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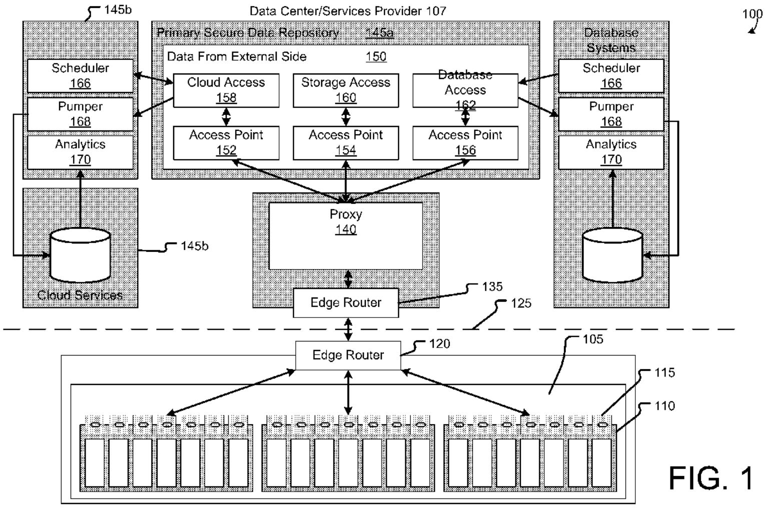


FIG. 1

(57) Abstract: Scaling out and managing database queries to large data files or datasets is provided. Large data files or datasets received at a storage repository are separated into a number of data segments or chunks. Groupings of subsets of the data segments or chunks are stored at each of multiple servers. When a data query is received from the enterprise for processing against the data file or dataset, the query is passed to each server and is simultaneously run against the smaller data chunks groupings at each server. Results of the query process are returned back to a primary server. Duplicate results are discarded, and remaining results are aggregated. A report then may be generated from the aggregated results and may be passed back to the querying enterprise.

MANAGEMENT OF DATABASE QUERIES AGAINST LARGE DATASETS

BACKGROUND

[0001] Enterprises, for example, companies, educational entities, government entities, and the like often operate hundreds or thousands of computers and computing systems for their employees, students and affiliates. Often such computers and computer systems are operated at various enterprise locations, or often such computers or computer systems are operated at large data centers. Many enterprises store and process data via data storage and processing services providers operating remotely from the enterprise where data storage, data processing and online services are provided at the remote services provider over a distributed computing network such as the Internet.

[0002] Often an enterprise sends data queries to the services provider for running various processing jobs against the enterprise's data and systems stored and operated at the services provider or at an associated services provider data center. The query submitted by the enterprise includes query logic created by the enterprise so that the enterprise may perform self-service queries on the enterprise's data and subscribed-to systems at the services provider or data center. For example, an enterprise may send a data query to a large data center/services provider for running a report detailing the various computer operating systems in use by thousands or even millions of its customers who have logged into an online software service. Such a report may be needed by the enterprise for properly managing its computing resources. Unfortunately, data associated with such large numbers of users or systems can overwhelm the databases, database services and processing functionalities of the services provider to which the data query is sent. Often data queries applied against such large datasets take excessive amounts of time to process or fail altogether due to limitations in the resources of the receiving services provider.

[0003] It is with respect to these and other considerations that the present invention has been made.

SUMMARY

[0004] This summary is provided to introduce a selection of concepts in a simplified form that are further described below in the detailed description. This summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended as an aid in determining the scope of the claimed subject matter.

[0005] The above and other problems are solved by a reporting infrastructure for large datasets that provides methods and systems for scaling out and managing database queries to large data files or datasets. According to aspects of the invention, large data files or datasets received at a storage repository (data center and/or services provider) are separated into a number of data segments or chunks. Groupings of subsets of the data segments or chunks (e.g., groupings of three chunks) are stored at each of multiple servers (e.g., each of 12 servers operating in a server cluster).

[0006] When a data query is received from the enterprise for processing against the data file or dataset, the query is passed to each server and is simultaneously run against the smaller data chunks groupings at each server. Results of the query process are returned back to a primary server. Duplicate results are discarded, and remaining results are aggregated. A report then may be generated from the aggregated results and may be passed back to the querying enterprise.

[0007] The details of one or more embodiments are set forth in the accompanying drawings and description below. Other features and advantages will be apparent from a reading of the following detailed description and a review of the associated drawings. It is to be understood that the following detailed description is explanatory only and is not restrictive of the invention as claimed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] The accompanying drawings, which are incorporated in and constitute a part of this disclosure, illustrate various aspects of the present invention.

[0009] Fig. 1 is a simplified block diagram of one example of a system architecture for processing data queries against large data files or datasets separated into smaller data chunks.

[0010] Fig. 2A illustrates a large data file or dataset separated into data chunks against which data queries may be processed.

[0011] Fig. 2B illustrates one example of a system architecture for processing multiple data chunks at corresponding servers.

[0012] Fig. 3 is a flowchart of an example method for processing a data query against a large data file or dataset separated into smaller data chunks.

[0013] Fig. 4 is a block diagram illustrating example physical components of a computing device with which aspects of the present invention may be practiced.

[0014] Figs. 5A and 5B are simplified block diagrams of a mobile computing device with which aspects of the present invention may be practiced.

[0015] Fig. 6 is a simplified block diagram of a distributed computing system in which aspects of the present invention may be practiced.

DETAILED DESCRIPTION

[0016] The following detailed description refers to the accompanying drawings. Wherever possible, the same reference numbers are used in the drawings and the following description to refer to the same or similar elements. While embodiments of the invention may be described, modifications, adaptations, and other implementations are possible. For example, substitutions, additions, or modifications may be made to the elements illustrated in the drawings, and the methods described herein may be modified by substituting, reordering, or adding stages to the disclosed methods. Accordingly, the following detailed description does not limit the invention, but instead, the proper scope of the invention is defined by the appended claims.

[0017] As briefly described above, aspects of the present invention are directed to scaling out and managing database queries to large data files or datasets. Large data files or datasets received at a storage repository are separated into a number of data segments or chunks. Groupings of the data segments or chunks are stored at each of multiple servers. Data queries received for processing against the data files or datasets are passed to each server and are simultaneously run against the smaller data segments/chunks groupings at each server. Results of the query process are returned back to a primary server. Duplicate results are discarded, and remaining results are aggregated for reporting back to the querying party (e.g., enterprise or other individual or entity).

[0018] Referring now to Fig. 1, an example system architecture for uploading and downloading data files, datasets, queries and responses to queries between a source (e.g., enterprise, individual or other entity) and a services provider or associated data center is illustrated and described. According to aspects of the present invention, the system architecture 100 is comprised of various example computing components for passing data, queries and responsive information between a variety of source computing systems (or individual computers) to a variety of destination locations such as data centers and services providers.

[0019] At the bottom of Fig. 1, a data center 105 is illustrative of a data center operated by an enterprise or individual or entity subscriber of services (hereafter “enterprise” or “subscribers) that may need to upload data of various types, including production and test queries, to a data center or services provider (hereafter “data center” or “services provider”) at which uploaded data and queries may be stored and/or processed. The data center 105 may house hundreds, thousands or more individual computers or computing systems 110 on which may be stored data of a variety of data types that may be processed using a variety of different computing processes, for example, a variety of software applications. For example, each of the computing devices 110 may include computers of various types, for example, server computers, for storing user data in databases, electronic mail systems, document management systems, and the like, and the computing systems 110 may be used for running a variety of computing system software applications, for example, database applications, electronic mail systems applications, web services applications, online software provision applications, productivity applications, data management system applications, telecommunications applications, and the like.

[0020] As should be appreciated, the data center 105 is also illustrative of one of many data centers that may be co-located, or that may be located at different locations and that may be associated with each other via various transmission systems for passing data between disparate data centers. In addition, while the data center 105 is illustrated as a data center in which numerous computer systems 110 may be located for provision of data and services, as described above, the data center 105 is equally illustrative of an entity, such as a company, educational entity, government entity or a single computing device, for example, a desktop, laptop, tablet, handheld, or other computing device operated by an individual user from which user data and/or computer system production and test queries may be uploaded to a services provider.

[0021] Referring still to the data center 105, each computing device 110 is associated with an uploader module 115 that is operative for uploading user and/or system data and production or test queries from each associated computer/computing system 110. As should be appreciated, the data uploader and downloader may be identical modules and are only designated as uploader versus downloader based on the direction of the data movement. According to one aspect of the invention, an uploader module 115 may be installed on each associated computer/computing system 110 or may be accessed by each computer/computing system 110.

[0022] The data uploader or downloader (hereafter also referred to as “data loader”) 115 may utilize various data reader, data transformation and data export plug-in modules required for different types of data reading, transformation and export. For example, a services provider which needs to receive transformed data from various computing devices operated at a data center 105 may provide data reader plug-ins, data transformation plug-ins, and data export plug-ins for use by data loader modules 115 for reading, transforming and exporting data according to their individual needs.

[0023] A configuration file or instructions may be provided to a given data uploader for providing processing information to the uploader. According to aspects of the present invention, an uploader module may be configured to send a data file, dataset and/or associated data query directly to a primary server 220-275 (described below with reference to Fig. 2B) for processing as described herein. For example, the configuration file may provide the uploader module or direct the uploader to a data export plug-in module that will allow/cause the uploader to pass data and queries to a required primary server for processing.

