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Research Letter

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Positioning CortexDB – Innovative Bi-Temporal, Multimodal NoSQL Technology

CortexDB is a bi-temporal, multimodal NoSQL database technology proving a flexible platform for agile enterprise web applications. It has been developed based on findings in brain research.

What makes CortexDB unique?

It differs from all known databases via its **index structure**.

Different types of database management system are determined by their database schema. In the case of relational databases, data are organized in tables with columns and rows. Columns are nominated as unique identifiers and represent relationships across tables. Columns with the same domain are used to join tables. Other NoSQL databases (NoSQL = "Not only SQL") have a different database schema like key-value store, document store, etc. All these databases are different in the way they organize data. Also, in many cases, it is the application that defines the schema. The use of indices is common for all databases. Indices are flat structures of data with a reference to records (either table rows, document IDs etc.) so that they can access data in a sorted order. Hence, special indices for different types of data make up the main differences between databases, but their index structure is always flat.

CortexDB works differently. At first glance, it is a **schemaless** database, and one may compare it to document stores, but it is much more. It comes with a content based index structure (CorAIT[1]). This means that each item of content (value) knows in what kind of fields (keys) and in which records (Doc-ID) it exists, and every key knows what different types of values are used. So, CortexDB has a universal index of all fields with all occurrences representing the whole database. Consequently, all data queries are based on the index structure without the need for joins. This also implies that a database schema is only used for output of data (data records or data documents). The memory consumption for all indices is about the same size as the size of a CSV file containing the raw data.

[1] AIT = Active Index Transformation

Features of CortexDB:

- CortexDB acts like **multimodal NoSQL** technology. It combines ALL the advantages of the various types of NoSQL databases (Key value; Document store; Graph DB; Multi value DB; Column DB). This is achieved by the index structure of CorAIT. That means that no special or user-defined index is used for fast data access, as the content is stored in schema-less mode inside CortexDB. All queries to the database run at the same speed as index databases – for all fields, combinations of fields, and even for linked information.
  - Example: When exploding a bill of materials for generic structures – such as in the automotive industry – this technology makes it possible to search recursively structured data quickly and efficiently, using any reference chains or attributes required. This enables users to determine the bill of materials for the vehicle concerned. A real-life case like this usually takes several seconds – or even minutes – but with CortexDB the result is displayed in a few milliseconds.
- In CortexDB, each value is represented by an actual value and optional data block (**multi-value option**). The server also offers the option of virtual fields that can be added to data records (documents) to hold values valid at each point of time or the value in different systems, if they are not equal (may be also indexed). This "Reporter" functionality solves the problem of transactional data consistency. Last but not least, CortexDB has implemented Multi-Version Concurrency Control (MVCC) instead of locking data.
- The CortexDB Reporter dynamically calculates **virtual fields**. Virtual fields in CortexDB are always up-to-date and consistent with the values of all related fields. They can be used for data selection. This feature is similar to calculated, virtual fields in multi-dimensional OLAP databases.
- CortexDB is a **bi-temporal database technology**. A bi-temporal database includes valid time and transaction time. CortexDB also combines these attributes to form bi-temporal data. Temporal databases are more powerful than traditional databases that ensure only the truth at the transaction time and ignore the validity period.
  - Example: In master data management, users need a validity date ("valid from...") of information in each field in a data set. That enables them to view and track back each change in any time-related context they choose. As a result, the database knows exactly how all the information has evolved over time, including both past and future values. Furthermore, the management of event data is necessary in many use cases. Event data is data that is only valid at a given point in time, such data collected via meters (electricity, gas, water etc.). Such a feature considerably facilitates the management of redundant temporal data.
- CortexDB is a **distributed database technology** that runs on Linux, Windows and MacOS. The CortexDB has also been ported to Android and ARM systems like Raspberry Pi.
  - Distributed databases use master/slave synchronicity. A slave server only receives filtered data, enabling dedicated servers to be brought in for special tasks. This ensures data integrity and increases security.
- CortexDB includes a **sophisticated security concept** that can be activated automatically, even for in-house applications. Software developers can take advantage of this function, saving them the extra work in their own source code.
- CortexDB can be delivered on **premise** or via a **cloud** model. Cortex AG provides server capacity based in the datacenter of a German provider, enabling customers, partners and Cortex itself to

run CortexDB (and applications based on it) as cloud solutions. Large enterprises and other companies wishing to operate the database in-house are free to do so.

