

# The Use of Agent Technology in Database Technology and Data Warehousing

Mr. Sackey Prince Joseph

Lecturer

Department of Information Technology  
Sikkim Manipal University  
Accra, Ghana  
[josackey3@gmail.com](mailto:josackey3@gmail.com)

Mr. Okafor I. Sylvestre

Student

Department of Information Technology  
Sikkim Manipal University  
Accra, Ghana  
[sylvestreanderson5@gmail.com](mailto:sylvestreanderson5@gmail.com)

**ABSTRACT:** In recent years technology has gone through a lot of evolution which has brought about the term Agent technologies. Research over the past years has found the agent technology paradigm to be useful for many applications. This article aim at finding how agent technology will be used to enhance database technology and data warehousing, showing the broad applicability of agent technology in database technology and data warehousing, and to explore the implications of this broad applicability. It however, provides an overview of agent technology, with focus on the role and benefits of agent technology in data warehousing and database technology.

**KEYWORDS:** Agent technology, Data warehousing, Database technology, OLAP, encapsulating, JADE, JIPMS, Mobile Agent

## I. INTRODUCTION

The use as well as the need for agent technology in database technologies and data warehousing cannot be over-emphasized. This is because over the last two decades database technologies have evolved into different construct to support the ever-growing information needs for organizations. The evolution has span the spectrum of operational and analytical processing as well as data warehousing in organizations and has continue to build various data warehouses and data marts to meet the needs of integrating and consolidating information across the business enterprise. This expansion of database technology has been used over a wide range of applications for reporting at various management decision levels [22]. "Agent technology, which is already affecting almost every aspect of computing, could become for e-commerce what Windows was for PCs - a relatively simple and user-friendly way of utilizing the new technology" [21]. Therefore, Agent technology has no limitations to the areas at which it influences. The demand of agent technology in real-time access to enterprise-wide data has caused the worlds of real-time, near-real time and batch analytics to come closer together than ever before.

Data warehouses and databases are becoming part of the technology with a prediction of every business

having one within ten years. However, large quantities of data are stored in specific categories so it can be more easily retrieved, interpreted, and sorted by users. Little impact is been made by storing data in a data warehouse. The agent technology plays a vital role such as systematic management of data, scalability, and intelligence, in data warehousing and database technology and offers benefits like recording of the information and availability of information at once and so forth.

The aim of this paper is to take advantages of Agent technology that are intelligent programs, composed of a set of agents, each one offering a set of services, to perform complex data integration. We can indeed assimilate the different tasks of the integration process, which is technically difficult, to services carried out by agents. Data extraction: This task is performed by an agent in charge of extracting data characteristics from complex data. The obtained characteristics are then transmitted to an agent responsible for data structuring. Data structuring: To perform this task, an agent deals with the organization of data according to a well-defined data model. Then, this model is transmitted to an agent responsible for data storage. Data storage: This task is performed by an agent that feeds the database with the source data, using the model supplied by the data structuring agent.

## II. LITERATURE REVIEW

A database is a shared collection of logically related data (and a description of this data), designed to meet the information needs of an organization [4]. The collection of data, usually referred to as the database, contains information relevant to an enterprise. A database-management system (DBMS) is a collection of interrelated data and a set of programs to access those data. The primary goal of a DBMS is to provide a way to store and retrieve database information that is both convenient and efficient [18]. The essential feature of database technology is that it provides an *internal* Representation (model) of the *external* world of interest. Examples are the representation of a particular date/time/flight/aircraft in airline reservation or of item code/item description/quantity on hand/reorder

level/reorder quantity in a stock control system. The *technology* involved is concerned primarily with maintaining the internal representation consistent with external reality [5].

A data warehouse is the data repository of an enterprise. It is generally used for research and decision support. The concept of data warehousing provides a powerful solution for data integration and information access problems. Data warehousing idea is based on the online analytical processing (OLAP). Basically, this technology supports reorganization, integration and analysis of data that enable users to access information quickly and accurately. A Data Warehouse (DW) is defined as “a subject-oriented, integrated, time-variant, non-volatile collection of data in support of management’s decision-making process” [9]. Data warehouses store huge amount of information from multiple data sources which is used for query and analysis. Therefore, the data is stored in the multidimensional (M D) structure [8]. Data warehousing technologies are now considered mature and can form the base of such a decision-support system. Though they primarily allow the analysis of numerical data, the concepts of data warehousing remain valid for what we term complex data. In this context, the warehouse measures, though not necessarily numerical, remain the indicators for analysis, and analysis is still performed following different perspectives represented by dimensions. Large data volumes and their dating are other arguments in favor of this approach. Data warehousing can also support various types of analysis, such as statistical reporting, on-line analysis (OLAP) and data mining [5].