[0024] Referring still to Fig. 1, an edge router 120 is illustrative of a typical router device for passing queries from a given uploader module to systems external to the data center 105. As should be appreciated, the edge router 120 may be responsible for ensuring that data passed from a given data center 105 is properly passed to a desired destination system component, for example, that packetized data passing from the uploader module is properly routed to a correct destination component of the system 100. The edge router 135 is illustrative or a receiving edge router through which queries may be passed to a proxy service 140 (described below) responsible for ensuring received data and/or queries are properly authenticated prior to allowing received data and/or queries to be passed to one or more destination storage repositories 145a-c at the services provider 107.

[0025] The distributed computing network 125 (illustrated in Fig. 1 as a dotted line) is illustrative of any network such as the Internet or an intranet through which data may be passed from the data center to components external to the data center such as destination storage repositories 145a-c of the secure data management center/repository, described below.

[0026] According to embodiments, the proxy service 140 may perform a number of functions. The proxy service 140 may serve as an authentication point for authenticating data and queries passing to/from a potentially unsecure enterprise and to a secure data center or services provider 107 at which the data and/or queries may be processed. In addition, the proxy service may include or may be able to read an export plug-in module for causing data and data queries to be distributed directly to a specified server 220-275 for processing, as described below with reference to Figs. 2A-3. In addition, functionality for separating a large data file or dataset into smaller data segments or chunks and for grouping the data segments or chunks for processing at a server 220-275 may be operated at the proxy service.

[0027] The storage repositories 145a-c are illustrative of any data storage repository that may be authorized to receive data or queries uploaded via the uploader modules 115. For example, the destination storage repositories 145a-c may be associated with a secure data management center/repository of a services provider for receiving, storing and analyzing data (in response to one or more production or test queries) associated with computing systems and software services provided for subscribers of the services provider.

[0028] For example, the data repository 145a may serve as a primary secure data receiving repository for a services provider. Access points 152, 154 and 156 represent access points at the data repository 145a through which data and queries may be passed from the proxy service 140 for uploading data to one or more specific data locations 160, or for passing data or queries through one or more specific data access points 158, 162 for passing the data to other data repositories 145b, 145c. As illustrated and described below with reference to Fig. 2B, the data repository 145a may also house a cluster or collection of servers at which grouping of data segments or data chunks may be stored and processed by a received query. As should be appreciated, however, such a cluster or collection of servers may be operated at any component of the services provider 107, including the repositories 145b-c, described below.

[0029] The data repository 145b may be designated for receiving and analyzing user data and systems data, as well as, various queries associated with one or more services or data types. For example, the data repository 145b is illustrative of a cloud services system operated at the secure data management center/repository 144 of a given services provider. A scheduler module 166 is illustrative of a software module or device operative for scheduling data uploads and downloads to and from the data repository 145b. A pumper module 168 is illustrative of a software module or device operative for distributing data to and from components of the data repository 145b. An analytics module 170 is illustrative of a software module or device operative for outputting and/or displaying or otherwise presenting data from the storage repository 145b.

[0030] The destination storage repository 145c is illustrative of another component of the services provider 107. For example, the destination storage repository 145c may be in the form of a database system operated at the services provider 107. A scheduler module 166 is illustrative of a software module or device operative for scheduling data uploads and downloads to and from the data repository 145c. A pumper module 168 is illustrative of a software module or device operative for distributing data to and from components of the data repository 145c. A analytics module 170 is illustrative of a software module or device operative for outputting and/or displaying or otherwise presenting data from the storage repository 145c.

[0031] As should be appreciated, the descriptions of the components of the services provider and the individual components 145a, 145b, 145c are for purposes of example and illustration only and are not limiting of various other components or systems that may be operated as part of the secure data management center/repository to which data may be uploaded or from which data may be downloaded from/to an external (and potentially unsecure) data generator/user. For example components of the secure data management center/repository 107 may provide for online software and data management provision, for example, provision of word processing services, slide presentation application services, database application services, spreadsheet application services, telecommunications application services, and the like provided to various users via one or more online software application services and data management systems.

[0032] Fig. 2A illustrates a large data file or dataset separated into data segments or data chunks against which data queries may be processed. As briefly described above, according to aspects of the present invention, a large data file or dataset to which data queries may be applied may be stored at a data center and/or services provider. For example, a given data file 210, as illustrated in Fig. 2A, may include hundreds of gigabytes or more of data stored at a data center 145a-c, as illustrated and described above with reference to Fig. 1, associated with various operations of a given enterprise.

[0033] For example, the data file 210, illustrated in Fig. 2A, may include data representing login data, usage data, authentication data, and the like for thousands or millions of computers or computer users managed by a given enterprise. From time-to-time, the enterprise for which the data is stored may pass a data query to the storage repository requesting various aggregations, calculations and/or computations to be run on the data file 210. For example, a stored database function may be operated at the storage repository 145a, and data queries passed to the storage repository from the requesting enterprise may pass query parameters, for example, computations or questions to be applied to the data contained in the data file 210, for causing reporting to be generated for passing back to the requesting enterprise. For example, a requesting enterprise may pass a data query having parameters calling for a computation of the numbers of its customers logging in to its systems using each of many different computer operating systems for allowing the enterprise to assess and manage its resources. As should be understood, these are but a few examples of the almost limitless numbers and types of data items that may be stored and processed as described herein.

[0034] Referring still to Fig. 2A, according to aspects of the present invention, the data file 210 may be separated into a number of data segments or data chunks, for example, 12 data chunks 215, as illustrated in Fig. 2A. As should be appreciated, the data file may be broken into a number of identically sized data segments or chunks (hereafter referred to as "data segments" or "data chunks" to mean a portion or subset of a given dataset or data file), or the data file may be broken into separate data segments or chunks at logical breaking points wherein each of the data segments or chunks are different file sizes. That is, as should be appreciated, one data chunk may include a certain category or type of data, a second data chunk may include a second category or type of data, and so on where the total of all the data segments or chunks comprises the total data file or dataset.

[0035] Referring still to Fig. 2A, according to aspects of the present invention, the data chunks separated from the data file 210 may be grouped into data chunk groupings, and each data chunk grouping may be stored at a different server, for example, servers comprising a server cluster at the storage repository 145a-c, illustrated and described above with reference to Fig. 1. According to an aspect of the invention, the data chunk groupings are organized such that the data chunks placed in each data chunk grouping overlap with succeeding data chunks so that when the data chunk groupings are processed for a received data query at each of the separate servers, each data chunk is processed multiple times (at least two or more times) across the set of servers.

[0036] As illustrated in Fig. 2A, for example, at server 1, data chunks 1, 2 and 3 are stored. At server 2, data chunks 2, 3 and 4 are stored. At server 3, data chunks 3, 4 and 5 are stored. At server 4 data, chunks 4, 5 and 6 are stored, and so on. Thus, as will be described in further detail below with reference to Fig. 3, if the same query logic is applied at each server against each data chunk grouping, then each data chunk will be processed multiple times across the set of servers. For example, for the 12 data chunk arrangement and 12 server arrangement illustrated in Fig. 2A, each data chunk 1-12 will be processed three times across the set of servers 1-12. Thus, if the query logic fails at any given server 1-12, or if a malfunction of the server computing system occurs at a given server, then the processing applied or attempted to be applied to the data chunks at that server may be discarded, and because of the redundancy of processing applied to each chunk in parallel at each of the servers 1-12, reliability of processing of each data chunk is ensured.

[0037] As should be appreciated, the separation of a data file 210 into 12 data chunks 215, and the processing of data chunks in three chunk groupings at 12 separate servers is for purposes of example and illustration only and is not limiting of other data file separation, chunk groupings, and server arrangements that may be utilized. For example, if desired, a data file could be separated into 15 data chunks, and data chunks could be grouped into four chunk groupings that could then be run on 15 servers for achieving a similar redundancy and reliability outcome. That is, according to aspects of the invention, separating a large data file or dataset into segments or chunks that are then processed in separate servers such that each data segment or chunk is processed at least more than once is a key to ensuring processing of smaller amounts of data at each server and to ensuring that each segment or chunk of data is indeed processed.

[0038] Fig. 2B illustrates one example of a system architecture for processing multiple data chunks at corresponding servers. As illustrated in Fig. 2B, a number of data centers 105a-n are illustrated from which data files or datasets, as well as, data queries to be operated against data files or datasets may be passed across a distributed computing network 125 through a proxy service 140 for storage at various storage repository servers 220-275 at a storage repository 145a of a large data center or services provider, as illustrated and described above with reference to Fig. 1. Access points 152, 154, 156 are illustrative of access points that may be utilized for receiving the datasets and data queries from the proxy service 140 and for directing the data files and data queries to each of the servers 220-275.

[0039] According to one aspect of the invention, a dataset grouping and distribution module 218, illustrated in Fig. 2B, is software module or device operative for breaking a received data file into data chunks, and for distributing groupings of data chunks to each of the servers 220-275, as described above with reference to Fig. 2A. The dataset grouping and distribution module 218 may be operated at the storage repository 145a with access to each of the servers 220-275, or it may be operated at one of the servers 220-275 for receiving, separating, grouping and distributing data chunks to other servers 220-275 for processing. Alternatively, the dataset grouping and distribution module 218 may be operated at the proxy service 140, and an associated upload plug-in module may be operated at the proxy service

140 for automatically passing each chunk grouping to a prescribed server 220-275 for processing, as described above with reference to Fig. 2A. Alternatively, the access points 152, 154, 156 may include the dataset grouping and distribution module 218 breaking the received data file into data chunks and for grouping the data chunks for distribution to each of the servers 220-275. According to yet another alternative, the dataset grouping and distribution module 218 may be maintained at a given data center 105a-n by a querying enterprise, and each data chunk grouping may be passed to respective servers 220-275 at the receiving data center and/or services provider via the proxy service 140, as described above with reference to Fig. 1.

