International Journal of Emerging Trends & Technology in Computer Science (IJETTCS)
Web Site: www.ijettcs.org Email: editor@ijettcs.org, editorijettcs@gmail.com
Volume 3, Issue 4, July-August 2014 ISSN 2278-6856

# Towards Service-Oriented Reference Model and Architecture to e-Learning Systems

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**Abstract:** ***E-learning systems are moving away from monolithic applications towards more open, flexible components, capable of interoperating with other learning components. In spite of the diversity of learning environments, there is a lack of uniformity regarding their basic functionalities. Thus, the establishment of core functionalities represents an issue to the development of learning environments. In a different but related perspective, reference architectures have emerged as an alternative for promoting reuse of design expertise and facilitating the development of E-learning systems. Reference architecture increases the scalability, flexibility and availability of e-learning systems. Service-oriented architectures (SOAs) provide a successful model for structuring complex distributed software systems, as they reduce the cost of ownership and ease the creation of new applications by composing existing services. Service-based architectures take legacy application functionality and expose it to the Internet in a reliable, highly available, scalable, flexible, manageable and secure manner, easy and reliable internet-based method to create and access learning. The objective of this paper is to provide Service-Oriented Reference Model and Architecture to e-Learning Systems (SORMALS). The SORMALSs designed to support maximum scalability and high service levels and an optimized management environment. It enables new levels of scalability while providing a very cost-effective modular solution. The key values of Interoperability, durability, compatibility, manageability, dynamic reusability and accessibility in the proposed architecture enhance the future e-Learning systems to communicate more efficiently and share data more easily.***

**Keywords:** Service-Oriented, E-Learning Systems, Personalization, Reference Model/Architecture, Scalability.

## 1. INTRODUCTION

E-learning systems have become a central part of the learning process and play an increasingly important role in personalized student-centered learning. The concept and application of E-learning has become progressively more prevalent in educational settings ranging from modern postsecondary institutions to the smallest and most remote rural schools; as well, E-learning systems now have an integral role in many educational organizations. The ability to manage and deliver online courses has become an important aspect of the learning models, and this importance has created a tremendous dependency upon E-learning systems as educators strive to deliver quality education to their learners.

The Internet had great impact on E-learning due to the fact that it is an effective and economical medium for making information available to dispread individuals. E-learning is considered to be the use of Internet technologies for the delivery and management of training. It involves a wide set of applications and processes, such as web-based learning, computer-based learning, virtual classrooms and digital collaboration. E-learning provides engaging training in a 24x7 fashion to the learners across the globe.

It is important to point out that reference architectures for developing learning environments are still very specific, sometimes considering only one type of environment, for instance, e-learning systems. Besides that, SOA (Service-Oriented Architecture) [11] has been the basis for almost all architectures, such as [6], [8], [9]. Using (SOA), one can build durable e-learning contents, regardless of changes or evolutions in technology. The new content should be added to existing content without costly redesign, reconfiguration, or recoding. SOA differs from the more general C/S model in its emphasis on loose coupling between software components. From a technology perspective, a service is a defined interface with input and output parameters. Web Services work with technologies like XML, SOAP, WSDL and UDDI. They are platform-independent, vendor independent and language independent and therefore are better suited for exposing and consuming services. It frees the client and server from any platform-specific implementation restrictions, allowing much greater flexibility in a heterogeneous computing environment. In e-learning systems, the challenges are increase of the complexity and more interoperability between systems in distributed environment. An efficient way of developing new e-learning solutions in which development work is done over and over again with re-using what was done in the past. The aim of this thesis is to provide reference architecture for personalized e-learning systems using Service-Oriented Reference Architecture (SORA) because they provide a faster deployment of technology and a flexible technology base. The ultimate aim of this research is to investigate and design SORA for PES and evaluate the reference architecture. The main aims of the reference architecture are as follows:

- To facilitate personalized delivery of e-content and to build durable e-learning contents, regardless of evolutions in technology.

- To increase the performance ELSs without redesigning/rebuilding and to delivers appropriate performance using scalable SOA
- To keep the data secure.
- To creates a plug-and-play e-learning architecture that supports interoperability.
- To provide flexibility in the overall e-learning system as it matures.
- It needs to be adaptable to changing emerging technologies and Seamless integration of components that comprise e-learning systems.

The problem statement is to investigate and design if a service-oriented reference architecture for personalized e-learning system with scalability in mind. The solution is to investigate and design Service-Oriented Reference Architecture for Personalized E-learning Systems (SORAPES) using Web Services and SOA. It needs a highly scalable architecture that supports more reusability to especially personalized e-learning systems.

This research article is organized as follows: Chapter 2 presented the basic information required to write this paper. Chapter 3 presented the literature survey and the related works in reference architecture using Service-Oriented architectures. Chapter 4 presented the motivation example and the proposed architecture and finally Chapter 5 concluded this paper.