An agent is a computer software that is situated in some environment, and that is capable of autonomous action in this environment in order to meet its design objectives’ [10]. The operation of agents is supported and managed by distributed software platforms known as agent systems. The name of multi-agent systems usually refers to systems that support stationary agents and mobile agent systems refer to systems that support mobile agents. An agent technology is a classical program that is qualified as “intelligent”. Intelligent agents are used in many fields such as networks, on-board technologies and human learning. An intelligent agent is supposed to have the following intrinsic characteristics: intuitive – it must be able to take initiatives and to complete the actions that are assigned to it; reactive – it must be aware of its environment and act in consequence; sociable – it must be able to communicate with other agents and/or users. Moreover, agents may be mobile and can independently move through an acceptor network in order to perform various tasks [9]. The needs for agent technology are simply an approach to structuring and developing software that offers certain benefits. Agents reduce coupling and are autonomous, which can be seen as encapsulating call. Coupling is reduced not only by the

encapsulation provided by autonomy but also by the robustness, reactivity and proactiveness of agents. When data is sent to the agent, the agent has control of how to control the data. So in the database if an agent is built in, the action that an external entity needs to perform on the data in the database can be done by the agent [3].

Increment in database technology and data warehousing is inevitable and so its increase in size lead to the application of agent technology. Competition in the market today depends on companies’ ability to convert the amass mountain of raw materials into information for easy usability and maintenance. Predefined programmable task can be performed by agent technology and so aids in carrying out certain task. Agent technology when used in database and data warehousing can be used to alert users of predefined business conditions.

Also agent technology can be used in data mining and predictive modeling techniques. In terms of databases, agent technology can be used to sort and filter out data according to rules defined by user. Agent technology also can aid in the marketing analyst needs with rigid regularity to identify threat and opportunity conditions that can offer business advantages to the enterprise. Agent technology is used also to automate ordering process according to pre-determined inventory levels or to search for cheaper sources of materials (even airline tickets) on the internet. A bidding agent can monitor online exchange activity for the best time to buy a commodity or material, and then inform the contact person via beeper, phone, fax, or email.

#### **A. Scenarios of agent technology use**

Suppose you are to receive call and filter to give answers to the call. These answers to customer may come from manuals, CD-ROM or even the internet. Instead of you taking time struggling to get answers to these problems, the problem is rather subjected to an intelligent agent technology to help you solve. Imagine a help desk where an intelligent agent takes the problem as described by the authors, automatically searches the relevant databases (whether local, CD-ROM, or via the Internet), then presents a consolidated answer with the most likely information.

## **II. METHODOLOGY**

#### **A. Agent**

The growth in networked information resources requires information systems that can be distributed on a network and interoperate with other systems. Such systems cannot be easily realized with traditional software technologies because of the limits of these technologies in coping with distribution and interoperability. The agent-based technologies seem be a promising answer to facilitate the realization of such

systems because they were invented to cope with distribution and interoperability [10].

Till today, several efforts have been done towards the standardization of agent technologies and one of major standards is the FIPA (Foundation for Intelligent Physical Agents). The Foundation for Intelligent Physical Agents (FIPA) [11] is an international non-profit association of companies and organizations sharing the effort to produce specifications of generic agent technologies. FIPA is envisaged not just as a technology for one application but as generic technologies for different application areas, and not just as independent technologies but as a set of basic technologies that can be integrated by developers to make complex systems with a high degree of interoperability.

However, the use of a common communication language is not enough to easily support interoperability between different agent systems. The standardization work of FIPA is in the direction to allow an easy interoperability between agent systems, because FIPA, beyond the agent communication language, specifies also the key agents necessary for the management of an agent system, the ontology necessary for the interaction between systems, and it defines also the transport level of the protocols [12].

### **B. Mobile Agent**

Mobile agent technology as in [13] is a paradigm that can take advantage of current distributed environments. The mobile agent technology comes from two different disciplines: artificial intelligence, which defines agent concepts [14], and distributed systems, which deals with code mobility [15]. Mobile Agent, also known as traveling agents, these programs will shuttle their being, code and state, among resources. This often improves performance by moving the agents to where the data reside instead of moving the data to where the agents reside. The alternative typical operation involves a client-server model. In this case, the agent, in the role of the client, requests that the server transmit volumes of data back to the agent to be analyzed. Often times the data must be returned by the agent to the server in a processed form. Significant bandwidth performance improvements can be achieved by running the agents within the same chassis as the data. Mobile agent frameworks are currently rare, however, due to the high level of trust required to accept a foreign agent onto one's data server [12]. The emerging mobile agent (MA) technology can play an important role in distributed network and systems management (NSM) [16]. With advances in technologies for accountability and immunity, mobile agent systems are expected to become more popular [12].