[0040] In any case, each data chunk grouping, as illustrated and described above with reference to Fig. 2A, is passed to and stored at a respective server 220-275, as illustrated at the data repository 145a. The numbered boxes illustrated in each of the servers 220-275 are illustrative of different data chunks comprising data chunk groupings, as illustrated and described above with reference to Fig. 2A.

[0041] According to an aspect of the invention, a database function 219 (represented by the character "F" in each server) is stored at each of the servers 220-275 for receiving data queries of various types for processing the data chunk groupings stored at each respective server. According to one aspect, the functions stored at each server 220-275 are identical for a given data type or data query type so that a data query passed to each stored function may be operated in an identical fashion to the same data query passed to each other server in the server grouping or cluster 220-275. As should be appreciated, any number of functions may be stored at each of the servers 220-275 for receiving and processing data queries against data chunk groupings, as described herein.

[0042] In order to process a data query against a given data file, a data query along with appropriate data query parameters, as described above, is passed from a querying enterprise at a data center 105a-n through the proxy service 140 for uploading and passing to the stored functions at each of the respective servers 220-275. According to one aspect of the invention, each data query may be configured for passing to a designated server 220-275 that may operate as a primary server 220-275 for the received data query. The primary server 220-275 may then distribute the received data query to each of the other servers 220-275 so that the data query is received and distributed to each of the servers 220-275 for processing against the data chunk groupings, as described above. As should be appreciated, any of the servers 220-275 may be designated as a primary server for different data queries. That is, by designating different servers 220-275 as primary servers for different data queries, the processing resources and requirements associated with receiving and processing data queries is spread across different servers 220-275 so that no one server is overwhelmed with processing received data queries.

[0043] Having described an example architecture and various components of aspects of the present invention with reference to Figs. 1-2B, Fig. 3 is a flowchart of an example method for processing a data query against a large data file or dataset separated into smaller data segments or chunks. The routine 300 begins at start operation 305 and proceeds to operation 310 where a stored function is uploaded to a server cluster comprised of a number of servers onto which a data file or dataset 210 has been loaded or will be loaded at operation 315 from a given enterprise or data center and to which one or more data queries may be applied for allowing a querying enterprise to perform various types of processing and for obtaining various types of reporting on the uploaded data file or dataset.

[0044] At operation 320, the data file or dataset uploaded by the enterprise is separated into data chunks, as illustrated and described above with reference to Fig. 2A. At operation 325, the data chunks are organized into data chunk groupings that may be stored at each of a set of servers 220-275 for processing, as described above with reference to Fig. 2B. At operation 330, the chunks groupings are stored at separate servers 220-275, as illustrated and described above with reference to Figs. 2A and 2B. As described above, the uploaded data files and/or datasets may be separated into separate data chunks and organized into data chunk groupings via software applications and/or devices operated at the data center and/or services provider at which the data is to be stored and processed or at the proxy service 140, or at the data centers 105a-n from which the data was originally uploaded.

[0045] At operation 335, a data query directed to the received data file or dataset is received at the storage repository 145a-n from a querying enterprise for processing a given set of data query parameters against the stored data file or dataset that has been separated and organized into data chunk groupings at each of the servers 220-275. At operation 340, the data query along with any data query parameters is uploaded to a primary server 220-275 from which the data query may be distributed to each of the servers 220-275 for operation against the data chunk groupings stored at each respective server.

[0046] At operation 345, the received data query is distributed by the primary server to each server receiving data chunk groupings. At operation 350, in accordance with the data query parameters received with the data query, the data query is run at each server on each data chunk grouping. At operation 355, results of the running of the data query at each server on each data chunk grouping are returned to the primary server from which the data queries were distributed to each of the other servers 220-275.

[0047] At operation 360, duplicate results are discarded. That is, as described above with reference to Fig. 2A, because the data chunk groupings are comprised of overlapping combinations of data chunks, each data chunk is passed to multiple data servers and is processed multiple times by the same data query. Thus, if every server 220-275 and every data query applied to the data chunk groupings stored at the respective servers 220-275 are operating properly, then results may be returned for each instance of the data chunk stored with a data chunk grouping at each server 220-275. That is, referring back to Fig. 2A, a given data chunk, for example, data chunk 2 would be processed three times at three different servers, and results for the processing of this server against data chunk 2 would be returned to the primary server at operation 360. Thus, before the results of the processing of each data chunk are aggregated, duplicate results are discarded.

[0048] At operation 365, the query results are aggregated so that a single query result is aggregated for each data chunk to generate an aggregation of query results for the entire data file of dataset. At operation 370, the results of the received query may be provided to the requesting enterprise in any format or report type or report template prescribed by the requesting enterprise. As should be appreciated, the aggregated query results may be separated into chunks and may be queried against for yet additional analysis of a data file comprised of aggregated query results from the starting data file. That is, the process described herein may be applied to any data file or data set that is considered to be too large for processing as a single file at a single server. The routine 300 ends at operation 395.

[0049] As should be appreciated from the foregoing, a large data file or dataset (e.g., comprised of potentially many gigabytes or more of raw data) may be separated into smaller data segments or chunks that then may be organized in overlapping data chunk groupings so that each data chunk grouping may be processed at a separate server by the same data query. Thus, if a given data server malfunctions, or if data stored at a given data server becomes corrupted, the reliability of the results of the data queries operated against the data chunk groupings will remain high, because the data queries will be run against duplicate data chunks causing a return of duplicate results which may be discarded after ensuring that data results are in fact returned for all data chunks. Thus, an aggregated result for application of the received data query may be processed against a very large data file or dataset, and the reliability of the returned results may be maintained at a very high level.

[0050] While the invention has been described in the general context of program modules that execute in conjunction with an application program that runs on an operating system on a computer, those skilled in the art will recognize that the invention may also be implemented in combination with other program modules. Generally, program modules include routines, programs, components, data structures, and other types of structures that perform particular tasks or implement particular abstract data types.

[0051] The embodiments and functionalities described herein may operate via a multitude of computing systems including, without limitation, desktop computer systems, wired and wireless computing systems, mobile computing systems (e.g., mobile telephones, netbooks, tablet or slate type computers, notebook computers, and laptop computers), hand-held devices, multiprocessor systems, microprocessor-based or programmable consumer electronics, minicomputers, and mainframe computers.

[0052] In addition, the embodiments and functionalities described herein may operate over distributed systems (e.g., cloud-based computing systems), where application functionality, memory, data storage and retrieval and various processing functions may be operated remotely from each other over a distributed computing network, such as the Internet or an intranet. User interfaces and information of various types may be displayed via on-board computing device displays or via remote display units associated with one or more computing devices. For example user interfaces and information of various types may be displayed and interacted with on a wall surface onto which user interfaces and information of various types are projected. Interaction with the multitude of computing systems with which embodiments of the invention may be practiced include, keystroke entry, touch screen entry, voice or other audio entry, gesture entry where an associated computing device is equipped with detection (e.g., camera) functionality for capturing and interpreting user gestures for controlling the functionality of the computing device, and the like.

[0053] Figures 4-6 and the associated descriptions provide a discussion of a variety of operating environments in which embodiments of the invention may be practiced. However, the devices and systems illustrated and discussed with respect to Figures 4-6 are for purposes of example and illustration and are not limiting of a vast number of computing device configurations that may be utilized for practicing embodiments of the invention, described herein.

[0054] Figure 4 is a block diagram illustrating physical components (i.e., hardware) of a computing device 400 with which embodiments of the invention may be practiced. The computing device components described below may be suitable for the computing devices 110, 115, 145, described above. In a basic configuration, the computing device 400 may include at least one processing unit 402 and a system memory 404. Depending on the configuration and type of computing device, the system memory 404 may comprise, but is not limited to, volatile storage (e.g., random access memory), non-volatile storage (e.g., read-only memory), flash memory, or any combination of such memories. The system memory 404 may include an operating system 405 and one or more program modules 406 suitable for running software applications 450. The operating system 405, for example, may be suitable for controlling the operation of the computing device 400. Furthermore, embodiments of the invention may be practiced in conjunction with a graphics library, other operating systems, or any other application program and is not limited to any particular application or system. This basic configuration is illustrated in Figure 4 by those components within a dashed line 408. The computing device 400 may have additional features or functionality. For example, the computing device 400 may also include additional data storage devices (removable and/or non-removable) such as, for example, magnetic disks, optical disks, or tape. Such additional storage is illustrated in Figure 4 by a removable storage device 409 and a non-removable storage device 410.

[0055] As stated above, a number of program modules and data files may be stored in the system memory 404. While executing on the processing unit 402, the program modules 406 may perform processes including, but not limited to, one or more of the stages of the method 300 illustrated in Figure 3. Other program modules that may be used in accordance with embodiments of the present invention and may include applications such as electronic mail and contacts applications, word processing applications, spreadsheet applications, database applications, slide presentation applications, drawing or computer-aided application programs, etc.

