Innovative Evaluation System – IESM

An Architecture for the Database Management System for Mobile Application

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Abstract - *As the mobile applications are constantly facing a rapid development in the recent years especially in the academic environment such as student response system [1-8] used in universities and other educational institutions; there has not been reported an effective and scalable Database Management System to support fast and reliable data storage and retrieval. This paper presents Database Management Architecture for an Innovative Evaluation System based on Mobile Learning Applications. The need for a relatively stable, independent and extensible data model for faster data storage and retrieval is analyzed and investigated. It concludes by emphasizing further investigation for high throughput so as to support multimedia data such as video clips, images and documents.*

Keywords: Mobile Computing, Mobile Exam System, Database Management System, XML Schema

1 Introduction

Ever since Mobile Technologies emerged in 1980s, enormous amount of development has been made and improvements are constantly evolving everyday that almost any given Internet application can now be utilized to its maximum usability on a handheld device such as PDA, iPhone, iPod, Android etc [16]. Further developments are being made to enhance higher data rate, effective use of smaller screen size and the ability to handle multimedia data formats such as images, documents and video clips as if they are used on a personal computer or a work station [17]. Currently the academic bodies are making good use of mobile applications for e.g. student response system [1-8] particularly mobile based response system which can be evolved to support a large number of concurrent users to access resources [18].

This objective of this investigation is to propose a suitable architecture for database management to support 'Innovative Evaluation System in mobile learning.

2 Background

2.1 Wireless Response System

The XDIR research group proposed a new prototype to improve operational efficiency of wireless response system based on pure mobile devices [9]. Objective of this research was to identity a simple and relatively faster solution for using the mobile based response system simultaneously for e.g. in a class room.

It has been found in this system:

- Mobile based application could be simple and faster.
- Users does not have to always rely on internet browsers, therefore cost effective by using alternate methods such as Wi-Fi connection.
- Importantly, mobile devices can potentially reduce a large amount of hardware, memory, storage and maintenance in comparison with workstation.

2.2 Database Management System for Mobile Applications

Because of the fact the data collected by the response system [9] are short codes of limited character sets; the need for a data model seems inevitable and hence structured data for storage in data management systems such as relational databases in considered as the starting stage of the database architecture and hence the idea of using RDBMS arises [12].

2.2.1 RDBMS in Mobile Applications

Ideally the data model has to evolve in such a way that whenever the application interfaces are changed, the database mechanism acts in a relatively stable manner. This will strongly pave way to scale the data model to accommodate multiple application support.

Table: 1 RDBMS Advantages and Disadvantages

RDBMS	Advantages	Disadvantages
1	Relational theory	Increase resources – increase performance linearly
2	Transactions: atomicity, consistency, isolation levels	Throughput
3	Multiple indexes, auto increments/sequences and triggers	Vertical scalability (scaling up)
4		Horizontal scalability (scaling out)
5		Performance(sub-queries/correlation, joins, aggregates)

Many successful and effective RDBMS are available in the market such as MS SQL Server, Oracle, MySQL, MS Access, SyBase etc. For the initial investigation, the database architecture will implement MySQL and analyze the results.

There has been constant increase in the number of companies using MySQL for instance Youtube video, Adobe, Virgin Media, McGraw-Hill Education, iStockphoto, social networks such as Wikipedia have currently benefited and effectively using MySQL [13].

Relational database servers generally provide:

- Data Management
- Data backup and recovery
- Data Integrity
- Data Security
- Transaction processing

2.2.2 ORDBMS

Object-Relational Database Management System is very similar to relational database management but with object-oriented database model like classes, objects, inheritance, polymorphism and other object-oriented concepts that are directly supported in database schemas and query language. When an application uses this type of database, it will generally consider the data that is stored as objects. Similarly, for data retrieval, it must be reconstructed from simple data to complex objects.

The aim of ORDBMS is bridge the gap between conceptual data modeling methods like ER diagrams with Object-Relational Mapping (ORM).

Table: 2 ORDBMS Benefits and Performance Constraints

ORDBMS	Benefits	Performance Constraints
1	The main benefit of this type of database is that the software to convert the object data between RDBMS format and object database format is already provided and therefore not necessary to write a code for conversion between two formats	ORDBMS converts the data between object oriented format and RDBMS format and hence the speed and performance of the database is degraded substantially
2	Database access is easy and simpler when accessing from an object oriented computer language	Additional conversion work for the database

2.2.3 ODBMS

Object-Oriented databases are also referred to as *Object Database Management System (ODBMS)*. These type of databases store objects instead of data such as numbers, strings and other integers.