### **C. JADE and JIPMS**

JADE (Java Agent Development Framework) is a software development framework aimed at developing

multi agent systems and applications conforming to FIPA standards for intelligent agents. It includes two main products: a FIPA compliant agent platform and a package to develop Java agents. JADE has been fully coded in Java and an agent programmer, in order to exploit the framework [17]. JADE is written in Java language and is made of various Java packages, giving application programmers both ready-made pieces of functionality and abstract interfaces for custom, application dependent tasks. Java was the programming language of choice because of its many attractive features, particularly geared towards object-oriented programming in distributed heterogeneous environments; some of these features are Object Serialization, Reflection API and Remote Method Invocation (RMI) [17]. JIPMS (JADE Inter-platform Mobility Service) is a service which allows Inter-platform mobility support to JADE. It is an extra module, which does not come with JADE package and can be downloadable from the net.

The paper adopted the Architecture of Extended ESOA (Expert System for Online Assessment) to explain the need for agent technology in database and data warehouse.

### **D. Architecture of EESOA**

The EESOA, includes mainly seven components:

1. **Apache Web Server:** listens for web page request
2. **Tomcat Servlet Engine:** serves dynamically generated web page using JSP and Servlet technology
3. **MySQL Database:** stores the student information and the question bank of various courses.
4. **XML:** files for external Rule Base
5. **JESS Engine:** for online assessment
6. **JADE:** for agent platform
7. **JIPMS:** for agents' mobility support

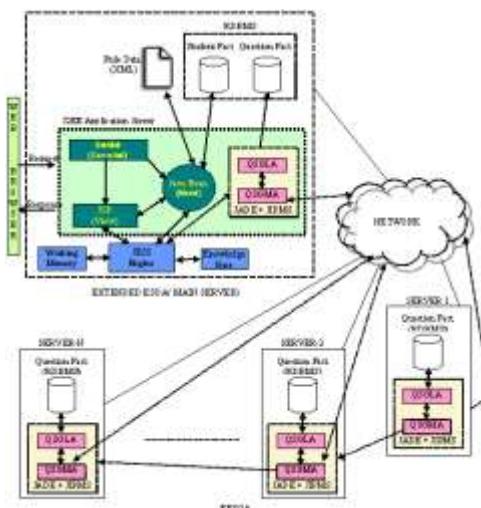


Figure 1: Architecture of Extended ESOA  
Source: Khurshid, A. B, Ridip, D. C & Shikhar, K. S (2013)

In the EESOA, all of the known question database servers, also the main EESOA server must have JVM, JADE with JIPMS support. For a rule-based expert system as an agent, facts and rules are mandatory to make decisions/inferences/results. In EESOA, facts and rules are generated dynamically according to the students' parameters and subject/paper about which the assessment will be conducted. In JESS, facts can be stored in the working memory in three forms: (a) ordered facts (b) unordered facts and (c) shadow facts. Based on the proposed system adopted shadow facts will be used. Shadow facts are just unordered facts that serve as "bridges" to Java objects. All these facts will be stored into MySQL databases. The main reason for not storing the facts directly into the working memory of JESS is that if we do so, the facts will be static for the system. Using JSP and Servlet technology, MySQL databases and JESS will be integrated and generate some dynamic facts and load into the working memory of JESS. Here JavaBeans are used to implement the shadow facts [20].

A Jess rule is something like an "if... then" statement in a procedural language, but it is not used in a procedural way. While "if... then" statements are executed at a specific time and in a specific order, according to how the programmer writes them, Jess rules are executed whenever their if parts (their left-hand-sides or LHSs) are satisfied, given only that the rule engine is running. This makes Jess rules less deterministic than a typical procedural program [20].

Initially, the JADE should also be running with JIPMS. So, after loading student fact and rules, the mobile agent, QSGMA (Question Set Generation Mobile Agent), will move in each of the question database servers, contact with a local agent, QSLGA (Question Set Generation Local Agent), and gets questions and then move to next server and so on until required numbers of questions are extracted and then return back to the EESOA main server [19].

#### IV. CONCLUSION

Agent technology has become a means to develop an effective and efficient databases and data warehouses for system to work independently without the intervention of external environment. This paper adopted the Extended Expert System for Online Assessment to explain the need to implement agent technology in database and data warehouse.

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