. The data structure of claim 32, wherein said database comprises one or more interconnected relational databases.

34. The data structure of claim 32, wherein said database management system comprises an interface and a validation module.

5 35. The data structure of claim 34, wherein said interface controls access to said database by one or more external applications.

36. The data structure of claim 32, wherein said database management system is further configured to convert data from a subjective representation into a preferred representation.

10

37. A data structure for use in a database management system, comprising:
a first table of values representing preferred characterizations of a parameter;
15 a second table of values representing input data characterizing a parameter;
a third table of values arranged in a hierarchy to facilitate the process of matching said input data to a corresponding preferred characterization, wherein each of said tables comprises a sparse matrix linked list.

20

38. A method for characterizing a parameter, comprising:
receiving input data characterizing a parameter in a first table;
modifying said input data in accordance with a table of alias characterizations stored in a second table; and
25 matching the modified input data to a preferred characterization stored in a third table.

39. An address management system comprising:
a superset comprising a primary database operatively connected to
one or more secondary databases, each of said databases comprising a plurality of
linked tables, and each of said tables sharing a common data structure;
5 an enhancement module configured to transform one or more of
said tables into a sparse matrix linked list;
a publication and subscription module for controlling the
distribution of data in a server-client network environment;
a matching and validation module for converting a subjective
10 representation of an address into a preferred representation of said address; and
an interface for controlling access to said superset by one or more
external applications.

40. The system of claim 39, wherein said enhancement module is
15 further configured to arrange the records of one or more of said tables in
hierarchical order, in a series of levels from general to specific, based upon said
data.

41. The system of claim 39, wherein:
20 said primary database includes source tables,
a first secondary database includes alias tables,
a second secondary database includes standardization tables, and
a third secondary database is configured to accept and store input
data.

42. The system of claim 41, wherein:
said source tables comprise data records obtained from a public or
private source,
5 said alias tables comprise one or more equivalent representations of
a record, and
said standardization tables comprise one or more standardized
representations of a record.
- 10 43. The system of claim 42, wherein said source tables comprise
address records obtained from a government postal service and a commercial
source.
- 15 44. The system of claim 40 for storing records comprising one or more
address artifacts, wherein:
a first table includes preferred records,
a second table includes primary alias records, and
a third table includes secondary alias records.
- 20 45. The system of claim 44, wherein:
said preferred records comprise one or more preferred
representations,
said primary alias records comprise one or more equivalent
representations of a primary address artifact, and
25 said secondary alias records comprising one or more equivalent
representations of a secondary address artifact.