Table: 3 ODBMS Advantages and Disadvantages over RDMBS

ODBMS	Advantages over RDBMS	Disadvantages over RDBMS
1	Easier Navigation	Lower efficiency when the data and its relationships are simple

2	Better concurrency control	Relational tables are simpler
3	Less code required when applications are object-oriented	More user tools exist for RDBMS
4	Data model is based on the real world	Standards for RDBMS are more stable
5	Works well for distributed architectures	Late binding may slow access speed
6	Reduced paging	Support for RDBMS is more certain and changes are less likely to be required

2.2.4 XDBMS

An XML Database Management System is also called as XDBMS, innovative database technology software that allows the data to be stored in an XML format. The data thus stored can be queried, exported and serialized into any desired format.

There are two types of XML database that exist. They are:

- XML – Enabled
- Native XML (NXD)

2.2.4.1 Advantages of XML Databases

- Efficient - Eliminates redundancy; generates consistent and cost-effective workflow.
- Sturdy - Fast, stable, traceable and comes with a sophisticated authorization system.
- Simple - Automatically takes care of complex tasks and relatively simple.
- Connected - Effortlessly assimilates existing data collections.
- Object-oriented and relational.
- Embedded security and high speed access to even the complex data models.
- Reduced maintenance and flexible interfaces.
- No more redundancy.

Table: 4 XDBMS Vs RDBMS

	XDBMS	RDBMS
1	An XML based database management system does not worry about relations between data. It just stores the data in the database.	A relational database management system stores the data in such a way that it explicitly shows the relation between the data.

3 Problems Identified

However, the system has also identified that there are a few major limitations as follows:

- Traditional data management system could pose bottle neck because the response system is based on ‘many to many’ relationship at any given time and will scale to a large number of simultaneous responses.
- The system has to serve a large number of concurrent users accessing or responding to the system and hence the need for a suitable database management system arises.
- The response collected was in an unorganized format and concern for storing this data and retrieve readily is inevitable.

4 Aims and Objectives

Based on previous investigation, the student response system can be scaled to an ‘Innovative Evaluation System’ and the paper proposes:

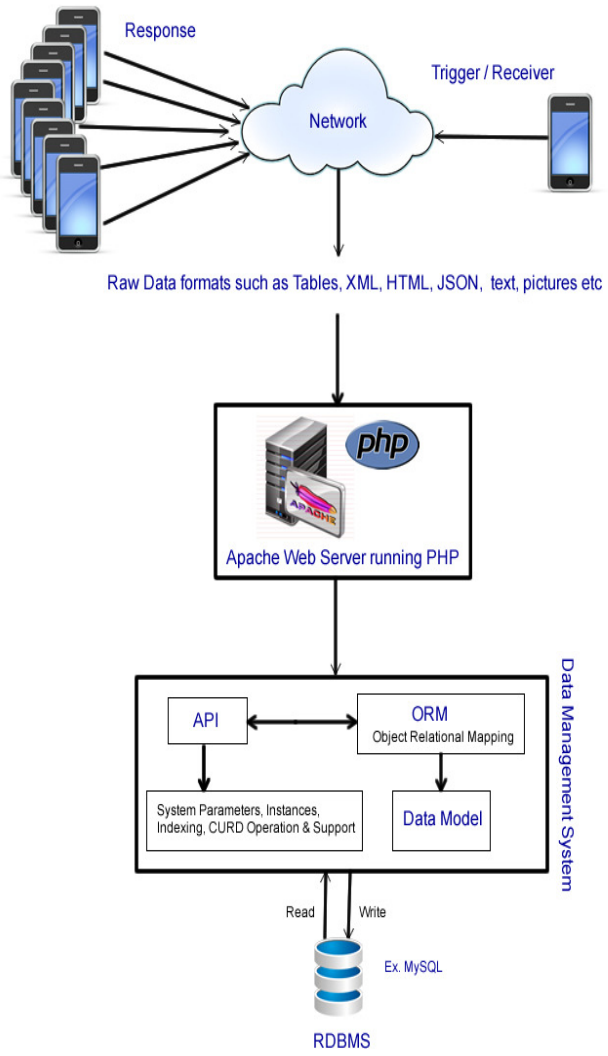
- To design a suitable architecture for database management system to support ‘Innovative Evaluation System’.
- The architecture to support an independent data model that is relatively stable and scalable.
- Effectively convert raw data or responses that are in the form of tables into well defined XML schema

so that it can be stored as data objects into database and to be able to retrieve readily when required.

