DATABASE DYNAMIC MANAGEMENT PLATFORM (DBDMS) IN OPERATIVE SOFTWARE SYSTEMS

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1. INTRODUCTION

In a globalized society with state of the art informational technologies, Operative Software systems (OSS) that companies use are always under stress to adapt to the dynamics of always more sophisticated demands of precise information delivery. These systems need to adapt as soon as possible to deliver information to all online connected users that need to access Databases (DB) used to store information by the systems.

Because of these conditions, Databases used by OSS are always undergoing changes and updates both in the data they are storing but also in their structure and schemas, in order to quickly adapt to changes in requirements, at a low cost in order to provide an optimal cost-benefit relationship.

These are a few of the basic sources of database structure and content updates that require updating and storing new versions of databases:

- the evolution of the systems in question determined by the requirements to integrate it in a globalized world; this evolution imposes an update dynamic for OSS in order to provide adequate responses for attribute dynamics: exact information provided timely, anywhere, anytime, to any number of online users;
- the explosive evolution of new information technologies, imposes the adoption of some precautionary measures in order for OSS to be transferred on new hardware and on new operating systems;
- the evolution of Database Management Systems (DBMS) performance and data storing opportunities;
- legal changes in the business environment and the IT&C environment;
- the list could go on;

The solutions offered by cloud DBMS are different from other locally found systems, because they do not require physical installation and because they can be accessed with just an Internet connection and a Web browser.

Regardless of where it is being accessed from (home, work, automobile, anywhere), the DBMS stores and offers at any time the software, documents, files and data that are needed to keep an OSS functioning. This can be seen as the technical means required to keep pace with the ever growing activity of the system in question.

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The DBDMS offers access from anywhere and any device connected to the Internet - computer, mobile phone, tablet - without interruption, without time loss and at affordable prices. In a cloud environment, the DBDMS platform handles in a permanent and continuous way, the updates of structure and content for operational databases, using an operational versions management system.

Access for company users for these versions of the operational databases are managed by this platform, removing down times caused by technical and data security requirements, allowing for an increase in productivity for company personnel.

The DBDMS platform is an advanced technical solution, without huge extra initial costs (servers, licenses). The costs for servers and storage space decrease significantly, allowing for a flexible configuration of access for authorized users to data stored in different successive versions (content and dynamic structures) following current business needs. In the cloud costs are predictable, easy to measure and always optimized.

The DBDMS platform can be adapted to the specifics of the system in question, maintaining its essence unchanged and this way eliminating the barriers that appear in the natural evolution of structures and data contents that are stored in these databases. System upgrades are offered at a periodic rate in order to keep up with the level of competitiveness and be against it. DBDMS can be integrated in a stable, unitary and perfectly operational platform in any system regardless of company size and domain.

Any altering of the requested data or data structure determines the transfer of those changes instantaneously to other operational versions, thus saving time because there is no need to input the data again and data query is assured to be easy no matter the version of database they are stored in.

The proposed cloud solutions work in pair with other software applications that are in use and that are to be kept in use.

The cloud DBDMS platform offers a safe and secure work environment which allows for safe and secure data storage and keeps unwanted users away and data is not lost in the race of changes, number of users or change of files and documents. Access is reserved only to authorized users.

The cloud DBDMS solutions are designed to best address the requirements of each department of the system in question and offer dedicated solutions that cover the entire range of the following interest levels: efficient integrated internal process management (data content and structure), streamlining of the operational flow, productivity increase and optimization of the cost-performance relationship.

These are a few of the advantages offered by the DBDMS platform:

- Reduced costs – there are no initial acquisition, implementation and equipment maintenance costs, because there is no need to create a new infrastructure;

- Flexibility – the solution is easy to implement, there is no need to install hardware / software, and it can be used from anywhere and any device. Moreover, at any time new users can be added to the system;
- Scalability – costs are based on effective number of users and updating their number is done immediately;
- Mobility – the solution can be accessed at any time and from anywhere, from any equipment as long as there is a connection to the Internet;
- Modularity – each company activity is managed by a specific application. The solution's models work either in an integrated manner, using a single database, or independently;
- Security – an advanced level of security is provided for stored data. This data is protected against industrial espionage, theft or definitive loss of data;
- Integrability – the solution integrates the whole activity of a company in a unique database. The tracking of all financial and accounting documents within the company is allowed, along with processes undertaken on these documents and contribution from each user that has worked on the database;
- Business process efficiency – The systems allows for organizational objective fulfillment, providing for real time control and efficiency growth by offering decisional support;
- Coordination – The system allows for activity planning and work flow control in real time.