ADDRESS SUPERSET 130

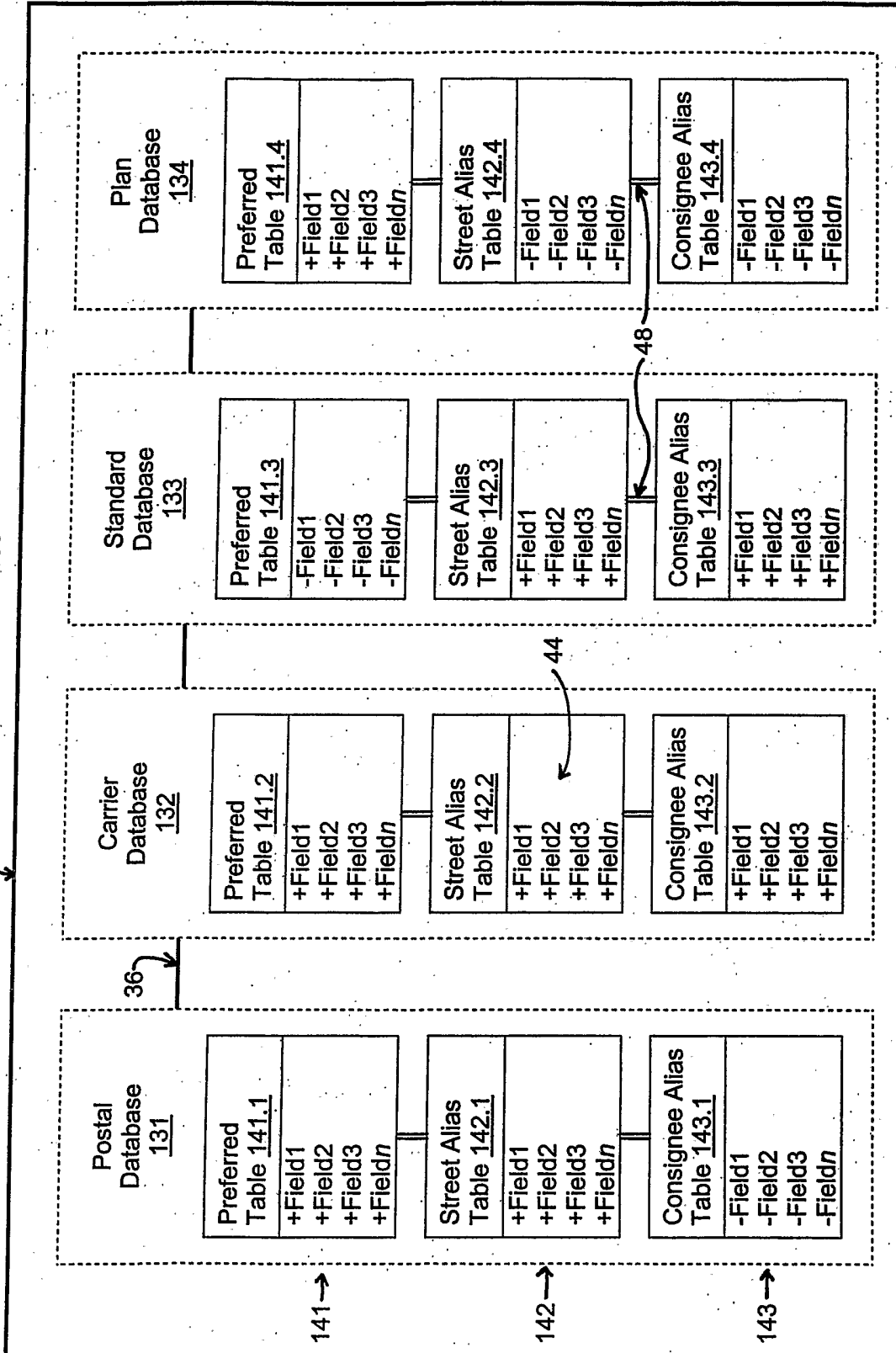


FIG. 1

DATA SUPERSET 30

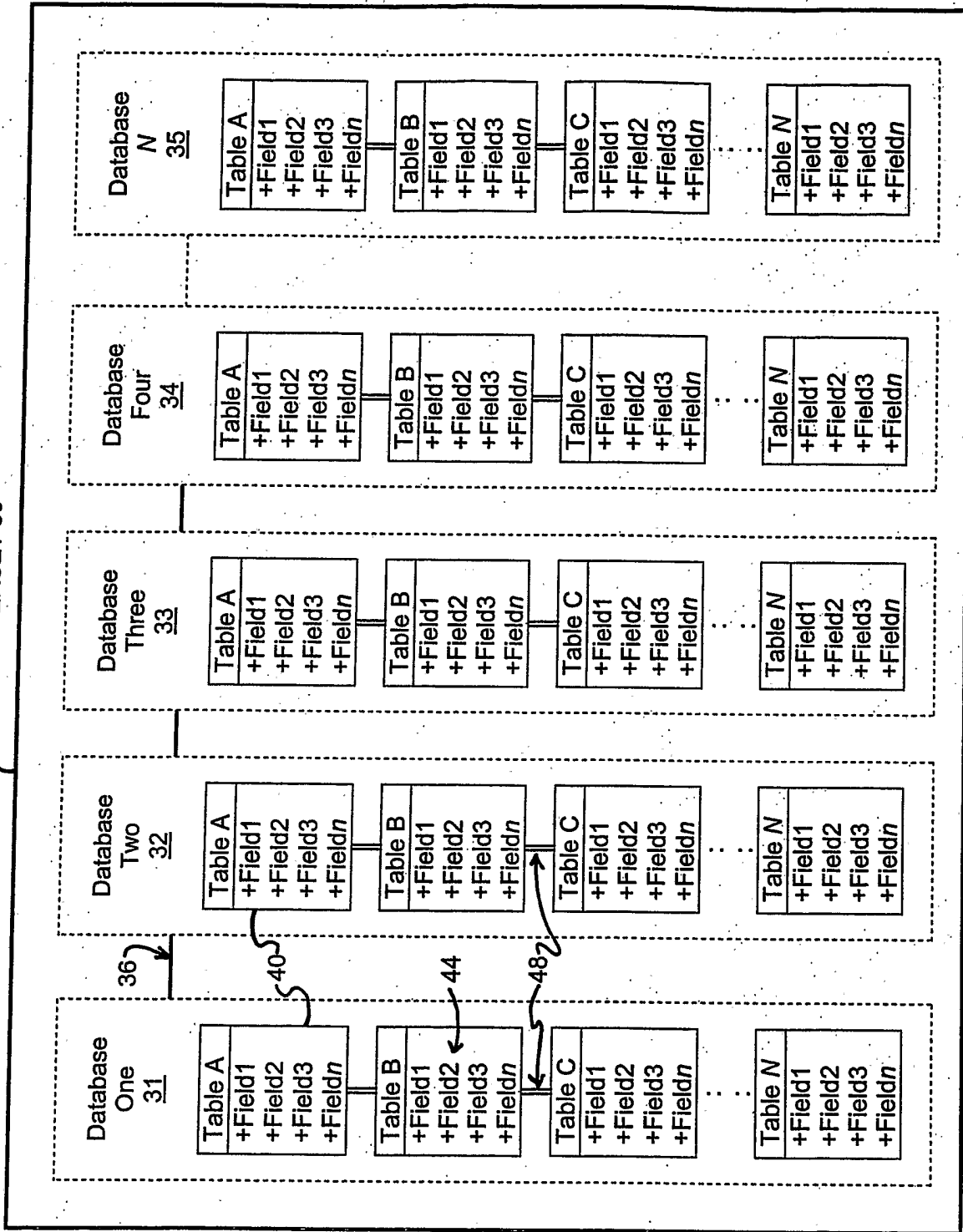


FIG. 2

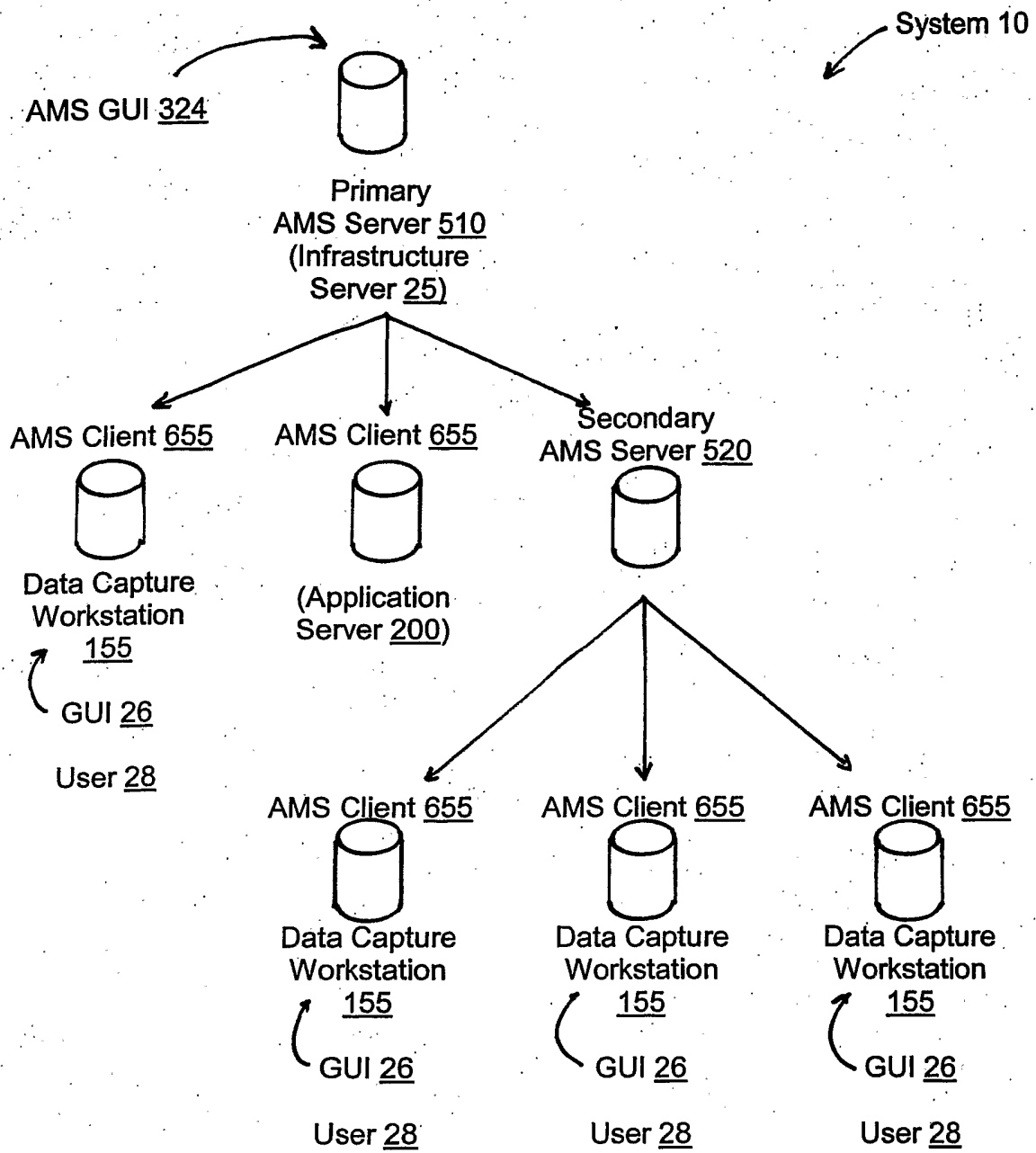


FIG. 3

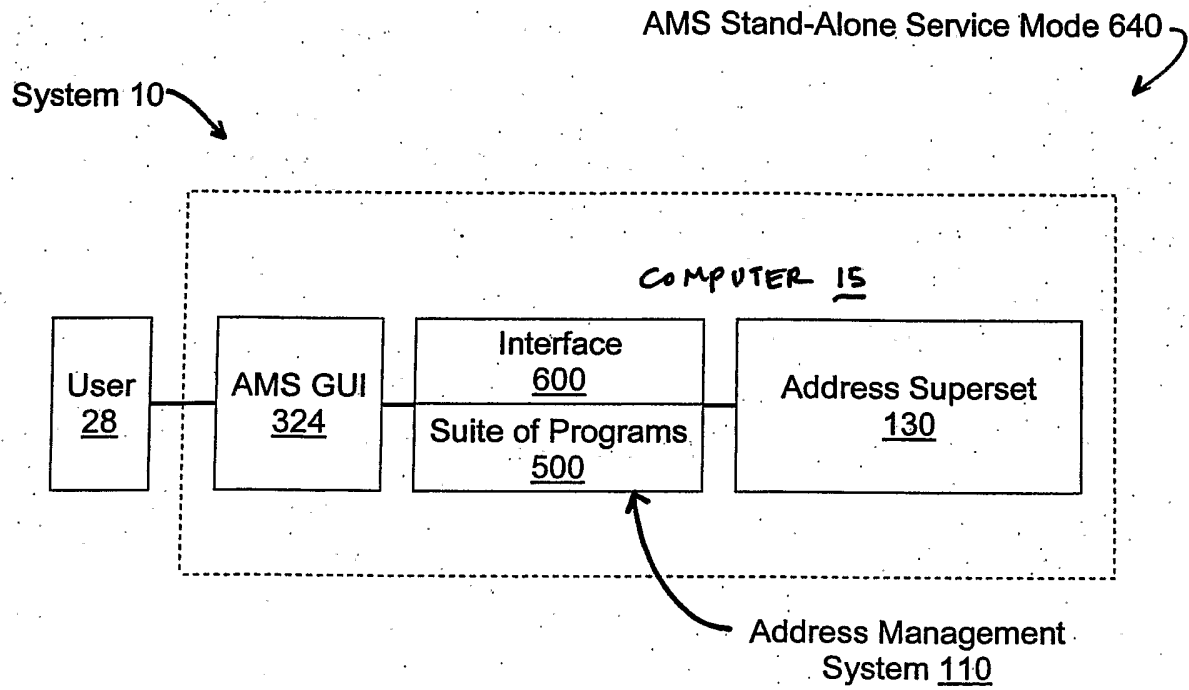


FIG. 4

Record 42

Field 44

Table 40

| FIELDS (row i, column j) | Column 1 | Column 2 | Column 3 |
|-----------------------------|-------------|-------------|-------------|
| Row 1 | Field (1,1) | Field (1,2) | Field (1,3) |
| Row 2 | Field (2,1) | Field (2,2) | Field (2,3) |
| Row 3 | Field (3,1) | Field (3,2) | Field (3,3) |
| Row 4 | Field (4,1) | Field (4,2) | Field (4,3) |

FIG. 5

Value 46

| VALUES | Column 1 | Column 2 | Column 3 |
|--------|-------------|-------------|-------------|
| Row 1 | 0 | Smith | 0 |
| Row 2 | 0 | 0 | 0 |
| Row 3 | 27 | 0 | 0 |
| Row 4 | 19 | 0 | 260B |