5 Proposed Database Architecture

The data or response collected in raw format such as tables, texts are parsed and converted into an XML schema. This well documented XML schema is then set as data feed through an API access over a server scripting language like PHP run on an apache server as shown in figure 1.

Figure 1. Database Architecture



XML schema is then converted into data objects by the use of Object Relational Mapping (ORM) open source tools such as Doctrine [10] or Propel [11] based on Objected Oriented Programming concepts and data model. This mechanism makes it possible to address the access and manipulate objects without having to consider how those objects relate to their data sources. Thereby lets the system maintain a consistent view of objects over time, even as the sources that deliver them, the sinks that receive them and the applications that access them change. The API then adds system parameters, deploys indexing techniques and automatically generates the code to create, insert, read, update, and delete (CIRUD) records from the database systems.

For the initial system architecture, RDBMS is used as the initial attempt but not limited to it. Keeping in mind they are powerful because they require few assumptions about how data is related or how it will be extracted from the database. As a result, the same database can be viewed in many different ways. Due to the fact that RDBMS is used, the data models describe structured data for storage at this stage. The API layer is designed to perform all the data storage and retrieval mechanisms associated with the system.

5.1 Data Indexing Algorithms

Even though there exist many ways of improving the performance of the database system, the most effective and efficient method should effectively implement the data indexing mechanism. The most used indexing mechanism in nowadays Database Request Module System (DBRMS) is *B+ Tree and Bitmap.*

5.1.1 Bitmap Indexing

Bitmap index is a unique structure of database indexing technique that uses bitmaps. This type of indexing has a significant advantage of space and performance over other data structures. Bitmap indexing generally uses bit arrays and functions by performing bitwise logical operations on these bitmaps.

5.1.1.1 History of Bitmaps

The concept of bitmap index was first introduced by Professor Israel Spiegler and Rafi Maayan in their research "Storage and Retrieval Considerations of Binary Data Bases", published in 1985 [14].

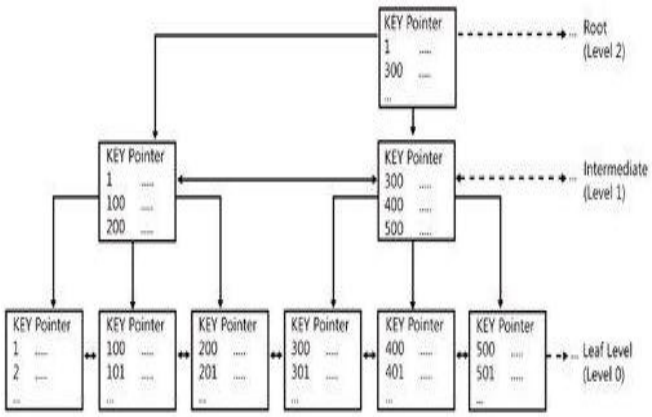
5.1.2 B+ Tree Indexing

B+ Tree is also called as a *Balanced Tree.* This tree represents sorted data that allows basic operations like insertion and deletion of records, each of those identified by their unique *key*. It is dynamic and multi-level index that has the block or node with maximum and minimum bounds on the number of keys in each segment. Its main objective is to store data for efficient retrieval of records in block-oriented storage structure, mainly file systems.

5.1.2.1 History of B Tree

The B tree was first described in the paper *Organization and Maintenance of Large Ordered Indices Acta Informatica* 1: 173–189 (1972) by *Rudolf Bayer* and *Edward M. McCreight* [15].

Figure 2: Architecture of B+ Tree [19].



6 Conclusions and Future Work

6.1 Achievements

- A scalable, stable and rationale database management system is required to build an 'Innovative Evaluation System' for mobile based application.
- Data model to effectively handle and manipulate objects or instances of data.
- Simple to use and fast data storage and retrieval for a mobile based application requiring a large number of concurrent users.

6.2 Future Work

The initial investigation of the database architecture has to evolve into the following:

- Database model establishment.
- Authentication techniques.
- Integration with mobile based application and possibly multiple interfaces.

Although the initial research is in the area of structured data formats collected from the student response system, further investigation is highly desirable to build a scalable data model that will enable multimedia support for unstructured data such as texts, images, documents, video clips on handheld devices without affecting the throughput or performance of the system.

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