[0056] Furthermore, embodiments of the invention may be practiced in an electrical circuit comprising discrete electronic elements, packaged or integrated electronic chips containing logic gates, a circuit utilizing a microprocessor, or on a single chip containing electronic elements or microprocessors. For example, embodiments of the invention may be practiced via a system-on-a-chip (SOC) where each or many of the components illustrated in Figure 4 may be integrated onto a single integrated circuit. Such an SOC device may include one or more processing units, graphics units, communications units, system virtualization units and various application functionality all of which are integrated (or "burned") onto the chip substrate as a single integrated circuit. When operating via an SOC, the functionality, described herein, with respect to providing an activity stream across multiple workloads may be operated via application-specific logic integrated with other components of the computing device 400 on the single integrated circuit (chip). Embodiments of the invention may also be practiced using other technologies capable of performing logical operations such as, for example, AND, OR, and NOT, including but not limited to mechanical, optical, fluidic, and quantum technologies. In addition, embodiments of the invention may be practiced within a general purpose computer or in any other circuits or systems.

[0057] The computing device 400 may also have one or more input device(s) 412 such as a keyboard, a mouse, a pen, a sound input device, a touch input device, etc. The output device(s) 414 such as a display, speakers, a printer, etc. may also be included. The aforementioned devices are examples and others may be used. The computing device 400 may include one or more communication connections 416 allowing communications with other computing devices 418. Examples of suitable communication connections 416 include, but are not limited to, RF transmitter, receiver, and/or transceiver circuitry; universal serial bus (USB), parallel, and/or serial ports.

[0058] The term computer readable media as used herein may include computer storage media. Computer storage media may include volatile and nonvolatile, removable and non-removable media implemented in any method or technology for storage of information, such as computer readable instructions, data structures, or program modules. The system memory 404, the removable storage device 409, and the non-removable storage device 410 are all computer storage media examples (i.e., memory storage.) Computer storage media may include RAM, ROM, electrically erasable read-only memory (EEPROM), flash memory or other memory technology, CD-ROM, digital versatile disks (DVD) or other optical storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other article of manufacture which can be used to store information and which can be accessed by the computing device 400. Any such computer storage media may be part of the computing device 400. Computer storage media does not include a carrier wave or other propagated or modulated data signal.

[0059] Communication media may be embodied by computer readable instructions, data structures, program modules, or other data in a modulated data signal, such as a carrier wave or other transport mechanism, and includes any information delivery media. The term “modulated data signal” may describe a signal that has one or more characteristics set or changed in such a manner as to encode information in the signal. By way of example, and not limitation, communication media may include wired media such as a wired network or direct-wired connection, and wireless media such as acoustic, radio frequency (RF), infrared, and other wireless media.

[0060] Figures 5A and 5B illustrate a mobile computing device 500, for example, a mobile telephone, a smart phone, a tablet personal computer, a laptop computer, and the like, with which embodiments of the invention may be practiced. With reference to Figure 5A, one embodiment of a mobile computing device 500 for implementing the embodiments is illustrated. In a basic configuration, the mobile computing device 500 is a handheld computer having both input elements and output elements. The mobile computing device 500 typically includes a display 505 and one or more input buttons 510 that allow the user to enter information into the mobile computing device 500. The display 505 of the mobile computing device 500 may also function as an input device (e.g., a touch screen display). If included, an optional side input element 515 allows further user input. The side input element 515 may be a rotary switch, a button, or any other type of manual input element. In alternative embodiments, mobile computing device 500 may incorporate more or less input elements. For example, the display 505 may not be a touch screen in some embodiments. In yet another alternative embodiment, the mobile computing device 500 is a portable phone system, such as a cellular phone. The mobile computing device 500 may also include an optional keypad 535. Optional keypad 535 may be a physical keypad or a “soft” keypad generated on the touch screen display. In various embodiments, the output elements include the display 505 for showing a graphical user interface (GUI), a visual indicator 520 (e.g., a light emitting diode), and/or an audio transducer 525 (e.g., a speaker). In some embodiments, the mobile computing device 500 incorporates a vibration transducer for providing the user with tactile feedback. In yet another embodiment, the mobile computing device 500 incorporates peripheral device port 540, such as an audio input (e.g., a microphone jack), an audio output (e.g., a headphone jack), and a video output (e.g., a HDMI port) for sending signals to or receiving signals from an external device.

[0061] Figure 5B is a block diagram illustrating the architecture of one embodiment of a mobile computing device. That is, the mobile computing device 500 can incorporate a system (i.e., an architecture) 502 to implement some embodiments. In one embodiment, the system 502 is implemented as a “smart phone” capable of running one or more applications (e.g., browser, e-mail, calendaring, contact managers, messaging clients, games, and media clients/players). In some embodiments, the system 502 is integrated as a computing device, such as an integrated personal digital assistant (PDA) and wireless phone.

[0062] One or more application programs 550 may be loaded into the memory 562 and run on or in association with the operating system 564. Examples of the application programs include phone dialer programs, electronic communication applications, personal information management (PIM) programs, word processing programs, spreadsheet programs, Internet browser programs, messaging programs, and so forth. The system 502 also includes a non-volatile storage area 568 within the memory 562. The non-volatile storage area 568 may be used to store persistent information that should not be lost if the system 502 is powered down. The application programs 550 may use and store information in the non-volatile storage area 568, such as e-mail or other messages used by an e-mail application, and the like. A synchronization application (not shown) also resides on the system 502 and is programmed to interact with a corresponding synchronization application resident on a host computer to keep the information stored in the non-volatile storage area 568 synchronized with corresponding information stored at the host computer. As should be appreciated, other applications may be loaded into the memory 562 and run on the mobile computing device 500.

[0063] The system 502 has a power supply 570, which may be implemented as one or more batteries. The power supply 570 might further include an external power source, such as an AC adapter or a powered docking cradle that supplements or recharges the batteries.

[0064] The system 502 may also include a radio 572 that performs the function of transmitting and receiving radio frequency communications. The radio 572 facilitates wireless connectivity between the system 502 and the “outside world,” via a communications carrier or service provider. Transmissions to and from the radio 572 are conducted under control of the operating system 564. In other words, communications received by the radio 572 may be disseminated to the application programs 550 via the operating system 564, and vice versa.

[0065] The visual indicator 520 may be used to provide visual notifications and/or an audio interface 574 may be used for producing audible notifications via the audio transducer 525. In the illustrated embodiment, the visual indicator 520 is a light emitting diode (LED) and the audio transducer 525 is a speaker. These devices may be directly coupled to the power supply 570 so that when activated, they remain on for a duration dictated by the notification mechanism even though the processor 560 and other components might shut down for conserving battery power. The LED may be programmed to remain on indefinitely until the user takes action to indicate the powered-on status of the device. The audio interface 574 is used to provide audible signals to and receive audible signals from the user. For example, in addition to being coupled to the audio transducer 525, the audio interface 574 may also be coupled to a microphone to receive audible input, such as to facilitate a telephone conversation. In accordance with embodiments of the present invention, the microphone may also serve as an audio sensor to facilitate control of notifications, as will be described below. The system 502 may further include a video interface 576 that enables an operation of an on-board camera 530 to record still images, video stream, and the like.

[0066] A mobile computing device 500 implementing the system 502 may have additional features or functionality. For example, the mobile computing device 500 may also include additional data storage devices (removable and/or non-removable) such as, magnetic disks, optical disks, or tape. Such additional storage is illustrated in Figure 5B by the non-volatile storage area 568.

[0067] Data/information generated or captured by the mobile computing device 500 and stored via the system 502 may be stored locally on the mobile computing device 500, as described above, or the data may be stored on any number of storage media that may be accessed by the device via the radio 572 or via a wired connection between the mobile computing device 500 and a separate computing device associated with the mobile computing device 500, for example, a server computer in a distributed computing network, such as the Internet. As should be appreciated such data/information may be accessed via the mobile computing device 500 via the radio 572 or via a distributed computing network. Similarly, such data/information may be readily transferred between computing devices for storage and use according to well-known data/information transfer and storage means, including electronic mail and collaborative data/information sharing systems.

[0068] Figure 6 illustrates one embodiment of the architecture of a system for providing the functionality described herein across components of a distributed computing environment. Content developed, interacted with, or edited in association with the applications described above may be stored in different communication channels or other storage types. For example, various documents may be stored using a directory service 622, a web portal 624, a mailbox service 626, an instant messaging store 628, or a social networking site 630. The application 450 (e.g., an electronic communication application) may use any of these types of systems or the like for providing the functionalities described herein across multiple workloads, as described herein. A server 615 may provide the functionality to clients 605a-c and 110. As one example, the server 615 may be a web server providing the application functionality described herein over the web. The server 615 may provide the application functionality over the web to clients 605a-c and 110 through a network 125, 610. By way of example, a computing devices 110 may be implemented and embodied in a personal computer 605a, a tablet computing device 605b and/or a mobile computing device 605c (e.g., a smart phone), or other computing device. Any of these embodiments of the client computing device may obtain content from the store 616.

[0069] Embodiments of the present invention, for example, are described above with reference to block diagrams and/or operational illustrations of methods, systems, and computer program products according to embodiments of the invention. The functions/acts noted in the blocks may occur out of the order as shown in any flowchart. For example, two blocks shown in succession may in fact be executed substantially concurrently or the blocks may sometimes be executed in the reverse order, depending upon the functionality/acts involved.

[0070] The description and illustration of one or more embodiments provided in this application are not intended to limit or restrict the scope of the invention as claimed in any way. The embodiments, examples, and details provided in this application are considered sufficient to convey possession and enable others to make and use the best mode of claimed invention. The claimed invention should not be construed as being limited to any embodiment, example, or detail provided in this application. Regardless of whether shown and described in combination or separately, the various features (both structural and methodological) are intended to be selectively included or omitted to produce an embodiment with a particular set of features. Having been provided with the description and illustration of the present application, one skilled in the art may envision variations, modifications, and alternate embodiments falling within the spirit of the broader aspects of the general inventive concept embodied in this application that do not depart from the broader scope of the claimed invention.