2. FACILITIES OFFERED BY CLOUD STORAGE

Cloud storage is a network of storage for data and data objects (images, text documents, sound and video files) in virtualized areas hosted by a provider. The provider operates with the data centers (BIGD) that are distributed among many servers and locations and a personnel that requires own data that has been stored in memory locations at a price. Data center operators virtualize available resources and provide, by request, memory locations that users can use by themselves to store data and data objects. The security of files is offered by the provider and by software applications that are being used.

The cloud storage system can be accessed through a web service application programming interface (API) or through applications that use this API like cloud desktop storage, cloud storage gateway or web-based content management systems.

The new concepts of cloud computing and cloud storage, first envisioned by Joseph Carl Robnett Licklider in the 1960s, work with a large array of terms, from which we underline: storage cloud, private cloud storage, mobile cloud storage, public cloud storage, hybrid cloud storage, personal cloud storage, public cloud, cloud backup, cloud enablement, hybrid cloud, cloud services, private cloud, cloud computing, Amazon Simple Storage Service - Amazon S3, etc. [5], [6].

Cloud storage provides a virtual IT structure that can evolve as fast as the system in question, offering a generous environment for developing operational software systems for companies and small and medium enterprises. Small companies can use a section of cloud storage and a specialized software (sync) managed by the provider where they can operate data storage and retrieval queries form any authorized mobile device. [4] Data back-up is made outside of company headquarters, on multiple servers, which allows for a better security model in case of force majeure situations like fires and floods. For example, we can mention some of the best known cloud storage systems like Dropbox and SugarSync or a large number of cloud drive systems like Google Drive, SkyDrive and others.

A lot of providers offer free space as a starting point, with ranges from 5 to 25 GB and only charge for extra space or bandwidth.

Companies and especially small companies that use these services benefit from significant saving in time and money.

These are some of the benefits:

- Cost reduction – the host cloud server optimizes the relationship between: computing speed – storage space – time – running costs and provides for a significant save at company level for these level when thinking about running software systems;
- Anytime and anywhere – desktop storage allows for cloud storage access of stored files from any authorized device anytime via a specific software application (sync). A user’s files are stored on multiple servers lowering the risk of technical incidents to a minimum;
- Easy collaboration – saving and accessing files in cloud storage is available in a multiuser-multitasking regime, so that all authorized users can access the same stored data at the same time;
- Risk reduction – cloud storage provides data security by off-site data backup, reducing the risk of virus infections and other cyber-attacks;
- Increase in efficiency – after migrating to cloud storage, small companies won’t have problems regarding computing power, storage space or access to specialized software;

Notions, concepts and definitions

Any software system stores data in records that are organized in files stored on magnetic drives to allow for quick retrieval.

Let there be:

{R} – array of records

{S} – array of address in the storage space where data is written for these records

{C} – array of data requests for records in storage

A database DB (R, S, C) for a software system is array R, stored on drive S, in order to satisfy the requests found in C (retrieval of requested data in time).

Any database (DB) has a structure of R arrays applied over S (expressed by the structure of files which store data) and a content for that data at the time $t+t_0$.

Organizing the DB, O {DB {R, S, C}} is defined as both the content and the files in which data is stored.

The main objective of any O {DB{R, S, C}} is the optimization of the relation between storage space S and retrieval time t(ci) under the aspect of total cost.

In mathematical terms, this objective can be formulated as follows:

With M {O {DB{R, S, C}}} being given, identify a structure O{DB{R, S, C}} that can optimize the following relationship:

Min {t(ci), Vci C} at the same time with min Cost (O{BD{R,S,C}}) – under the aspect of total cost.

A general solution for this problem is difficult to obtain because of the complex structures and the volume of data related to the arrays R, S, C.

