



An LMS Architectural Design Using Multi-Agent Based System Overview

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Abstract - Although a large number of Learning Management Systems (LMS) have been developed over the years, there is still a lot of room for improvement and research in the field. Unlike the other fields of studies and research, software developers and engineers, instead of building their research on the past experience, have to develop the new LMSs from a scratch. The reason is that experience from previous Learning Management Systems is not codified or documented, which compels the development teams to 're-invent the wheel'. This paper discusses how to integrate multi-agent systems construction concepts with LMS prospects ... The paper concludes with a practical pattern for learning management system overview using multi-agent system approach.

Keywords - Software Agent. Learning Management System. Agents Elicitation. Goals Grouping. Functionalities.

I. INTRODUCTION

A Learning Management System (LMS) is a software application for the administration, documentation, tracking, reporting and delivery of e-learning education courses or training programs (Ellis 2009) .

LMSs range from systems for managing training and educational records to software for distributing online or blended/hybrid college courses over the Internet with features for online collaboration. Colleges and universities use LMSs to deliver online courses and augment on-campus courses. Corporate training departments use LMSs to deliver online training, and to automate record-keeping and employee registration.

LMSs that are in use today are either commercial products (e.g. WebCT, Blackboard, TopClass), or free open source products (e.g. ILIAS, Manhattan Virtual Classroom), or customized software systems that serve the instructional purposes of particular organizations. LMSs that belong to the third category are exponentially increasing, as most education and training institutions are building or planning to build their own LMSs. This is due to the fact that a customized LMS will serve better their specific educational/learning purposes, and prove more useful in bringing higher returns of investment over the years. However, the design and implementation of such systems is not an easy task because they are complex systems that comprise a variety of organizational, administrative, instructional and technological components (Moore & Kearsley 1996; Carlson 1998). Therefore, systematic, disciplined approaches must be devised in order to leverage the complexity and assortment of LMS and achieve overall quality product within limited time and budget. One such approach is the use of design patterns which are based on re-usable design experience gained over several years of efforts. This will save the engineers the efforts of re-designing and developing new LMSs from scratch. The need for design patterns and pattern languages in the domain of Learning Management Systems is gradually being accepted by the LMS community and patterns are emerging for various aspects of e-Learning. It is well documented that patterns do need a rich variety of sample applications in order for them to be discovered and considered as widely adopted design solutions. In our research, we will integrate MAS (Multi agent system) approach to develop LMS.

Multi agent systems are systems composed of multiple interacting computing elements, known as agents. Agents are a software paradigm through which possibilities can be exploited by massive open distributed systems. The role of a Multi-Agent System makes an integrated online system to advance and develop its performance with unique options. Agents may be used by software developers to understand, model, and develop in a more natural way an important class of complex distributed systems.

In many ways, business intelligence (BI) is a catch-all phrase as it does not refer to one single type of analysis or data, but rather it represents a variety of methodologies, technologies, software applications and tools to organize and analyze business data. BI is the combination of software applications which plays a key role in the strategic planning process of a corporation.

Determination, elicitation and derivation of agents are the key points for development of any multi-agent system. In fact, there is no clear way to define agents during the analysis stage. Easy and new approach is proposed to devise agents from goals and functionalities of the required system. (Khozium 2013).

This paper presents an LMS architectural design using Multi-agent based System Overview, and is divided into six sections. The first section covers the introduction. The second section focuses on the related work. The third section discusses the overview of proposed system methodology. The fourth section explains how to identify and refine goals. In the fifth section an LMS architectural design is demonstrated by means of a case study to show how it is applied to the

design of a multi-agent based online system for a learning management system. In the sixth section, I have concluded my research with some recommendations for the future work.