FIG. 6

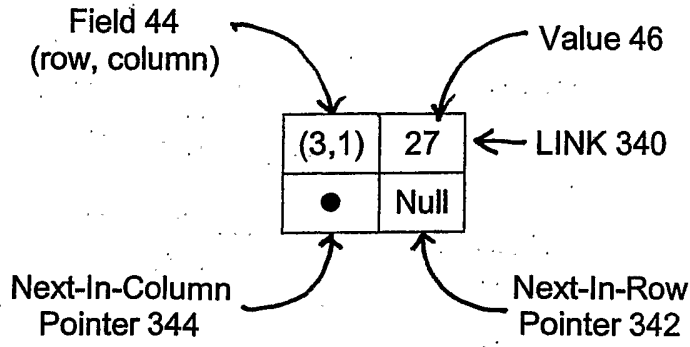


FIG. 7

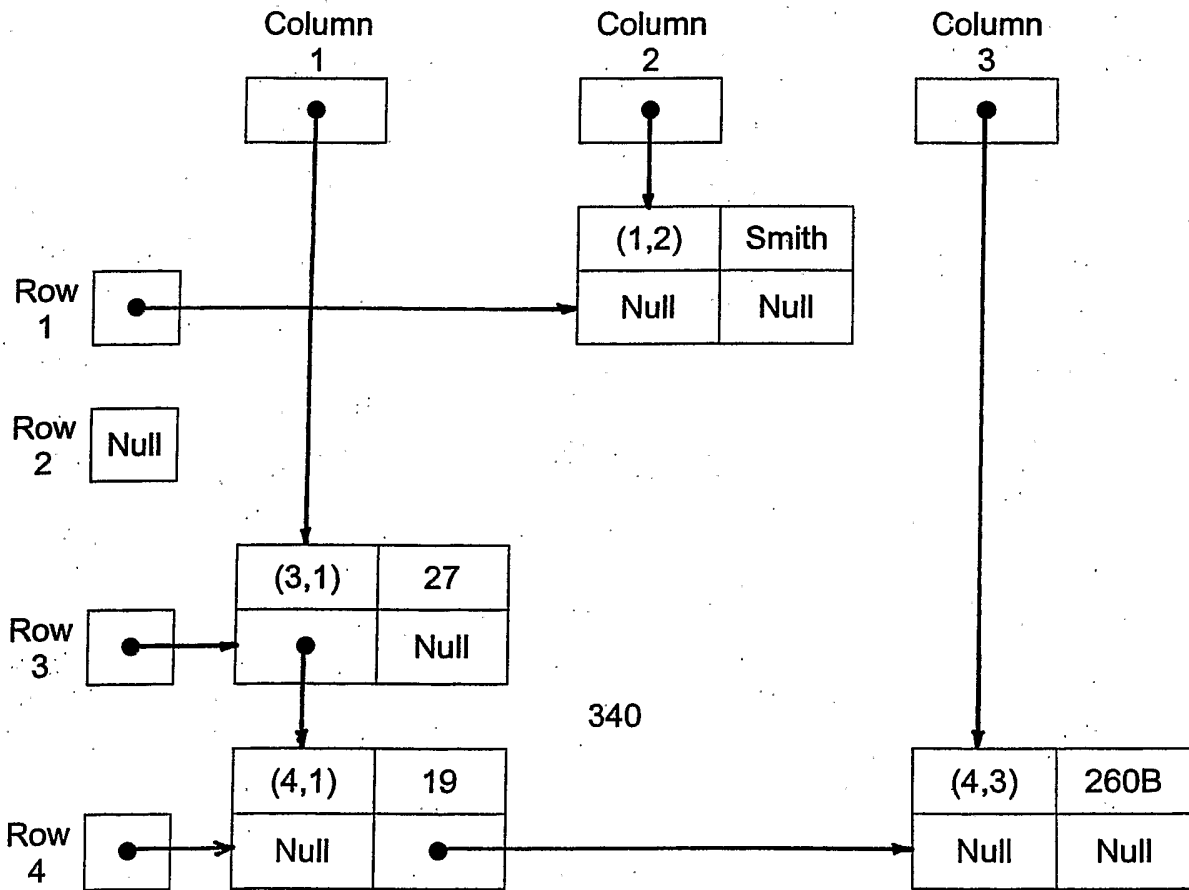


FIG. 8

Postal Preferred Table 141.1

| Node | Zip | Token | Street | Type | Lo | Hi | Odd/ Even | Consignee | Sec | Lo | Hi | +4 |
|------|-------|-------|--------|------|-----|-----|--------------|-----------------|-----|------|------|------|
| 1 | 20001 | T1 | FIRST | ST | 440 | 498 | E | | | | | 2023 |
| 2 | 20001 | T2 | FIRST | ST | 440 | 440 | E | | | | | 2028 |
| 3 | 20001 | T3 | FIRST | ST | 440 | 440 | E | | STE | 100 | 400 | 2028 |
| 4 | 20001 | T4 | FIRST | ST | 440 | 440 | E | | STE | 430C | 430C | 2028 |
| 5 | 20001 | T5 | FIRST | ST | 440 | 440 | E | | STE | 500 | 600 | 2028 |
| 6 | 20001 | T6 | FIRST | ST | 440 | 440 | E | APC | STE | 600 | 600 | 2017 |
| 7 | 20001 | T6 | FIRST | ST | 440 | 440 | E | AM POLLING CMTE | STE | 600 | 600 | 2017 |
| 8 | 20001 | T7 | FIRST | ST | 440 | 440 | E | NORCO | STE | 500 | 500 | 2030 |
| 9 | 20001 | T8 | FIRST | ST | 440 | 440 | E | PLEXTON | STE | 800 | 800 | 2080 |
| 10 | 20001 | T9 | FIRST | ST | 440 | 440 | E | ACME CORP | STE | 310 | 310 | 2085 |
| 11 | 20001 | T10 | FIRST | ST | 440 | 440 | E | | STE | 430A | 430B | 2042 |
| 12 | 20001 | T11 | FIRST | ST | 440 | 440 | E | | STE | 450 | 450 | 2042 |
| 13 | 20001 | T12 | FIRST | ST | 440 | 440 | E | | STE | 800 | 800 | 2043 |