WE CLAIM:

1. A computer implemented method for managing database queries to large datasets, comprising:

receiving a dataset at a data center;

separating the dataset into a plurality of data chunks;

organizing the plurality of data chunks into groupings of data chunks, each grouping being a subset of the plurality of data chunks and each grouping having the same number of data chunks;

storing each of the data chunk groupings at a different server; and

at each of the different servers, running a data query on each data chunk comprising each data chunk grouping.

2. The computer implemented method of Claim 1, further comprising returning a result of the running of the data query on each of the plurality of data chunks.

3. The computer implemented method of Claim 2, further comprising discarding duplicate results for any of the plurality of data chunks.

4. The computer implemented method of Claim 2, further comprising:

aggregating results for each of the plurality of data chunks; and

reporting the aggregated results to a querying party.

5. The computer implemented method of Claim 1, wherein organizing the plurality of data chunks into groupings of data chunks further comprises organizing the plurality of data chunks into groupings of data chunks wherein a number of groupings into

which the plurality of data chunks are organized is such that each data chunk is included in at least two or more groupings to ensure redundant query processing on each data chunk.

6. The computer implemented method of Claim 5, wherein separating the dataset into a plurality of data chunks includes separating the dataset into 12 data chunks.

7. The computer implemented method of Claim 6, wherein organizing the plurality of data chunks into groupings of data chunks includes organizing the plurality of data chunks into 12 groupings of data chunks.

8. The computer implemented method of Claim 7, wherein organizing the plurality of chunks into groupings of data chunks includes organizing the plurality of data chunks into groupings comprised of three data chunks per grouping such that each data chunk is included in at least three data chunk groupings.

9. The computer implemented method of Claim 1, further comprising installing a stored function on each of the different servers at the data center onto which each data chunk grouping is stored.

10. The computer implemented method of Claim 9, prior to running the data query on each data chunk comprising each data chunk grouping, receiving a data query at a primary server on which is installed the stored function.

11. The computer implemented method of Claim 10, further comprising distributing the received data query from the primary server to each of the different servers on which is installed the stored function.

12. The computer implemented method of Claim 11, wherein receiving the data query includes receiving the data query with one or more query parameters for causing the data query to process the dataset as requested by a querying entity.

13. A reporting infrastructure for large datasets, comprising;

one or more processors;

memory storing one or more modules that are executable by the one or more processors, the one or more modules comprising:

a dataset grouping and distribution module operative to

receive a dataset at a data center;

separate the dataset into a plurality of data chunks;

organize the plurality of data chunks into groupings of data chunks, each grouping being a subset of the plurality of data chunks and each grouping having the same number of data chunks;

store each of the data chunk groupings at a different server; and

a stored server function module stored at each of the different servers, the stored server function module being operative to

run a data query on each data chunk comprising each data chunk grouping at each of the different servers.

14. The system of Claim 13, the stored server function module being further operative to

receive a result of the running of the data query on each of the plurality of data chunks;

discard duplicate results for any of the plurality of data chunks; and

aggregate results for each of the plurality of data chunks; and

report the aggregated results to a querying party.

15. The system of Claim 13, the dataset grouping and distribution module being further operative to organize the plurality of data chunks wherein a number of groupings into which the plurality of data chunks are organized is such that each data chunk is included in at least two or more groupings to ensure redundant query processing on each data chunk.

16. The system of Claim 13, the dataset grouping and distribution module being further operative to

separate the dataset into 12 data chunks;

organize the plurality of data chunks into 12 groupings of data chunks; and

organize the plurality of data chunks into groupings comprised of three data chunks per grouping such that each data chunk is included in at least three data chunk groupings.

17. The system of Claim 13, the stored server function module being further operative to receive a data query at one of the different servers designated as a primary server prior to running the data query on each data chunk comprising each data chunk grouping.

18. The system of Claim 17, the stored server function module being further operative to distribute the received data query from the primary server to each of the different servers on which is installed the stored function.

19. A computer readable medium on which is stored computer executable instructions which when executed by a computer perform method for managing database queries to large datasets, comprising:

receiving a dataset at a data center;

separating the dataset into a plurality of data chunks;

organizing the plurality of data chunks into groupings of data chunks, each grouping being a subset of the plurality of data chunks and each grouping having the same number of data chunks;

storing each of the data chunk groupings at a different server;

at each of the different servers, running a data query on each data chunk comprising each data chunk grouping;

returning a result of the running of the data query on each of the plurality of data chunks;

aggregating results for each of the plurality of data chunks; and

reporting the aggregated results to a querying party.

20. The computer readable medium of Claim 19, further comprising discarding duplicate results for any of the plurality of data chunks.

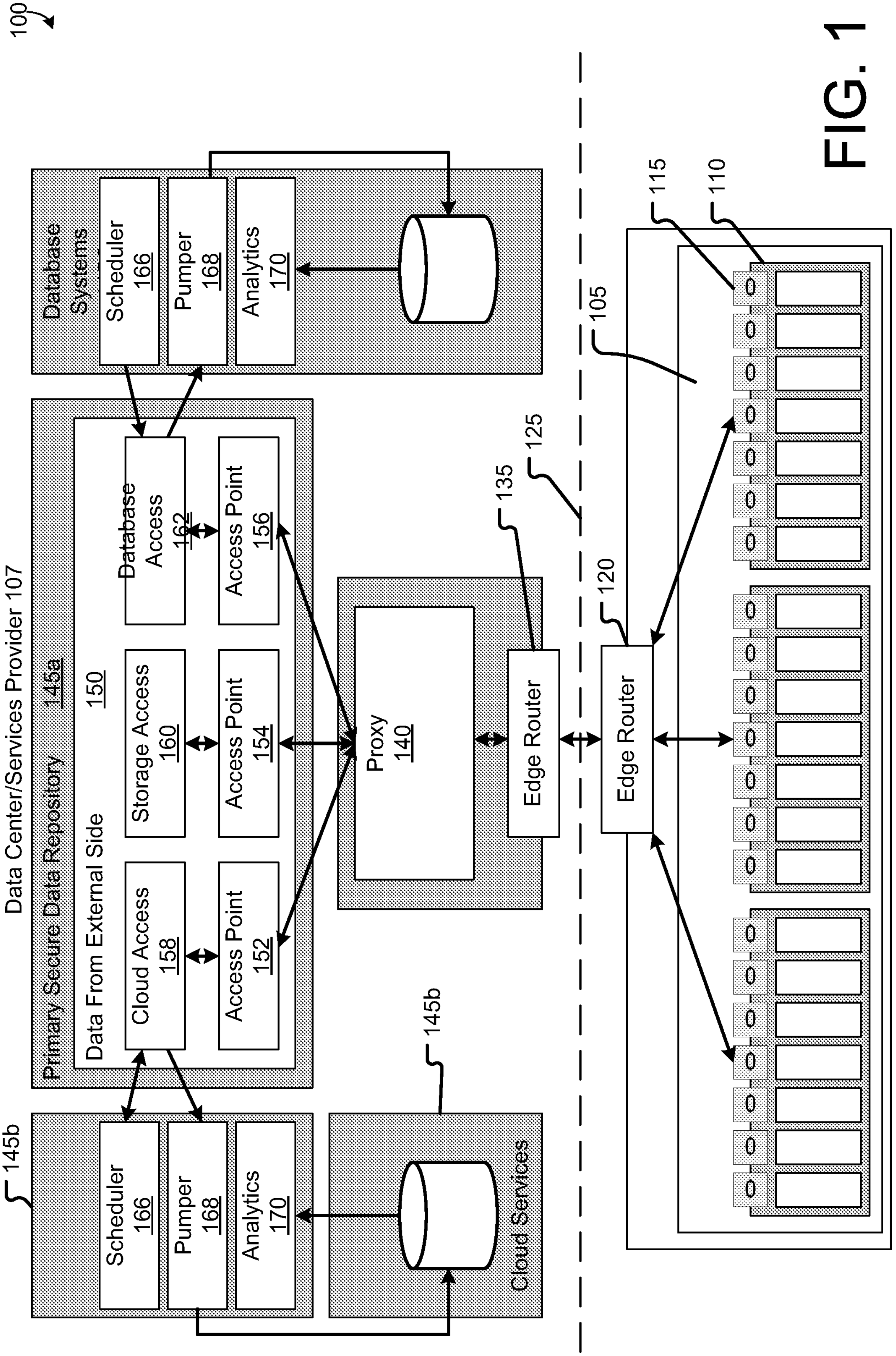
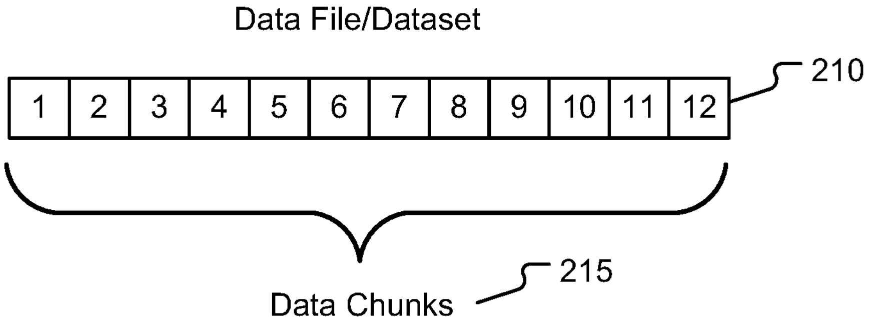

