

# NBU ADVANCED e-LEARNING SYSTEM

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**Abstract:** This paper introduces the design and implementation of information solution especially designed for the purposes of e-Learning at New Bulgarian University. The described architecture combines the best of modern technologies and theoretical foundations. In addition is examined the close future plans on researching for creation of data repository with semantic file system and its relation with the system.

## 1 INTRODUCTION

Databases are commonly used for storing structured data and for analysis of its content. They present the most modern manner of persisting and manipulating information. Most e-Learning systems (e.g. Moodle, A-tutor, OLAT) use relational database systems (RDBMS) when handling that process such as My SQL, PostgreSQL, Oracle, MS SQL Server. Each of these systems allows in different stage the organization and the systematical approach (ad hoc queries, stored procedures, views, materialized views) in data manipulation as well as optimal disk storage and security.

At the present moment this is the best way of working with large amounts of data, especially in the large fast growing field of e-Learning and especially in assessment, where the amount of content and active users is vast. The structure of the data itself is with critical importance for the correct functioning, ease collection and responsive interaction with the system. In the process of e-Learning as a whole the process of testing and assesment is using most actively the database resources provided by the particular RDBMS.

The modern need of handling large data amount activities leads to cross various combinations and techniques in definitely not so close fields like OLAP database architectures and e-Learning.

There are several, reported as successful, projects that combine OLAP technologies and use them as powerful data analysis tool.

iSUS (University of Manchester, 2006) uses the technology in the process of classifying items for tests. Some metrics of the product:

1. manages over 8000 learning events for more than 140 students
2. classified more than 24 000 qualitative and more than 2 000 quantitative test elements
3. perspective direct and aggregated view over data for objects like (again classified according to the product specification), Student, Teacher, Manager.

In others such as the system (Lay, 2006) from the presentation of Mhairi McApline form Scottish Qualifications Authority (SQA), who presents complex set of programatical methods implemented in services and business operations, the foundations of the system are based in centralized data repository.

On the other hand several e-Learning enterprise companies had developed OLAP compatible systems in addition to their product lines. For example such a tool is Docent Analytics (Docent, 2006) which gives the opportunity to analyze trends in education, certification, compatibility, partnership channels, sales and etc.

All projects present independent approaches toward solving the problem of manipulating and analyzing large amounts of data for the purposes of e-Learning. They influenced strongly the solution designed and implemented at New Bulgarian University, but still does not contain the key of mastering the solution for the concrete goals and further research activities, but rather are milestones showing that the direction is right.

In addition a very interesting application of the OLAP technology can be found in the process of generating tests, classifying items and calibrating

them as well as in presenting reports for test activities and results.

## 2 OVERVIEW

The solution is composed of system framework and four independent but integrated parts, grouped in two major segments according to their purpose:

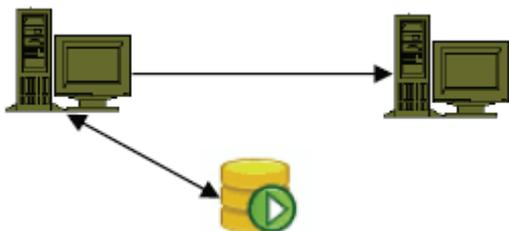


Figure 1: Segment A.

Segment A is covering the area of everyday activities: it includes LMS installation integrated with external database containing user accounts. The additional server on the figure is serving backup role and in case of failure can recover completely the working process.

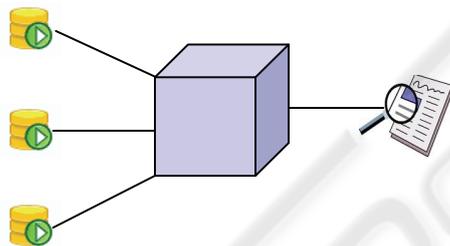


Figure 2: Segment B.

The foundation of Segment B is data analysis (using OLAP technology). The main purpose is processing assessment data for prognosis, simulations and further testing of different learning styles as well as observing student behaviour. The framework purpose is synthesized in the communication of both segments. It collects user data from Segment A which is then aggregated in the OLAP database in Segment B.

### 2.1 Background

At project initiation time NBU was using three separate web platforms which were partially serving the e-Learning activities, both for students and teachers. Yet no integration between the systems, nor abilities of sharing data, resources and activities

were met. In addition there were no feature in any of the systems to continuously monitor and analyze data, user activities and etc.

The needs of the modern times and the new challenges of e-Learning in nowadays had shaped the requirements into two separated but completely compatible systems and the framework beneath them: LMS for handling activities in everyday work and analytical system for collecting, analysing and reporting:

### 2.2 Design Concepts

The design policy is based on the best practices and theoretical basis in the software engineering and is completely focused on the two main streams of the solution and its supportive framework. The main concepts are as follows:

- modularity
- maintenance
- security
- customizations
- use design patterns in development practice
- scalability
- framework settlement
- open source

### 2.3 Major Objectives

There are two main objectives that shape the solution: First to provide solid base for everyday activities and then after successful deployment of the first stage, as second sequential phase, to develop an advanced analysis and reporting system for the resultant data of the first stage.