II. RELATED WORK

Bryant Nielson suggests in his paper "Implementing a Learning Management System" ten Steps Process to implement LMS including four stages: The first stage highlights the analysis and assessment of various aspects of the organization, its structure, and its learning needs; the second stage covers the overall structure of the policies related to LMS usage; the third stage illustrates the instructional design; The last and the fourth stage focuses on delivery issues. (Nielson 2010)

Many researchers highlight designing and implementing LMS including suggestion of process steps in a standard way such as (Avgeriou et al 2003; Pandey and Pandey 2009; Whelan and Bhartu 2007)

Some papers present frameworks to improve the current LMS such as (Georgouli et al 2008; Ellis 2009).

Another Researcher illustrates guidelines to choose suitable LMS (Berking and Gallagher 2010).

Many researches introduce interactions of web technology and LMS implementations such as (Sheridan et al 2003).

Some studies handle the interactions between developing learning management systems and web such as (Cristóbal et al 2007; Begam and Ganapathy 2013).

(Khoziium et al 2013) illustrate in their paper the meaning, definitions and importance of intelligent software agent by contrasting agents with objects. Furthermore, their paper highlights the multi agents structure, methodologies and common applications and provide surveys that allow researchers/developers to determine the directions in which agent-oriented methodologies are best suited to achieve goals of a particular project or system.

(Biabani et al 2013) present in their paper a model of Multi-Agent System (MAS) dedicated to the Project Chain Management (PCM) through Radio Frequency Identification (RFID). It describes technical research on the troubles of privacy and security and explores solution for its problems using five phase agent models.

(Khoziium 2013) in his paper proposes a methodology to determine, clarify and differentiate agents during development of multi-agent systems using goals and functionalities grouping approach. A step by step case of study is presented to explain the proposed methodology for the creation of an Online Intelligent System (OIS) for Board of Directors guide using Multi-Agent System to facilitate online communication between the board members and their president to monitor the policies and productivity of the company.

III. PROPOSED SYSTEM METHODOLOGY

The proposed methodology is intended to allow an online system for LMS to go systematically from a statement of requirements to an architectural design that is presented in a way to be implemented easily. This research work employs a combination of many common methodologies, such as ; PROMETHEUS (Santos et al 2012),TROPOS (Yu 1995), MASE (Deloach S., Wood M., 2001) and MASUPE (Bastos 2004)) to extract a simple technique which is suitable for designing an LMS starting with the definition of the goals and ending by the system overview architectural design.

The architectural design will use the system specification to build the system architecture. It will be developed in two stages where the system application agents and its interactions are specified, and the system overview is designed.

Architectural design consists of the following two stages:

A. The First Stage (Goals Stage)

This stage handles extraction of goals from the system specification. In this stage refinement, rearrangement and grouping of the goals takes place to define the functionalities. Section four explains goals stage step by step.

B. The Second Stage (System Overview Diagram)

This stage starts by the interactions of the functionalities with the related databases to extract and define agents. The Scenarios will be developed, finally system overview diagram will be created including actions, percepts and protocols. Section five explains the second stage in detail.

IV. CASE STUDY : GOALS EXTRACTION STAGE

We identify our initial set of goals by highlighting parts of this description:

We would like to develop a **fully online intelligent learning management system** for **enhancing learning capabilities**. The system should be **available for all the learners, instructors and administrators** and should offer a **personalized and a user-friendly interface**. This system provides several tasks as **information distribution, management of learning material, offering multiple communication facilities and class management**.

The implementation of our LMS should be effective, efficient and successful.

This then yields the following extracted system goals:

- Enhancing learning capabilities
- Fully online intelligent LMS
- Availability for all the learners, instructors and administrators
- Personalized, user friendly interface
- Providing information distribution
- Managing of learning material
- Offering multiple communication facilities

- Managing of classes
- Implementing effective, efficient and successful LMS

GOALS REFINEMENT

Here, we have an expanded list of goals and associated sub-goals resulting from asking 'how?'.