100
Database Systems
Scheduler 166
Pumper 168
Analytics 170
Data Center/Services Provider 107
Primary Secure Data Repository 145a
Data From External Side 150
Database Access 162
Storage Access 160
Cloud Access 158
Access Point 156
Access Point 154
Access Point 152
145b
Scheduler 166
Pumper 168
Analytics 170
145b
Cloud Services
Proxy 140
Edge Router
135
125
Edge Router
120
105
115
110

FIG. 1



220-275

215

Server	Data Chunks		
1	1,	2,	3
2	2,	3,	4
3	3,	4,	5
4	4,	5,	6
5	5,	6,	7
6	6,	7,	8
7	7,	8,	9
8	8,	9,	10
9	9,	10,	11
10	10,	11,	12
11	11,	13,	14
12	12,	1,	2

FIG. 2A

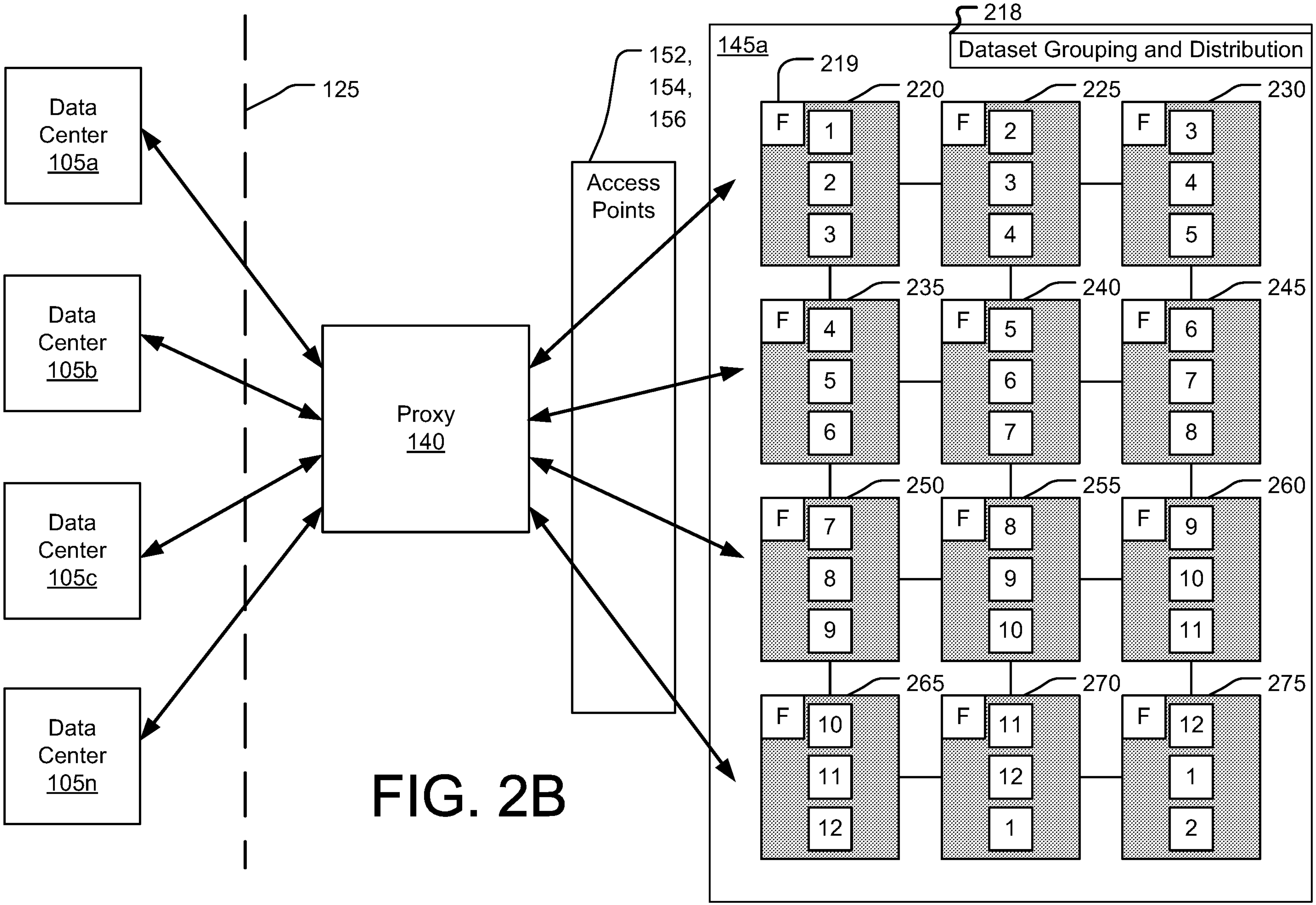

Data Center 105a
Data Center 105b
Data Center 105c
Data Center 105n
125
Proxy 140
Access Points
152, 154, 156
145a
218
Dataset Grouping and Distribution
219
220
225
230
235
240
245
250
255
260
265
270
275
F
1
2
3
4
5
6
7
8
9
10
11
12

FIG. 2B

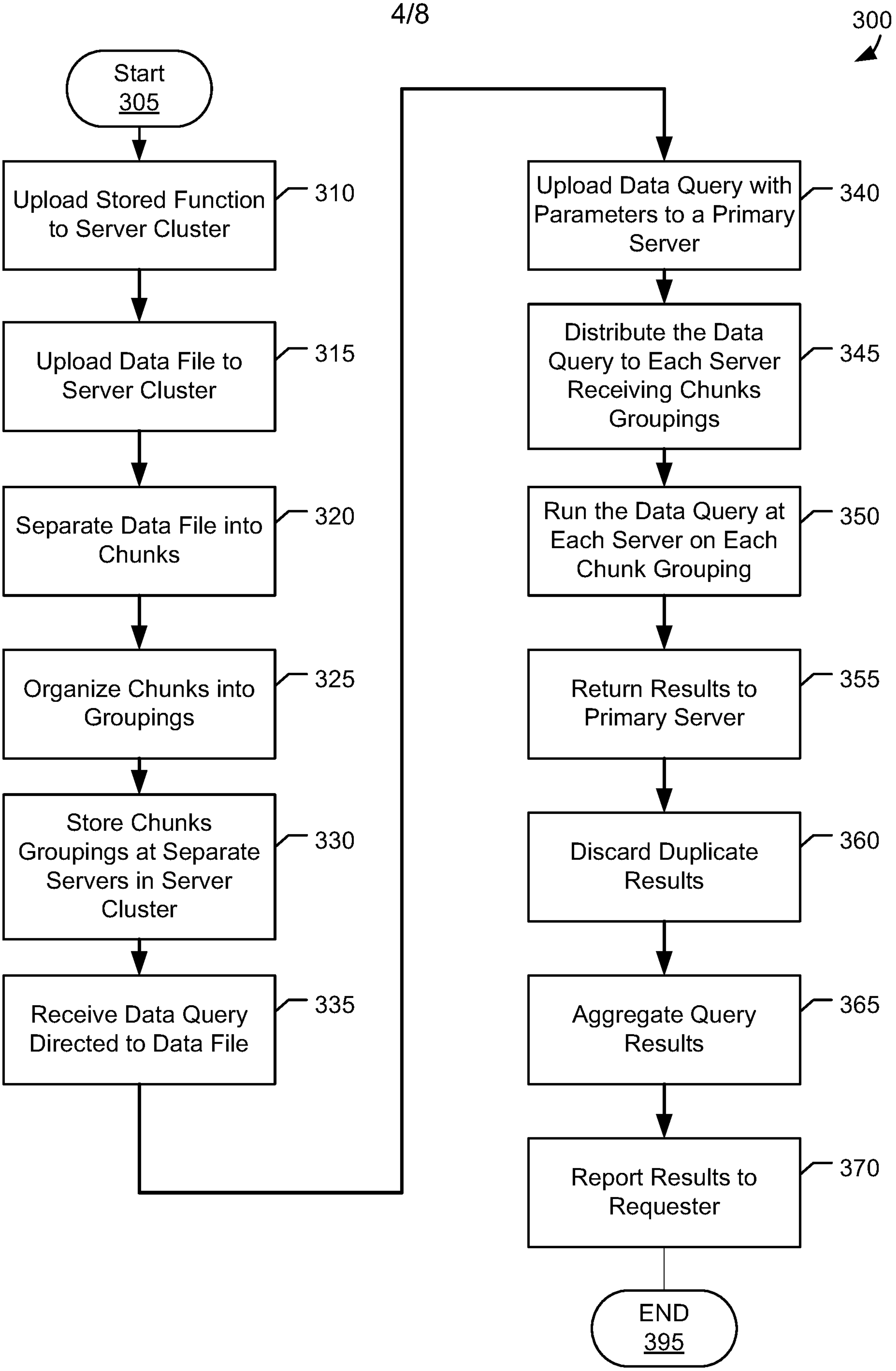

300
Start
305
Upload Stored Function to Server Cluster
310
Upload Data File to Server Cluster
315
Separate Data File into Chunks
320
Organize Chunks into Groupings
325
Store Chunks Groupings at Separate Servers in Server Cluster
330
Receive Data Query Directed to Data File
335
Upload Data Query with Parameters to a Primary Server
340
Distribute the Data Query to Each Server Receiving Chunks Groupings
345
Run the Data Query at Each Server on Each Chunk Grouping
350
Return Results to Primary Server
355
Discard Duplicate Results
360
Aggregate Query Results
365
Report Results to Requester
370
END
395