- provide LMS environment for completely serving various activities
- provide homogeneous approach in customizations and maintenance of the working environment
- provide high availability and security
- provide homogeneous approach in managing users
- provide service oriented framework
- provide analytical features
- provide ability for continuous monitoring in acceptable way of the user activities and testing results

### 2.4 Physical Structure of the Solution

Containing four physically independent servers responsible for management of the e-Learning process, the e-Learning content, management of

users, system backup and archive, and deployment of particular customization and modules source code. The servers are segregated according to its major priorities in the following manner:

- Working server – used for everyday work
- Staging server – pre-release with customizations after the successful deployment of particular features
- Deployment server – responsible mainly for the development and customization of the working installation
- Archive server – contains backups and archives of the working installation, as well as complete versioning of particular modules and services

## 2.5 Organizational Structure of the Solution

- Separate installation of LMS Moodle (latest stable version) used for everyday work
- Separate (legacy) system with users integrated with the working Moodle installation
- Development area – customizations, bug fixes and tests of new features with latest archived working copy as playground
- Regular backup of the working installation – with on demand feature as well as regularly scheduled timed backups of the database and the external data. The module is purposed as instant replacement and recovery of the working version.

## 2.6 Services Module

- User management- handle, secure, import/export, etc.
- Searches
- Dynamic ranking of searched results and categorization algorithms
- Data tier (for various data sources: relational database including pilot module with semantic file system)
- e-Learning content presentation
- OLAP Toolbox.
- Separate reporting module – user activity and others (e.g. test results)

## 2.7 Comparison of Different OLAP Strategies

The different strategies when designing OLAP solutions shape behaviour not only for the various products on the market but also sketch the different

purposes and goals of the respective information systems. At present moment 'four main options dominate' (White, 2003) in designing OLAP solution. The most conservative approach is when data is stored in a relational database and then accessed with SQL statements. Data is structured in star or snowflake table design and the database is managed by client or server RDBMS. One of the best features when using this way is that it avoids the need of purchasing specialized multidimensional database product while on the other hand its biggest fault resides in poor performance and limitations of traditional SQL. Vendors in the area like Microsoft, Oracle and IBM, are constantly working on improvements on SQL analysis power and performance. This option is supported from any product that can provide relational view of data.

The second approach is depending hardly on vendor provided OLAP engine which retrieves data from the working database and performs more complex processing on it. This processing is achieved by using vendor-specific visual tools or by applications that execute OLAP language statements through a provided API. There are couple of options for the OLAP engine: it can reside in the same operating platform as the RDBMS, it may be integrated with the RDBMS or may be presented as middle-tier server in a three-tier architecture. Solutions based on this option are provided by Applix, IBM, Microsoft, MicroStrategy and Oracle.

The third way offers the ability of storing data in a multidimensional database (as arrays or cubes) and manipulate it using queries and OLAP visual tools. As in the first approach the database may be managed by client- or server-based multidimensional DBMS (MDBMS). The reason why this approach is popular is because the MDBMS can be optimized for OLAP, which leads to good performance particularly in array processing large amounts of memory. But this still not means that the approach is scalable to processing large amounts of data and large user activities which results in using this approach for manipulation of summarized data. Key vendors in this area include Applix, Cognos, Comshare, Hyperion, Microsoft, Oracle and SAS.

The last way in designing OLAP solutions is to store small amounts of data in files in user computers and then access it with the OLAP engine. Usually this data is gathered from RDBMS or MDBMS. At the present moment this option is really popular, further more the growth in the use of Web-based thin clients indicates that the business is exploring the opportunity to move client OLAP processing

(described in the third option) to Web-based servers. Vendors working in the area of the fourth approach are Business Objects and Cognos.

Each option has its own positive and negative sides, so the successive OLAP solution will combine different features from the various approaches. Alternative method would be the integration of the OLAP solution with pilot module with semantic file system. The successive result would lead to various possibilities when collecting data not only from the current chosen LMS (Moodle) but actually from any other giving the opportunity to process and analyse different data sources.

### 3 RESULTS

The HP servers are operating on Gentoo Linux (Gentoo 2007) with PHP 5 and MySQL 5 (standart edition) as database server. We are expecting future migration to My SQL Enterprise Edition as the need of more data manipulation arises. Currently we server about 5 000 users with almost 3GB user data stored in the database and additional 10GB of data stored in the file system and served by the LMS Moodle.

The working server is operating with Moodle 1.7 with integrated module (both using the Moodle coding style and another with completely external method) for user import and verification.

Currently our plans are focused on establishing framework for handle and manipulation of large volumes of data and the process of reviewing, reporting and describing the university processes and activities as a whole. In order to sketch the contours of the big picture we evolved to initiating the development of OLAP module closely coupled with the chosen working LMS (Moodle) and implementation of data warehouse solution.

The OLAP toolbox will represent subsystem with two main branches: data visualization module and services for aggregating, collecting and feeding the reporting module.

In addition we plan implementation of a data repository with the particular goal of organizing and manipulating bank of items. Again this module as well all others in the system is designed in service oriented manner.

Finally we are discussing and exploring the possibilities of integration with other modern e-Learning systems as A-tutor and OLAT, keeping in mind that e-Learning still doesn't mean Moodle, although so wide spread and well accepted around the world

### 4 CONCLUSIONS

This paper has presented the conceptual basis and the implementation status of the NBU's university e-Learning system. The theory and practices behind the solution are inspired form the most advanced modern techniques, which are very new to the e-Learning in Bulgaria.

The homogeneous approach implemented in grid organized with operational LMS and the subsequent analyzing system are in harmony with the latest tendencies in modern technology and wich is more importeant serve better its purposes.

### REFERENCES

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