- Enhancing learning capabilities.
 - provide modern techniques for learning
 - track and improve learning capabilities
- Fully online LMS.
 - attend lectures online
 - solve exams online
 - view online learners
- Availability for all the learners, instructors and administrators.
 - learners login and attend lectures easily
 - instructors login and give lectures easily
 - administrators login for support and monitoring
 - each member has his profile and personal data
- Personalized, friendly user interface.
 - personalized welcoming
 - recommendations based on user profile
 - information available about lectures schedule and data
- Providing information distribution.
 - announcing the tips of the day
 - showing schedule on calendar
 - showing glossary
- Managing of learning material.
 - customization of the user interface to the needs of the instructor
 - updating the learning material
- Offering multiple communication facilities
 - asynchronous communication as schedules and info.
 - synchronous communication as lectures, exams and chat
- Managing of classes
 - on-line marking of learners' assessments
 - tracking learners' participation
 - management of learners' profiles
- Implementing effective, efficient and successful LMS.
 - making full analysis for provided services
 - making detailed helpful design for system screens and data flow
 - show results and attendances in clear way
 - adding the required testing techniques
 - providing training for users

GOALS RE-ARRANGEMENT

Below is an initial re-arrangement of the goals with moved sub-goals shown in italics.

The name chosen for the resulting grouping is shown in CAPITALS below each group of sub-goals.

- Enhancing learning capabilities
 - provide modern techniques for learning
 - track and improve learning capabilities
 - *offering synchronous and asynchronous communication facilities*

LEARNING ENHANCEMENT

- Fully online LMS.

- *online LMS*

ONLINE INTERACTION

- Availability for all the learners, instructors and administrators.
 - learners login and attend lectures easily
 - instructors login and give lectures easily
 - administrators login for support and monitoring

MEMBERS MANAGEMENT

- Personalized, friendly user interface.
 - personalized welcoming
 - *making detailed helpful design for system screens and data flow*

WELCOMING

- recommendations based on user profile

- information available about lectures schedule and data
- *management of learners' profiles*

PROFILE MONITOR

- Providing information distribution.
- announcing the tips of the day
- showing schedule on calendar
- showing glossary
- *solve exams online*
- *show results and attendances in clear way*
- *customization of the user interface to the needs of the instructor*
- *updating the learning material*

INFORMATION MANAGEMENT

- Managing of classes
- on-line marking of learners' assessments
- tracking learners' participation

CLASSES MANAGEMENT

- Implementing effective, efficient and successful LMS.
- making full analysis for provided services
- adding the required testing techniques
- providing training for users