In order to achieve this objective, a wide range of techniques for organizing O {DB{R, S, C}} have been developed from simple files to state of the art RDBM systems.

The operational software system (OSS) needs to provide exact data in time, anywhere, anytime, to any users connected online and, in this context, the contents of the database, as a support for the OSS, is a updated through the operational flows of the system in question.

The dynamics of these updates affect both the current contents of the DB (arrays R and S) and the structure of O {DB{R, S, C}}, influenced by the dynamics of the requests in array C.

We define a dynamic database (DDB) the array O_i{BD(R,S,C)}, for i=1,2 … n in which O_k{BD(R,S,C)} represents O{BD(R,S,C)} at the point in time $t=t_k$. We define the platform DBDMS as being the software platform that manages the different versions O_i{BD(R,S,C)} of the OSS by using cloud facilities.

3. THE DDBMS PLATFORM FOR OPERATIVE SOFTWARE SYSTEMS

Through the information flows of the system in question (companies, central or local state administrative unite, banks, etc.) the arrays R, S and C are always updated (many times the updates being in real time), both at the content and structure levels (files, file structures, keywords, etc.).

In [3] aspects related to Boolean algebra for record arrays are presented and a O{BD(R,S,C)} is proposed as a Boolean algebra of all possible answers and the mechanisms specific to large databases (BIGD).

Let us follow the dynamics of updates in a OSS and, implicitly, the dynamics of the O_i{BD(R,S,C)} array.

In order to secure the normal functionality of the OSS and to avoid system crashes in case of technical incidents, mechanisms for saving and restoring the state of the OSS have been refined. These are among the most known such mechanisms:

- Backups of different versions of DB and transaction files; in case of technical incidents (hardware or software malfunctions) the DB is to be restored base on these files and updated with the transactions from transaction files from the last DB save;
- For some certain OSSs (like banking systems), along backups the so called mirroring system is used, i.e. the parallel and real time activity of supplemental DB updating mechanisms;
- In all classical OSSs, the altering of DB structure is forbidden.

The facilities offered by cloud systems and state of the art software technologies leads to new approaches for the processes of updating, saving and restoring DB (R, S, C). The processes of updating the DB according to request dynamics have driven the development of new platforms that can provide updates to data and structures, but also to save / restore processes in real time to the last version of the O{BD(R,S,C)}.

In accordance with the dynamics of the OSS in the stage of facilities offered by cloud and new software technologies (laptop, mobile phone, tablet) we observe the following new notations in the DB:

$R \rightarrow R + Ri,$

$S \rightarrow S + Si$

$C \rightarrow C + Ci$

Where Ri, Si, Ci represent changes in structure for the DB, meaning either changes in records in some DB files or the addition or deletion of some files.

In this new context, using the previous notations, the aspects of dynamic update of the DB, using the mathematical notations from above, can be expressed as follows:

$$Oi\{BD(R + Ri, S + Si, C + Ci)\}, \text{ for } i = 1,2,\ldots n$$

Where

- {Ri} – the new structures of the R array (expressed by either changes in the structures of existing DB files or by the addition or deletion of files);
- {Si} – the array of addresses of the storage space in which these records are stored;
- {Ci} – new requests of the system in question

With the new notation let’s consider a number of keywords (fields contained in the DB records), denoted as k1, k2, k3 … kn with the property that any record in {R + Ri} contains at least one ki keyword.

We denote with:

R(ki) +Ri(ki)} set of records that contain the keyword ki;

{A(ki) +Ai(ki)} list of addresses that hold the records found in the array {R(ki) +Ri(ki)};

From [3] we can prove that any request from C for the DB can be written as a Boolean function like:

F(k1, k2, k3, …, kn) = Ki

The answer to this request for data is found in the record collection B B(R + Ri), where we name the array B(R + Ri) the array of all possible answers.

4. TECHNIQUES FOR SAVING / RESTORING OF THE DB IN OSS

In DBs of OSSs various files store numerical data and object data (images, text documents, multimedia files) as well as addresses for records that allow the retrieval of this data in time.

The file for direct transactions is an intermediary file that contains all data used to undertake the following operations on the DB:

- Inserting new records in the DB certain files;
- Deleting records from certain DB files;
- Changing records in certain DB files.