FIG. 9

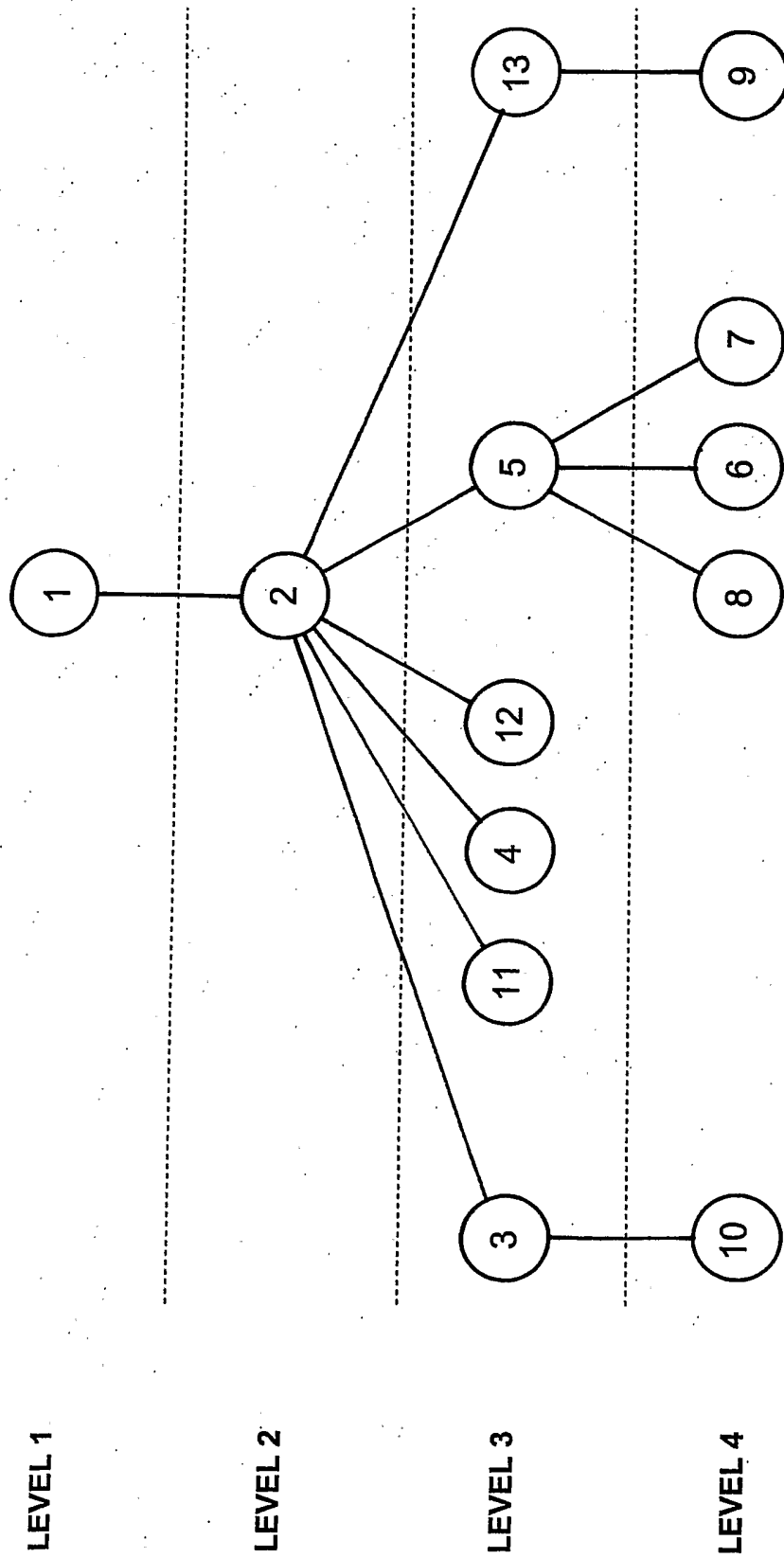


FIG. 10

| NODE | TOKEN | LEVEL | Zip | Street | Type | Lo | Hi | Odd/ Even | Consignee | Sec | Lo | Hi | +4 |
|------|-------|---------|-------|--------|------|-----|-----|--------------|----------------|-----|------|------|------|
| 1 | T1 | Level 1 | 20001 | FIRST | ST | 440 | 498 | E | | | | | 2023 |
| 2 | T2 | Level 2 | 20001 | FIRST | ST | 440 | 440 | E | | | | | 2028 |
| 3 | T3 | Level 3 | 20001 | FIRST | ST | 440 | 440 | E | | STE | 100 | 400 | 2028 |
| 10 | T9 | Level 4 | 20001 | FIRST | ST | 440 | 440 | E | ACME CORP | STE | 310 | 310 | 2085 |
| 11 | T10 | Level 3 | 20001 | FIRST | ST | 440 | 440 | E | | STE | 430A | 430B | 2042 |
| 4 | T4 | Level 3 | 20001 | FIRST | ST | 440 | 440 | E | | STE | 430C | 430C | 2028 |
| 12 | T11 | Level 3 | 20001 | FIRST | ST | 440 | 440 | E | | STE | 450 | 450 | 2042 |
| 5 | T5 | Level 3 | 20001 | FIRST | ST | 440 | 440 | E | | STE | 500 | 600 | 2028 |
| 8 | T7 | Level 4 | 20001 | FIRST | ST | 440 | 440 | E | NORCO | STE | 500 | 500 | 2030 |
| 6 | T6 | Level 4 | 20001 | FIRST | ST | 440 | 440 | E | APC | STE | 600 | 600 | 2017 |
| 7 | T6 | Level 4 | 20001 | FIRST | ST | 440 | 440 | E | AMPOLLING CMTE | STE | 600 | 600 | 2017 |
| 13 | T12 | Level 3 | 20001 | FIRST | ST | 440 | 440 | E | | STE | 800 | 800 | 2043 |
| 9 | T8 | Level 4 | 20001 | FIRST | ST | 440 | 440 | E | PLEXTON | STE | 800 | 800 | 2080 |