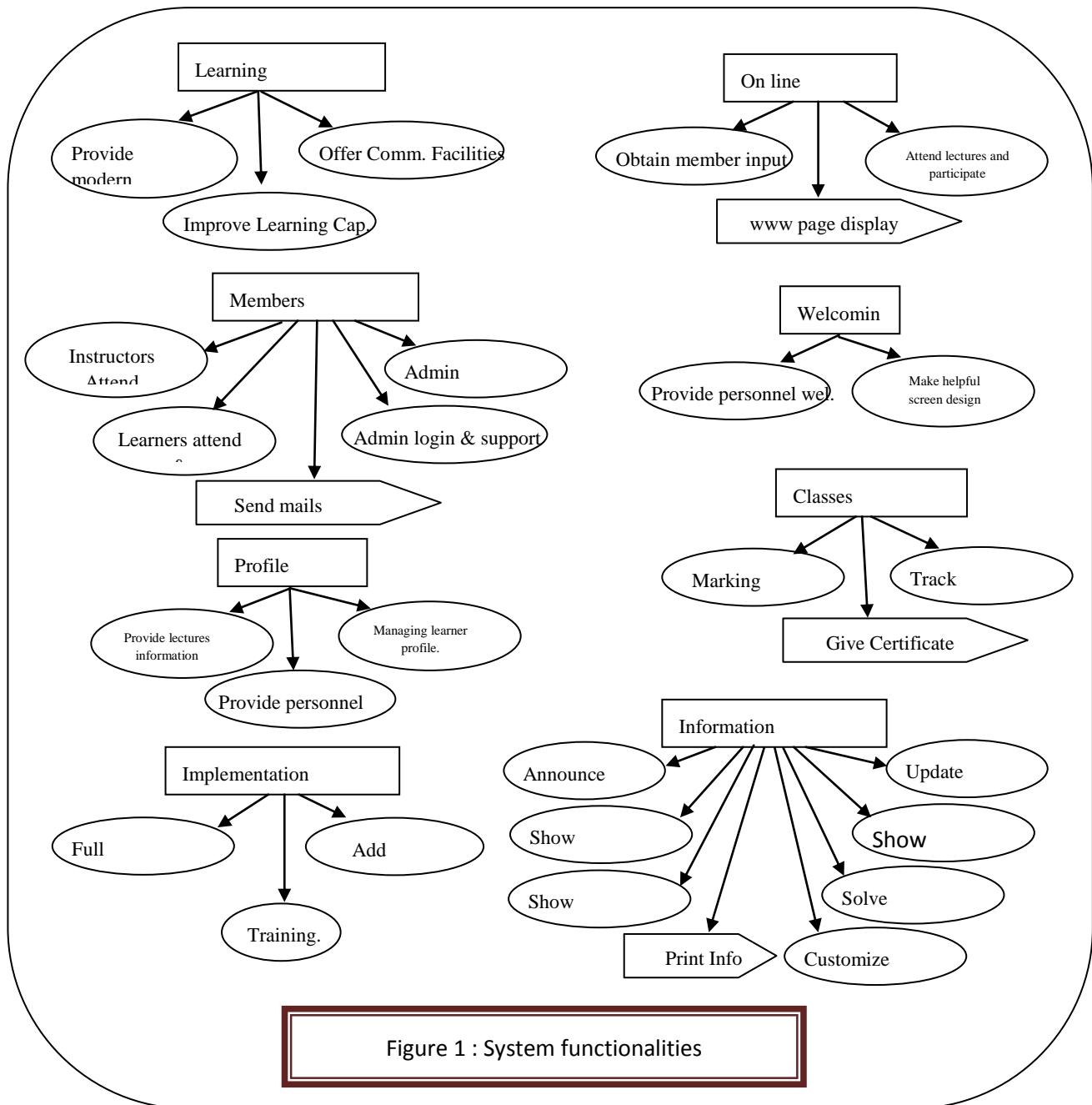
IMPLEMENTATION EFFICIENCY

GOALS GROUPING

The set of goal groupings that we developed after our initial pass at refining, coalescing and adding goals as needed:

- LEARNING ENHANCEMENT
 - provide modern techniques for learning
 - track and improve learning capabilities
 - offering synchronous and asynchronous communication facilities
- ONLINE INTERACTIONS
 - obtain member input
 - attend lectures and participate
- MEMBERS MANAGEMENT
 - learners login and attend lectures easily
 - instructors login and give lectures easily
 - administrators login for support and monitoring
- WELCOMING
 - provide personalized welcome
 - making detailed helpful design for system screens and data flow
- PROFILE MONITOR
 - recommendations based on user profile
 - information available about lectures schedule and data
 - management of learners' profiles
- INFORMATION MANAGEMENT
 - announcing the tips of the day
 - showing schedule on calendar
 - showing glossary
 - solve exams online
 - show results and attendances in clear way
 - customization of the user interface to the needs of the instructor
 - updating the learning material
- CLASSES MANAGEMENT
 - on-line marking of learners' assessments
 - tracking learners' participation
- IMPLEMENTATION EFFICIENCY
 - making full analysis for provided services
 - adding the required testing techniques
 - providing training for users

Figure 1 shows functionalities from the goals grouping



V. CASE STUDY : SYSTEM OVERVIEW STAGE

After defining the functionalities as shown in the previous section, we define the precepts and actions which will clarify the data bases.