FIG. 3

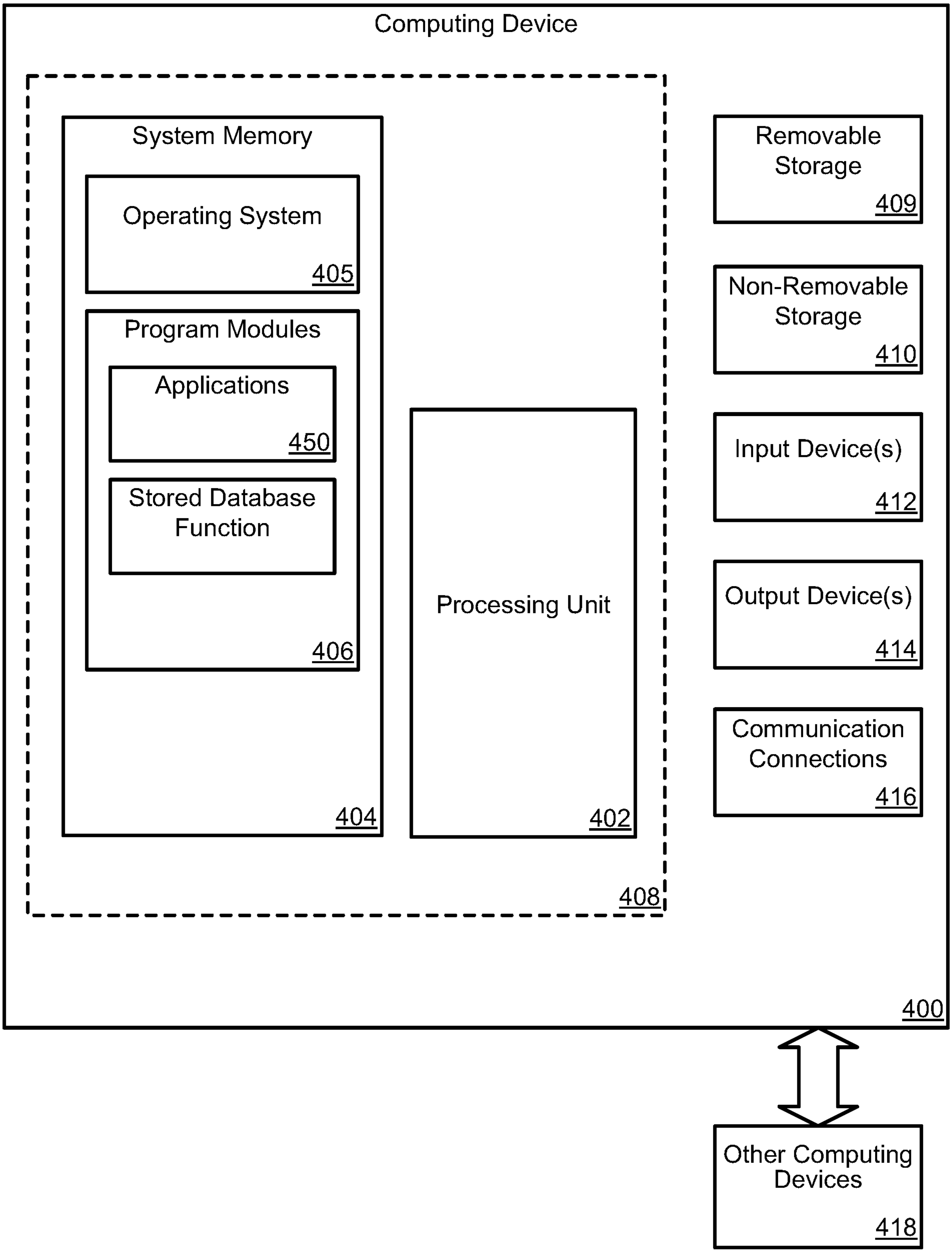
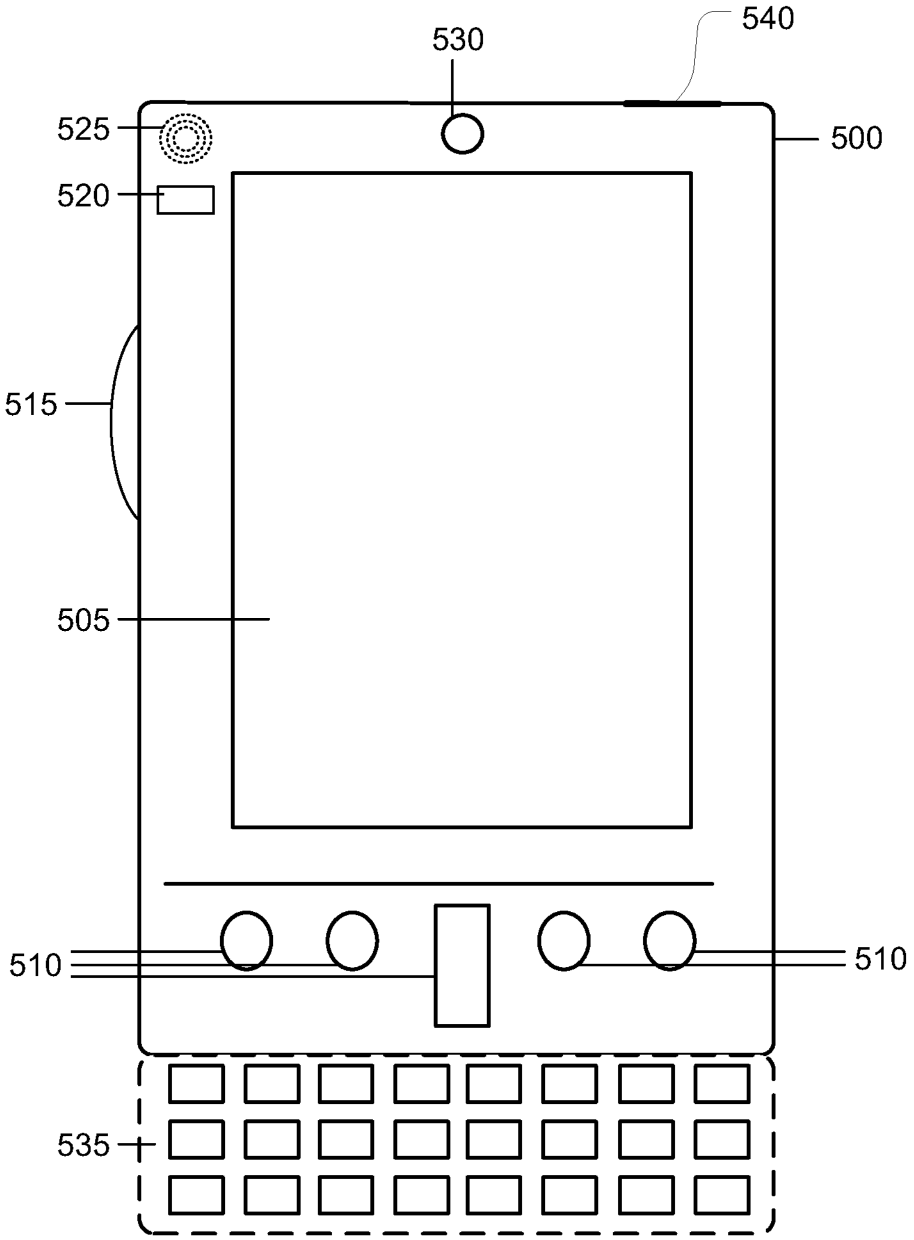

Computing Device
System Memory
Operating System
405
Program Modules
Applications
450
Stored Database Function
406
404
Processing Unit
402
408
Removable Storage
409
Non-Removable Storage
410
Input Device(s)
412
Output Device(s)
414
Communication Connections
416
400
Other Computing Devices
418