CortexDB – Architecture

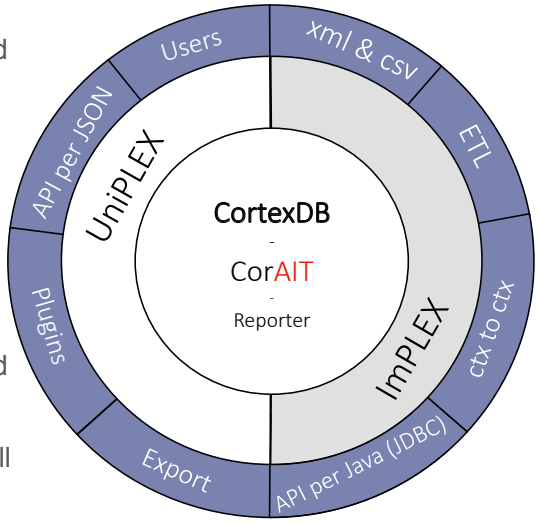
CortexDB: innovative bitemporal multi-model database with integrated CorAIT (Active Index Transformation)

UniPLEX: Enterprise application platform with tools or Data-Service

ImPLEX: Data integration tool

Reporter: Automatic processing for analyses, data consistency and other tasks

API: for any integration work, as well as end-user extensions and data import / export



CortexDB, a flexible platform for agile enterprise web applications

Source: Cortex AG

CortexDB Tools:

CortexDB can be used as a stand-alone database technology, but there are productivity tools for managing the input and output. They ease and speed up the usage of CortexDB.

- **UniPLEX** defines a database schema based on CortexDB to handle real data with defined field and record types, links and pointers as well as field based temporal data. It uses descriptions of field and record types (document types) to organize data in nested structures. The powerful integrated list functionality provides the user interface for data presentation. That includes the linking of data records in unlimited structural depth including recursively linked data. Complex database queries can be defined based on lists representing data joins. These lists, for instance, can be used as input for pivot tables and dashboard graphics. Object viewers can be configured to show all the necessary data in the nested data structures of a data object that is not directly linked to a record and should be jointly presented by multiple lists. As an example, in financial services, take a person as a data object that can now easily be linked to all his/her investments, stakes in organizations, real estate etc. across various data sources and applications. UniPLEX deals with data in json structures (stacked arrays of objects) which can be accessed either by JavaScript, php, C++ or Java. An implemented role system guarantees that each user only has access to the data he or she is authorized to use.
- **ImPLEX** is a data integration tool. It provides a connector to CortexDB and a software development kit (SDK) for developing application programming interfaces (APIs) to CortexDB. ImPLEX makes it easy to import data from other systems or from files into CortexDB.

CortexDB Advantages:

To summarize, CortexDB provides unique technical features delivering various benefits:

- Rapid and agile application development across innovative data services without programming.
- Flexibility to change the database schema as required by business departments and software developers – the system adapts to the processes rather than the other way round.
- Storing the validity time & transaction time of data objects accelerates and disburdens development: Faster application delivery means better time-to-market.
- Simple modeling of complex structures empowers short project times.
- No need of data transformations when linking different data sources.
- Change requests on the fly, enabling self-service usage by business units.
- One NoSQL technology for all enterprise applications where relational technology comes to its limits.
- Extremely high database performance on standard hardware (low footprint).
- CortexDB has a low TCO (total cost of ownership).

Take Away. CortexDB is a bi-temporal, multimodal NoSQL database technology that differs from all known databases via its index structure and its content-orientation. Its features include a multi-value option for managing repeated attributes and dynamically calculated virtual fields. Virtual fields do not only provided powerful in-database calculations, but can also be used for data selection. CortexDB is a distributed database technology, and it comes with a Multi-Version Concurrency Control (MVCC) as well as a sophisticated security concept. This makes CortexDB a very versatile NoSQL technology that can play the roles of all known NoSQL types of database technologies. Indeed, CortexDB can act as a GraphDB, as a key value store, as a multi-valued or as a document store, for instance. All NoSQL index structures special to a certain NoSQL type can be mapped by the CortexDB multi-dimensional index structure (CorAIT). Even new NoSQL database types can be defined by a mapping based on the CorAIT.

This makes CortexDB a preferred choice when selecting database technologies for networked systems, complex configuration systems, and very large data volumes, as well as for systems with high data dependencies and/or constant changes.

About Cortex AG

Cortex AG specializes in innovative NoSQL database technologies for processing large and complex data volumes. It provides an integrated family of products, suited to any type of enterprise application, that enable customers to create applications for data warehouses, business intelligence, business analytics, PDM, MES, CRM , CMS, etc. with no need for programming.

The product family is centered on CortexDB, which is a bitemporal multi-model database. It stores data in a completely new way and enables powerful database queries on any attributes as well as combinations of attributes and the relationships between them. Benefits to customers include agile software development, analytical and transactional data in the same database, change requests on the fly, self-service by business departments, and low-level hardware requirements.

Further information is available at **www.cortex-ag.com**

About the author

Dr. Wolfgang Martin is a leading European authority on:

- Business Intelligence, Analytics, Big Data, Performance Management
- Business Process Management, Information Management and Governance,
- Cloud Computing (SaaS, PaaS)

He focuses on technological innovations that drive business, examining their impact on organization, enterprise culture, business architecture and business processes.

More information at **www.wolfgang-martin-team.net**

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