Precepts And Actions

Percepts

- Arrival at WWW site
- Update material
- New lecture or exam
- User input
- Admin support

Actions

- Give certificate
- Print info
- Send e-mail
- Admin action
- WWW page display.

Databases

- Students DB – contains information about learners, their personal data, their profile and their schedules and exams results.
- Staff DB – contains information about instructors and administrative staff, their personal data, their profile and their permissions.
- Material DB– contains presented lectures and exams data. And also contains some tips, glossary and schedules for lectures and exams with info about them.

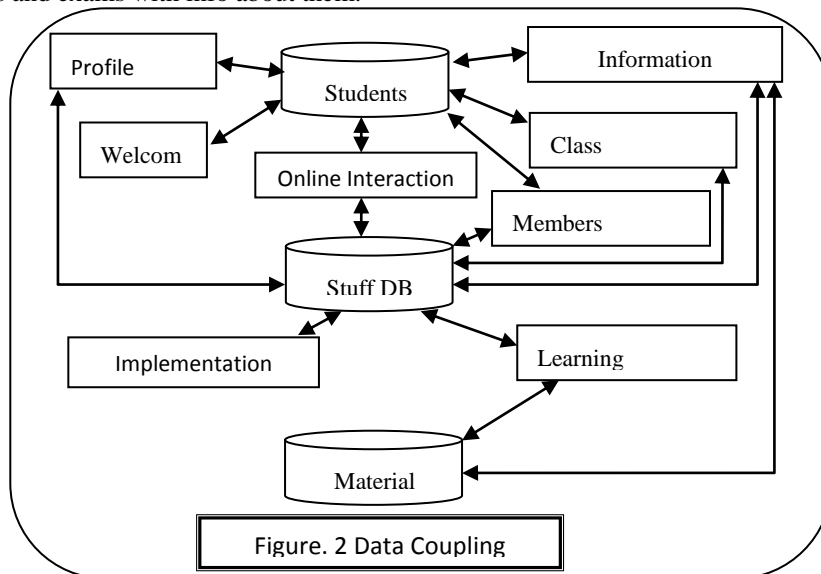
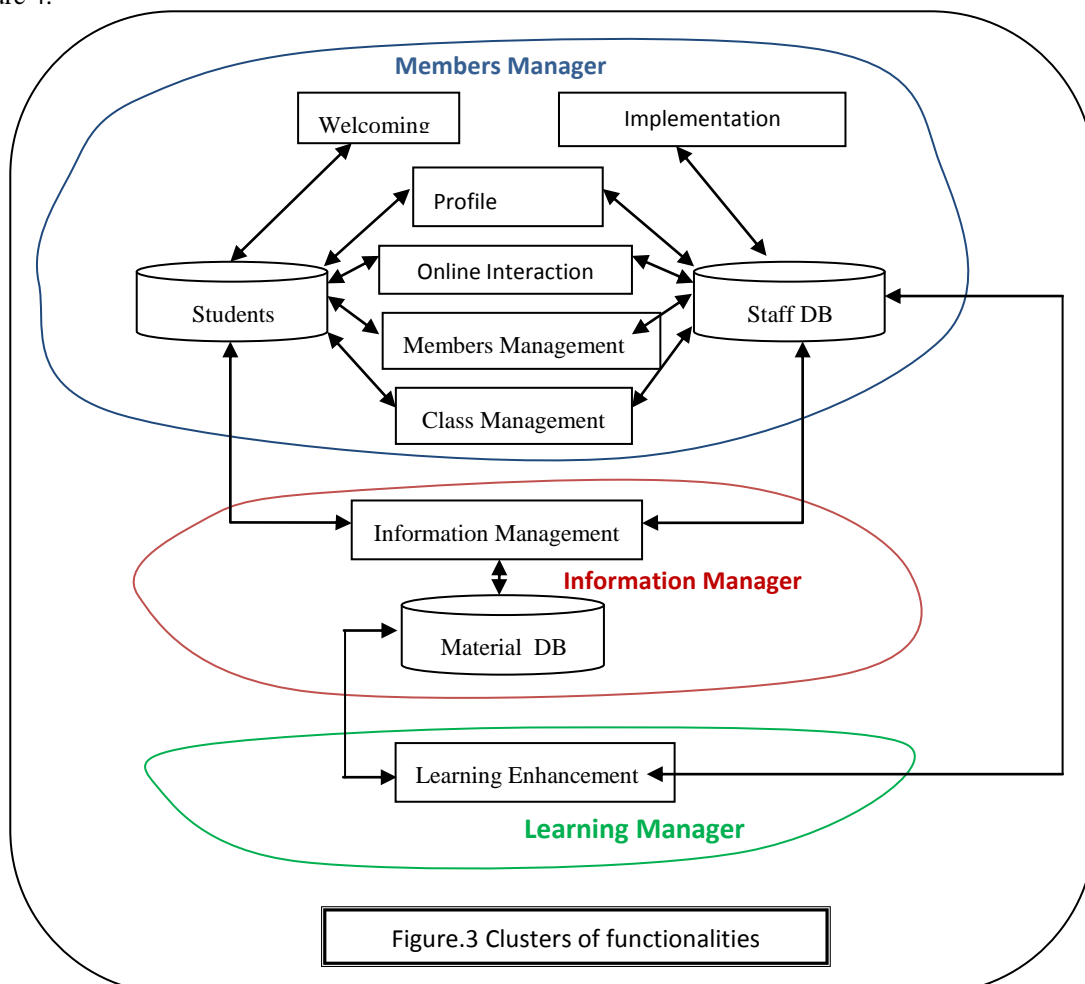
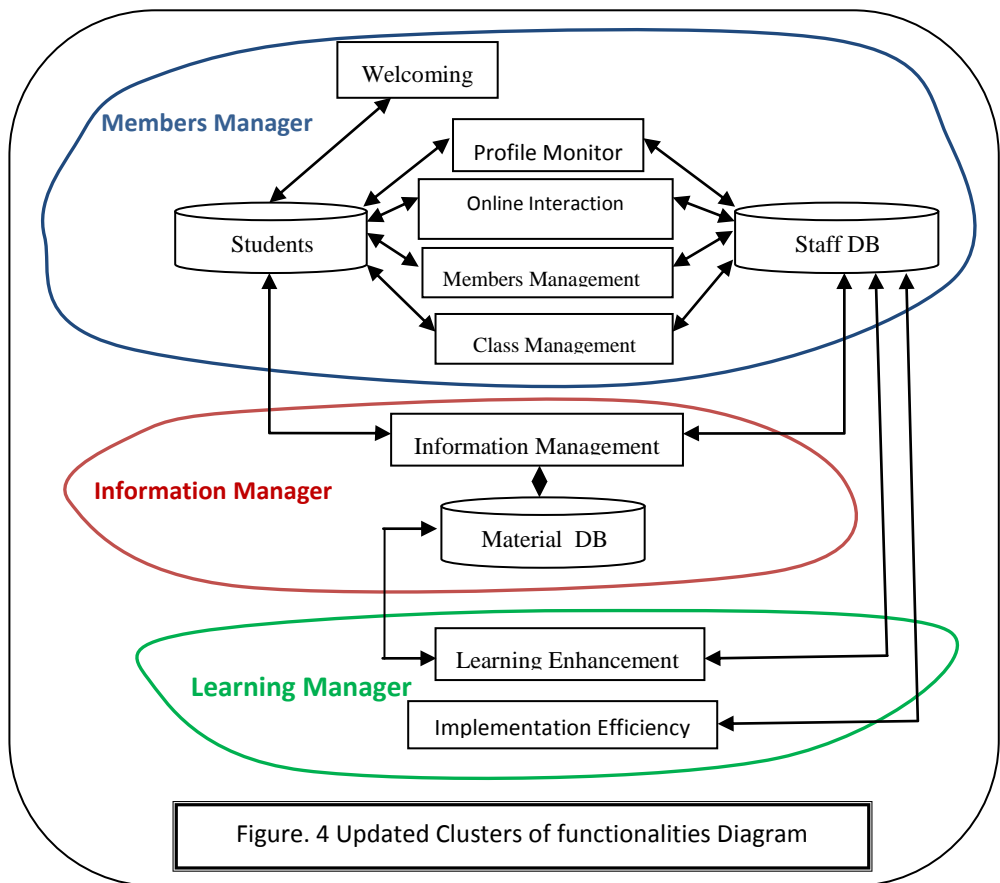
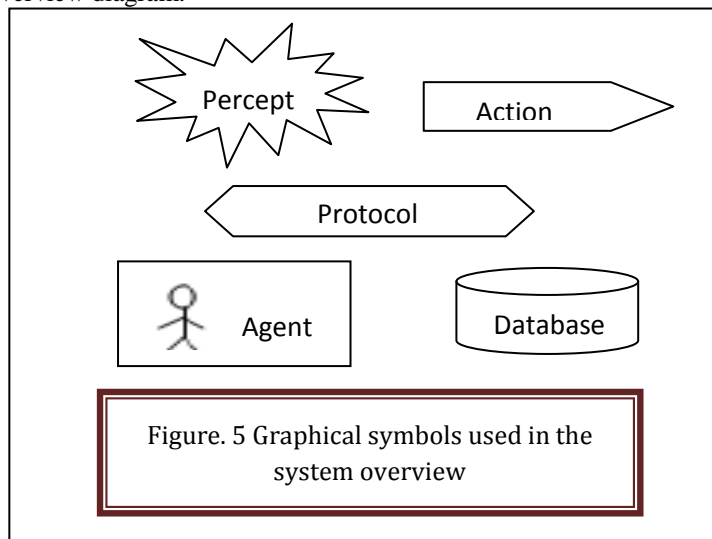