FIG. //

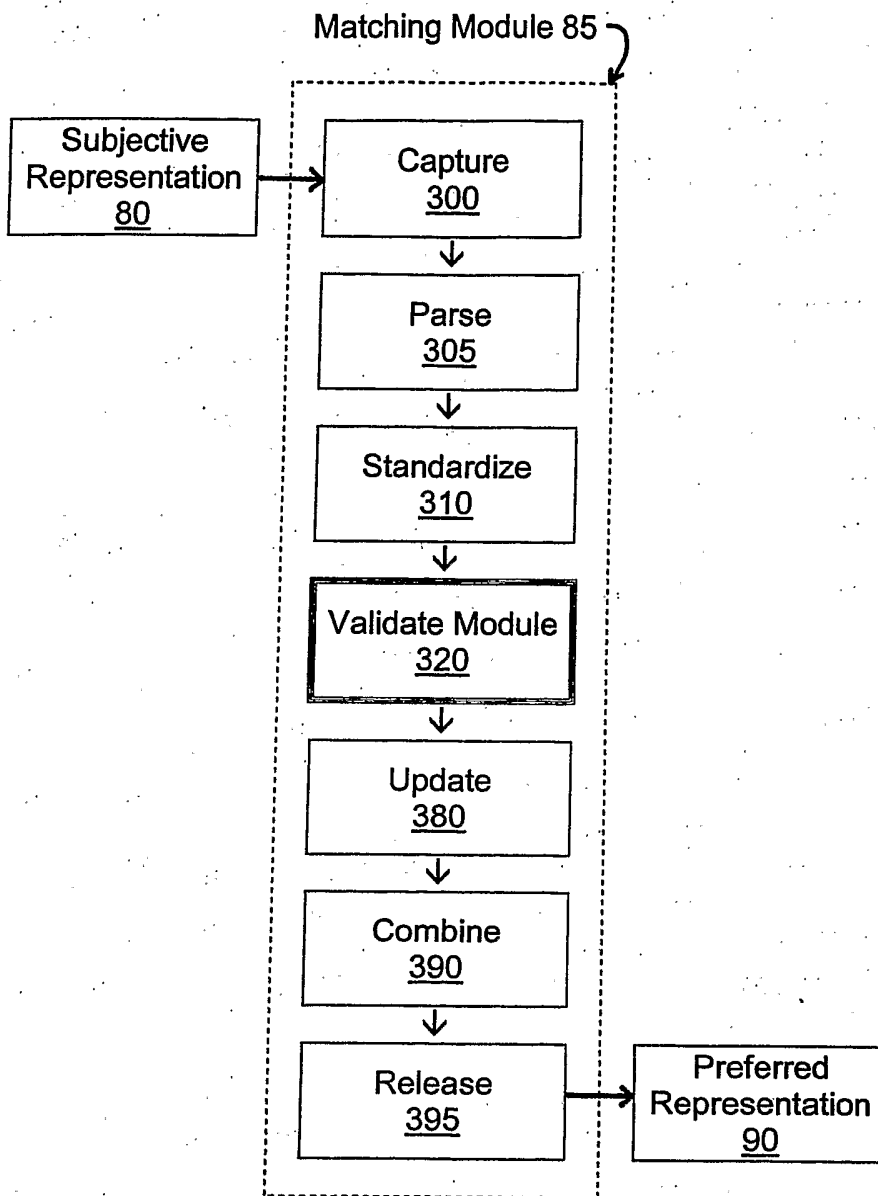


FIG. 12

Street Alias Table 142

| ZIP | Token | Street Name | Street Type | Alias Street Name | Alias Street Type |
|-------|--------|------------------------|-------------|------------------------|-------------------|
| 10015 | T4081 | 6TH | AVE | AVENUE OF THE AMERICAS | |
| 10015 | T4081p | AVENUE OF THE AMERICAS | | 6TH | AVE |
| 10015 | T4081 | AVENUE OF AMERICAS | | 6TH | AVE |
| 10015 | T4081 | AVENUE OF AMERICAS | | AVENUE OF THE AMERICAS | |
| 10015 | T4081 | 6TH | AVE | SIXTH | AVE |
| 10015 | T4081 | SIXTH | AVE | 6TH | AVE |

70

FIG. 13

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 03/33349

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G06F17/30

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G06F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|------------|---|-----------------------|
| Y | US 5 387 783 A (MIHM TERRANCE S ET AL) 7 February 1995 (1995-02-07) column 3, line 55 - column 5, line 50 column 11, line 21 - column 12, line 10 ----- | 1-45 |
| Y | HADERLE D J ET AL: "IBM DATABASE 2 OVERVIEW" IBM SYSTEMS JOURNAL, IBM CORP. ARMONK, NEW YORK, US, vol. 23, no. 2, 1984, pages 112-125, XP000748538 ISSN: 0018-8670 page 113, left-hand column, paragraph 1 - page 116, left-hand column, paragraph 3 ----- -/-- | 1-45 |

Further documents are listed in the continuation of box C.

Patent family members are listed in annex.

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- *T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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- *Y* document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.
- *&* document member of the same patent family

Date of the actual completion of the international search

9 July 2004

Date of mailing of the international search report

26/07/2004

Name and mailing address of the ISA

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Authorized officer

Jaedicke, M

INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 03/33349

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

| Category ° | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|------------|--|-----------------------------|
| Y | POOCH U W ET AL: "A survey of indexing techniques for sparse matrices" COMPUT. SURV. (USA), COMPUTING SURVEYS, JUNE 1973, USA, vol. 5, no. 2, June 1973 (1973-06), pages 109-133, XP002287934 ISSN: 0360-0300 page 119, right-hand column, paragraph 4 - page 121, right-hand column, last paragraph | 3,11,12, 15,32, 37,39 |
| A | ----- WO 96/34354 A (UNITED PARCEL SERVICE INC) 31 October 1996 (1996-10-31) abstract ----- | |

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 03/33349

| Patent document cited in search report | Publication date | Patent family member(s) | Publication date |
|--|------------------|-------------------------|------------------|
| US 5387783 | A | 07-02-1995 | NONE |
| WO 9634354 | A | 31-10-1996 | WO 9634354 A1 |
| | | | 31-10-1996 |