FIG. 4



Mobile Computing Device

FIG. 5A

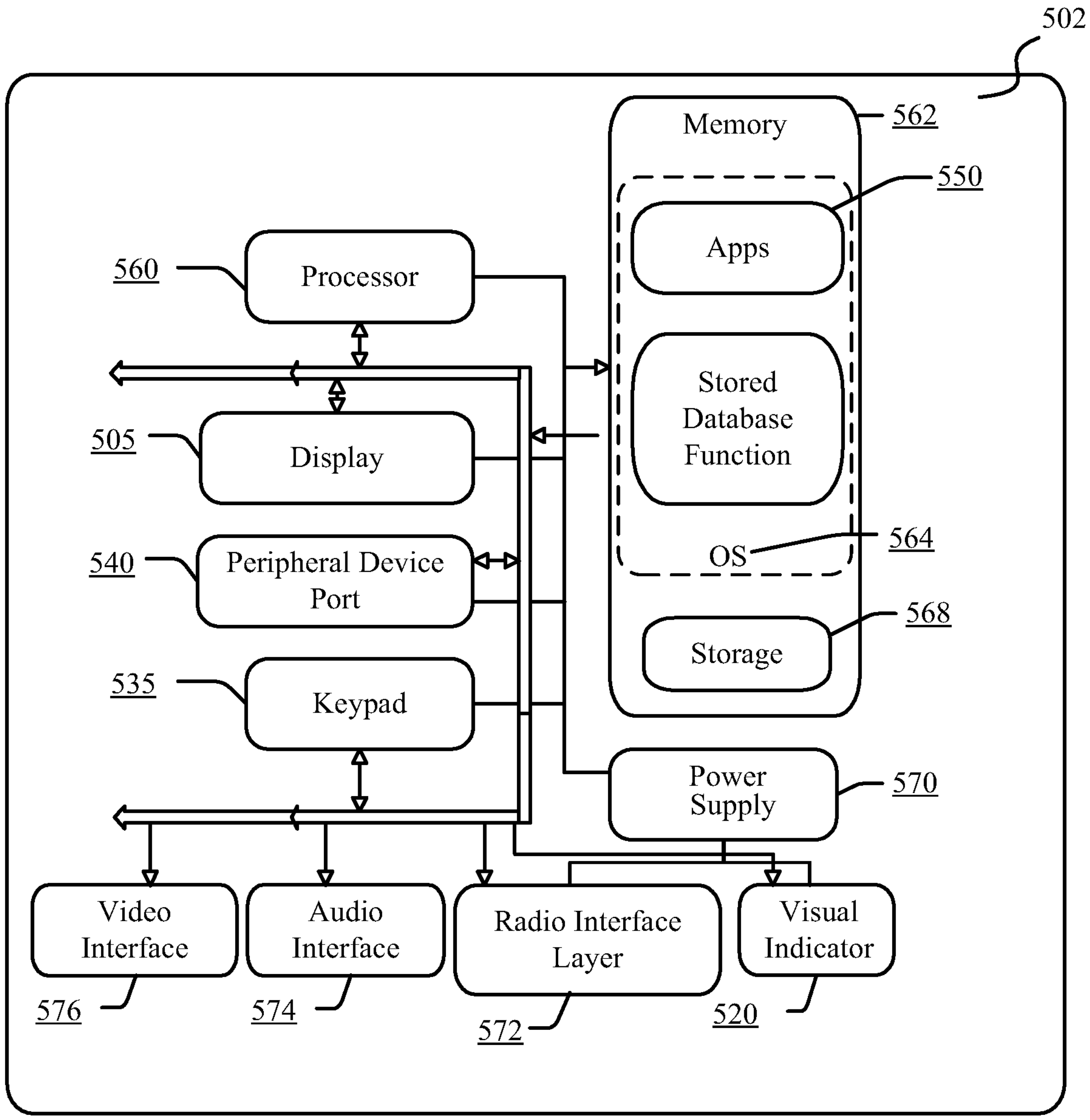

502
Memory
562
550
Apps
560
Processor
Stored
Database
Function
505
Display
564
540
Peripheral Device
Port
OS
568
Storage
535
Keypad
Power
Supply
570
Video
Interface
Audio
Interface
Radio Interface
Layer
Visual
Indicator
576
574
572
520

FIG. 5B

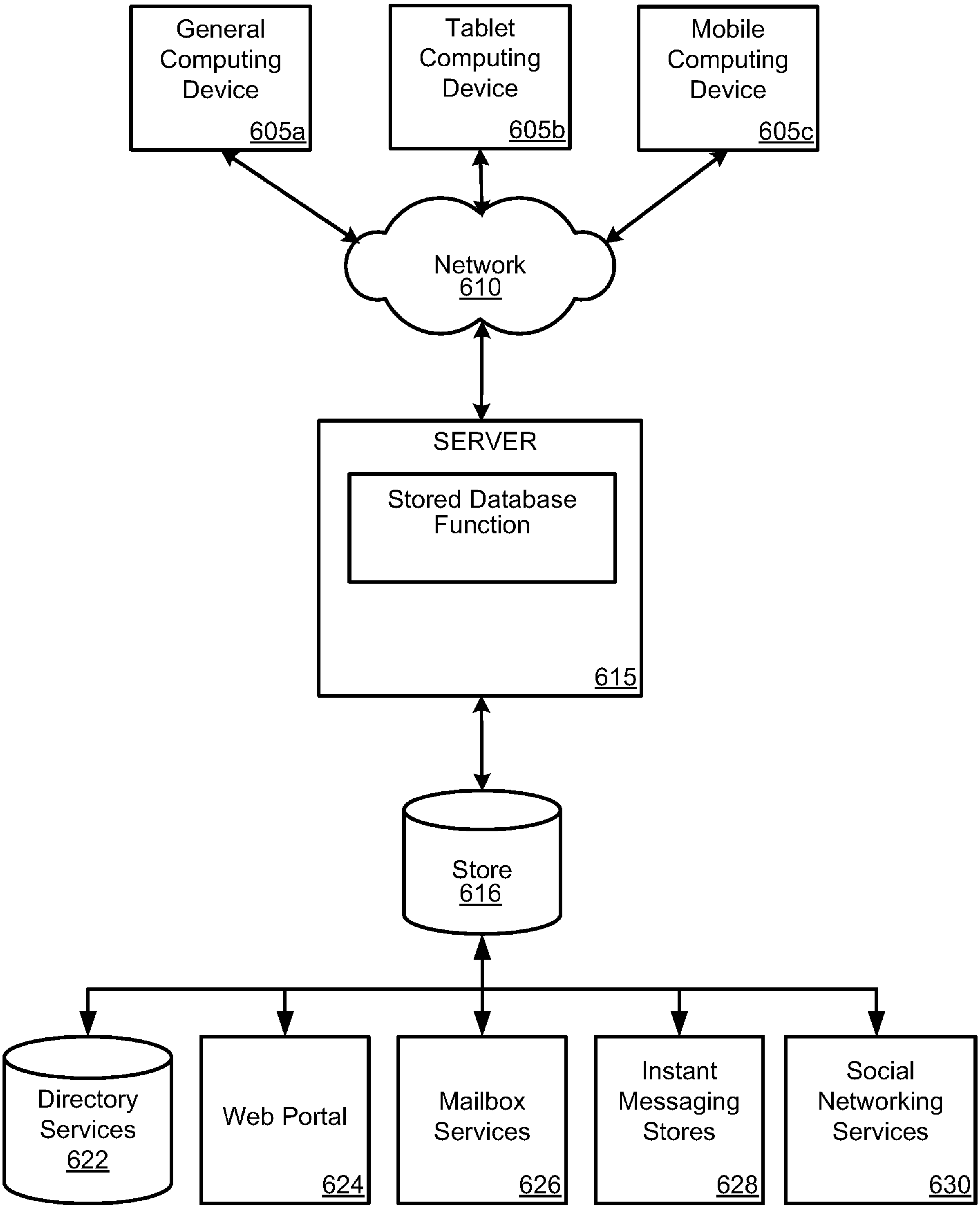

General Computing Device
605a
Tablet Computing Device
605b
Mobile Computing Device
605c
Network
610
SERVER
Stored Database Function
615
Store
616
Directory Services
622
Web Portal
624
Mailbox Services
626
Instant Messaging Stores
628
Social Networking Services
630

FIG. 6

INTERNATIONAL SEARCH REPORT	International application No. **PCT/CN2015/073489**

A. CLASSIFICATION OF SUBJECT MATTER

G06F 17/30(2006.01)i；G06F 12/08(2006.01)i

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)

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 practicable, search terms used)

CPRS, VEN, IEEE, CNKI: LARGE DATABASE? MASS QUER+ GROUP+ SUBSET? DATA CHUNK? SERVER? NODE

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2010332791 A1 (XU Y) 30 December 2010 (2010-12-30) description，paragraphs [0016] to [0027] and figures 1-5)	1，9-13，16-18
Y	US 2010332791 A1 (XU Y) 30 December 2010 (2010-12-30) description，paragraphs [0016] to [0027] and figures 1-5)	5-8，15
A	US 2010332791 A1 (XU Y) 30 December 2010 (2010-12-30) description，paragraphs [0016] to [0027] and figures 1-5)	2-4，14，19，20
Y	CN 101496012 A (MICROSOFT CORP) 29 July 2009 (2009-07-29) description，page 7，line 21 to page 8，line 24，and figure 4	5-8，15
A	CN 101496012 A (MICROSOFT CORP) 29 July 2009 (2009-07-29) description，page 7，line 21 to page 8，line 24，and figure 4	1-4，9-14，16-20
A	CN 101908075 A (SHANGHAI YUNJIAO INFORMATION TECHNOLOGY CO LTD) 08 December 2010 (2010-12-08) the whole document	1-20
A	CN 103473334 A (ZHEJIANG MULTIMEDIA CONTROL SYSTEM TECHN) 25 December 2013 (2013-12-25) the whole document	1-20

☑ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"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

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"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 **17 November 2015**	Date of mailing of the international search report **30 November 2015**
Name and mailing address of the ISA/CN **STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA** **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088, China** Facsimile No. **(86-10)62019451**	Authorized officer **HU,Yan** Telephone No. **(86-10)62089101**

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2015/073489

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 6772166 B1 (NCR CORP) 03 August 2004 (2004-08-03) the whole document	1-20

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2015/073489

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
US 2010332791 A1	30 December 2010	None	
CN 101496012 A	29 July 2009	JP 2009545060 A	17 December 2009
		US 7624118 B2	24 November 2009
		KR 20090035545 A	09 April 2009
		AU 2007277429 A1	31 January 2008
		CA 2656024 A1	31 January 2008
		WO 2008013632 A1	31 January 2008
		BR PI0714328 A2	25 December 2012
		MX 2009000589 A	27 January 2009
		US 2008027920 A1	31 January 2008
		TW 200820023 A	01 May 2008
		EP 2044536 A1	08 April 2009
CN 101908075 A	08 December 2010	None	
CN 103473334 A	25 December 2013	None	
US 6772166 B1	03 August 2004	None	