Figure 2 shows functionalities grouping and data coupling. Figure 3 shows functionalities clustering to extract the three agents; members manager, information manager and learning manager. Then update of the functionalities clusters will be hown in figure 4.





After updating the clusters of functionalities, we start to draw the system overview including actions, precepts, protocols, databases and relations between them. Figure 5 shows the graphical symbols used in the system overview diagram. Figure 6 depicts the system overview diagram.



From the system overview diagram figure 6, we can easily devise agents, **percepts**, actions and protocols.
Agent (percepts, actions):

Members Manager (percepts: Arrival at the WWW site and user input), (**Actions:** WWW page display and send e-mail)

Decision assistant (percepts: New question and President request), (**Actions:** Finish meeting and Decisions priorities)

Reporter (percepts: company performance info.), (**Actions :** final report)

Protocols between member manager and decision assistant agents:

Apply president request, Request choices information, Request choices and Show final decision.

Protocols between decision assistant and reporter agents :

Report ordering, member decision, history & performance and request final results.

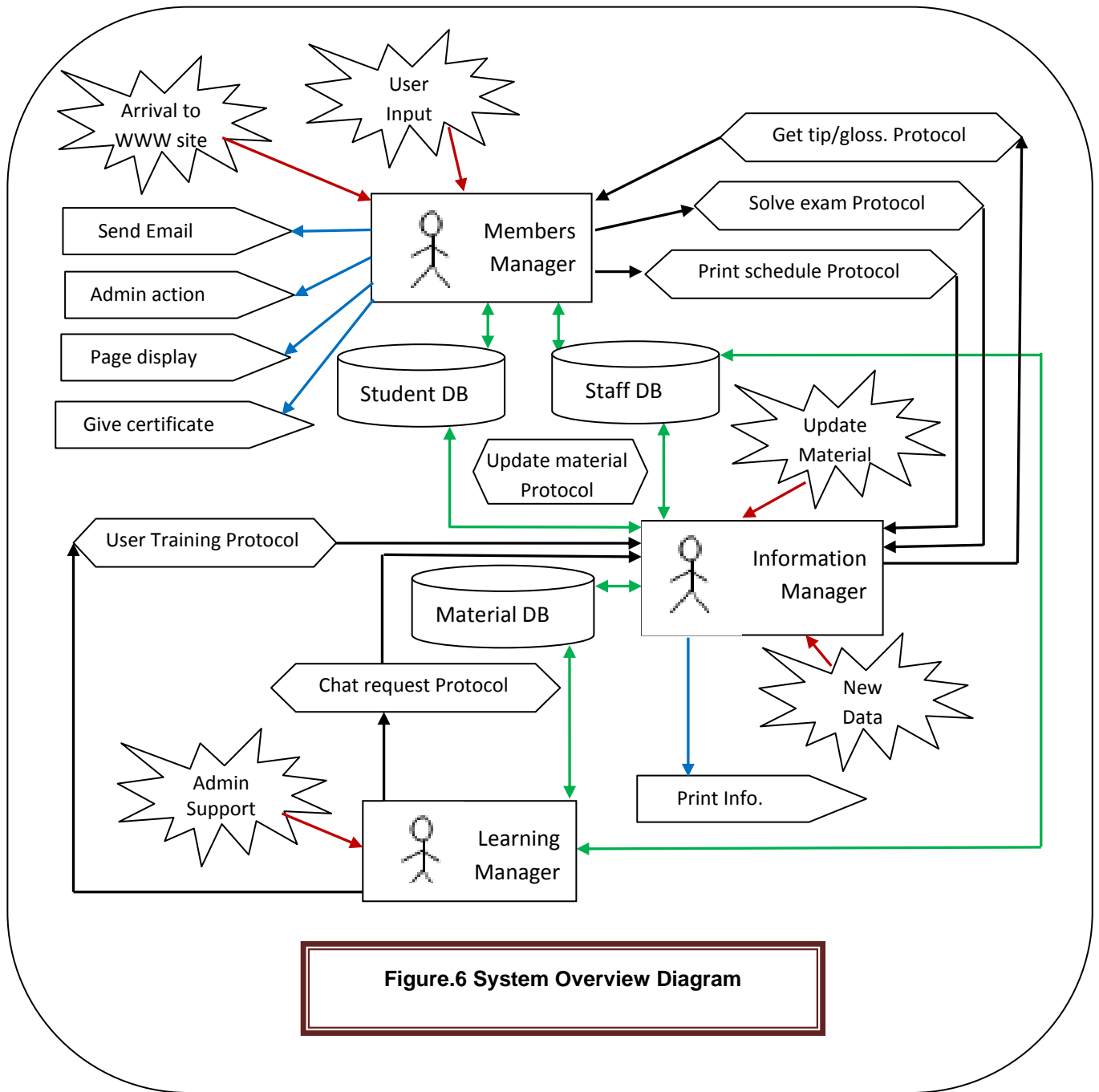


Figure.6 System Overview Diagram

VI. CONCLUSION AND FUTURE WORK

There are several methodologies, not all of which can be used in all cases. Every methodology is typically used for a specific situation. When choosing a methodology for a problem, it is important to consider its complexities. Methods that propose large and complex models in the development phase may not be suitable for analyzing and designing an online system. This paper offers an LMS Architectural Design using Multi-Agent Based System Overview, which has been evolved and derived from a number of commonly used methodologies to serve the purpose of educational organizations seeking to develop an integrated online system for multiple purposes. As a future work the idea is to implement the proposed methodology for designing more business applications.

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