The file for reflected transaction is a file attached to the direct transaction file of the system in the following way:

- For any record in the direct transaction file there is a record in the reflected transaction file defined as follows:
  Let us consider:
  - records of the direct transactions file:
    $x_i = \{d_{k_i}(t), k = 1 \dots n\}; i = 1 \dots p; t \in T$
  - records of the database
    $\tilde{x}_i = \{a_{k_i}(t), k = 1 \dots n\}; i = 1 \dots p; t \in T$
  - records of the reflected file
    $\bar{x}_i = \{\bar{d}_{k_i}(t), k = 1 \dots n\}; i = 1 \dots p; t \in T$

    $\bar{d}_{k_i}(t)$ is defined as:

    1. $\bar{d}_{k_i}(t) = -d_{k_i}(t), if\ a_{k_i}(t) := a_{k_i}(t) + d_{k_i}(t)$
    2. $\bar{d}_{k_i}(t) = d_{k_i}(t), if\ a_{k_i}(t) := a_{k_i}(t) - d_{k_i}(t)$

3. $\bar{x}_i := \bar{x}_i \cup \{\bar{d}_{k_i}(t), k = 1 \ldots n\}$ if $\tilde{x}_i := \tilde{x}_i \cap \{\bar{d}_{k_i}(t), k = 1 \ldots n\}$
4. $\bar{x}_i := \bar{x}_i \cap \{\bar{d}_{k_i}(t), k = 1 \ldots n\}$ if $\tilde{x}_i := \tilde{x}_i \cup \{\bar{d}_{k_i}(t), k = 1 \ldots n\}$

- Both files will be stored in cloud storage but on different servers and will serve for both monitoring the correct evolution of the DB (by comparing records from transaction T at the moment t1) and for rebuilding the DB in case of a technical incident, by using the backup of the DB at the moment t and undertaking direct and reflected transactions on that backup from the interval t + t1 and comparing the comparing the contents of these two rebuilt DBs by the use of the two rebuild procedures.

This way, by using the 3 entities (DB, direct transactions file, reflected transactions file) and by using the procedures for rebuilding the contents of the DB at the moment t + t1 procedures and methods are provided for rebuilding the DB at certain moments its evolution. This is requested on one hand by the possibility of the destruction of the DB (technical incidents, cyber-attacks, etc.) and on the other hand by the frequent reports demanded on the state of the system at a given point in time.

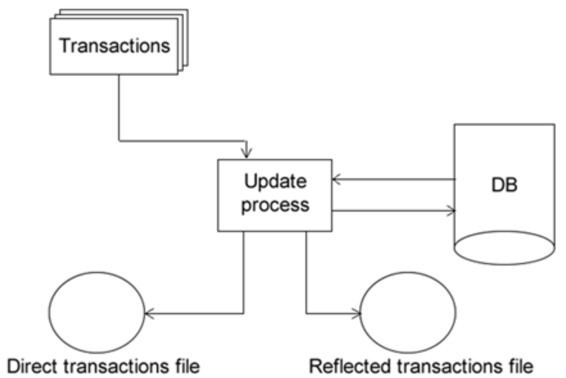

Figure 1 DB update and reflected transaction file creation

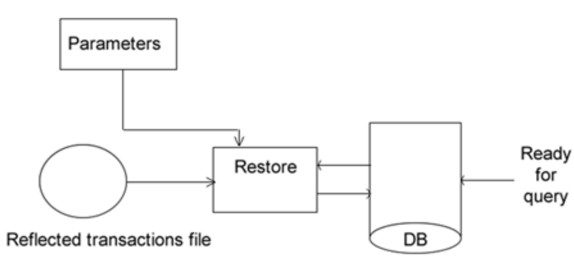

Figure 2 Restoring de DB at a certain stage

5. CONCLUSIONS

Cloud storage facilities for securely storing the three entities allows for designing and maintaining dynamic DBs in service. These DBs can support, besides the classical operations of updating (adding, deleting, changing records), the update of the DB structure, the change of the structure of records in DB files and the addition and deletion of DB files dynamically according to the evolution of the system in question.

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