## 2. PERSONALIZED E-LEARNING SYSTEMS

E-learning systems have become much more than course management and delivery systems as they increasingly facilitate the educational need to communicate, share data, problem solve and assist learners as they cooperatively arrive at new understandings and solutions. Pedagogically, teachers are moving to a constructivist environment for learning that lends itself to the creation of new understandings and new ways of problem solving. This evolution of pedagogical methodology has in turn caused the required growth and flexibility of E-learning systems. Figure 1, the evolution of E-learning displays the transformation of e-learning that has taken place since its beginning since last four decades.

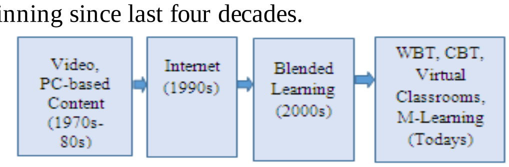



**Figure 1**: The Evolution of E-learning

The evolution of Web to Web 2.0 has influenced today's e-learning design. As a result, e-learning can take on a much more interactive and social-oriented format that is embedded in the context of the learner's work. The evolution of next-generation e-learning has created a fundamental shift from format e-learning to informal e-learning delivered in interactive, business-driven format.

E-Learning Systems (ELSs) have been topics of increasing interest in recent years. The number of users who are interested in E-learning increases daily. These users have many different interests and objectives, and they will need to access to a huge amount of data and information. Therefore, a successful ELSs will be one that addresses all issues for all type of users across the world. Such a system should be scalable, available, interoperable, extensible, and adaptable, and indeed, it should be based on novel technologies. Since such systems are very huge, many organizations and institutes should contribute to the construction of these systems. This way, development costs of these systems will highly decrease. As the reliance on these systems has increased at all levels of education, so too has the need to provide solutions that can integrate the E-learning systems with other technical infrastructure within the organizations. It is a tremendous challenge to effectively integrate new E-learning applications and technology within an organization's systems infrastructure in a manner that can ensure the efficiency of all processes. Software architects are challenged to provide a system design that possesses the flexibility to allow integration and the adaptability to support new technologies and emerging pedagogical practices.

### 2.1 Traditional Architecture of E-Learning

E-learning systems are usually developed as distributed applications. The architecture of distributed E-learning systems includes software components, like the client applications, an application server and a database server and the necessary hardware components like client computer, communication infrastructure and servers. Overall, this design is called a three-tiered architecture.

The traditional architecture for E-learning system is shown in Figure 2.

i. A typical E-learning application makes a request to a centralized E-Learning Web Portal (ELWP) server.
ii. The centralized ELWP Server parses the request and forwards it to an E-learning Application Server (ELAS), which runs one or more of the Web application programs to generate the response.
iii. The applications usually interact with one or more data repositories, typically by sending queries and updates to a database.

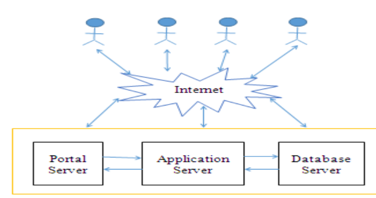



**Figure 2**: Traditional E-learning Architecture

In a traditional E-learning system, all three tiers aremaintained at a central location by the content provider and this design implementation is called E-Learning Server. The problem with the existing technologies is that they are platform specific and are not interoperable. They do not allow the learners to avail the e-learning resources from different places. They are not flexible and dynamically scalable infrastructure. Also, they decrease the performance and increases the overall cost.

### 2.2 Challenges in Traditional E-Learning Architectures

In a traditional three-tiered architecture, the ELWP Server and ELA Server do not maintain any persistent mutable state and thus can be easily replicated so that each replica remains lightly loaded even at high request rates. The main challenge in scaling the traditional architecture is to scale the centralized authentication, proxy, versioning, caching, notification and Learning Object Database (LOD) component by offloading database work from the Application's E-learning server. With the increase in number of students, rapid growth of education content and changing IT infrastructure, the educational institutes are confronted with a dramatic increase in costs and a decrease in budgets which leads to the need of finding some alternative for their e-learning systems. Also, the current e-learning systems are not scalable and do not lead to the efficient utilization of the resources. Overcoming this scalability is made hard by several common difficulties:

- Challenge 1 - Data Management: The traditional architectures restricts all aspects of data management to a single server component. This advantage is lost if the data is instead distributed and updated outside of the CELS. This problem arises due to the authentication, notification and learning object corruption risks entailed by distributed data management.
- Challenge 2 - Propagate Updates to the Database: To successfully off-load database work from the E-learning server, the scalability service must respond to database requests while requiring less work from the central database. Caching is an approach is for the scalability service. Here the challenge is to propagate updates to the scalability service without creating additional work for the E-learning server.
- Challenge 3 - High Latency: Most Web applications are interactive-oriented. Moving work from the CEL Server to a scalability service might increase the latency of some interactions between system components, since the scalability service and centralized E-learning server will often be located on different networks.
- Challenge 4 – Compatibility: The scalability service must execute Web applications designed for traditional centralized three-tier architecture without requiring the enterprise organization to redesign their system or re-implement their application. Any extra work required of the enterprise organization is an undesirable barrier to their use of the scalability service.
- Challenge 5 – Query Notification: In E-learning systems, the learners/users typically run the query frequently and they are constantly checking and rechecking. This wastes CPU cycles on both the learners and the E-learning database server which doesn't seem that important on modern hardware. Also consider that as the system needs to grow or as you look for redundancy, it needs more than one service checking the SQL queue.

### 2.3 Recent Computing Techniques in E-Learning

New technologies like Client/Server, P2P, Grid Computing, Web Services (WS) and recently Cloud Computing are continuously being introduced to the E-learning systems landscape that allow learners to have more control over their own learning, to think analytically and critically, and to work collaboratively in new environments. Web-Based Learning Systems (WBLS) [1, 2, 3] are very popular in E-learning systems. A WBLS allows a learner to complete the WBLS on his own time and schedule, without live interaction with an instructor. Most of the WBLS are based on the Client/Server model. The Client/Server model has several features that all are to execute management and to offer the exercise by the server machine. Although the Client/Server model has an advantage of easy construction and maintenance, the Client/Server systems generally lack scalability and robustness. There is Peer to Peer (P2P) model to supplement the disadvantage of client/server model. The challenge of P2P includes shifting the learning environment from traditional classrooms to virtual classrooms and developing/implementing effective P2P learning opportunities. Here, the response of the entire P2P network has improved. In the e-Learning system the changes are frequent, the node cannot exercise efficiently. In future it should verify the usability with a larger-scale system.Grid Computing [32] provides an environment where a widely distributed scientific and academic community shares it resources across different administrative and organizational domains. The purpose of Grid Computing is to solve large-scale computing and data intensive applications and collaborate in a wide variety of a virtual environment which facilitates physical resources across different administrative domains in order to beneficial; these resources are then abstracted into computing or storage units that can be transparently accessed and shared by large number of remote users.SOA [29] is a philosophy of design that can be informally described as “the software equivalent of Lego bricks” where a collection of mix-and-match units (called “services”) - each performing a well-defined task - can reside on different machines possibly under the control of a different service provider, and are ready to be used whenever needed.Cloud Computing is a combination of several services, such as Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS). The recent evolution of cloud computing has borrowed its basics from several other computing areas - Cluster and Grid Computing on one hand, and virtualization and systems engineering concepts. In this respect, it is essential to understanding the landscape of this novel computing field and defining its potentials and limitations [5].

## 3. LITERATURE SURVEY

A broad collection of E-learning Frameworks, architectures and models were considered and discussed in this chapter.

### 3.1 E-Learning Frameworks

As a result of the activities for creating a joint vision for common technical framework in e-learning area, and for defining international learning technology standards and specifications, several detailed frameworks were developed. These frameworks are identifying the needs to produce a coherent vision of how to integrate systems to support organizational and cross-organizational processes for enabling effective e-learning. Some of the most successful and comprehensive technical frameworks [4] developed are:

- JISC e-Learning Technical Framework (ELF) [7]
- IMS Abstract Framework (IAF) [10]
- Open Knowledge Initiative (O.K.I.) [12]
- LeAPP Learning Architecture Project [13]

The comparison of abovementioned frameworks shows that they all have layered architecture consisting of a set of services which can be used in e-learning context and collectively realize required business objective.

**3.2 E-Learning Architectures**

The existing E-learning reference architecture/models systems are revisited and analyzed in terms of the above quality attributes. These architecture / model identifies the main components of the reference architecture and indicates inter-relationships between the components. For brevity's sake only those relevant architectures are described and compared below.Li, Qing Lau, et.al. [23] provided an overview of e-learning system development with respect to a layered reference architecture. It is an open and scalable architecture, incorporation of learners' pedagogical features in Web-based learning environments, and support of digital game-based learning. All these issues, though not exhaustive, were important to ensure successful development of e-learning systems on an Internet platform. This paper outlined layered reference architecture that facilitates personalized e-learning.Ruben Miguez, et.al. [24] proposed a holistic framework that provided a set of ICT-based services designed taking into consideration the distinctive features of early care settings. It presented the main design guidelines of a standard-based reference architecture that fosters interoperability and convergence between diverse technologies and heterogeneous systems. This paper presented a reference model that facilitated personalized learning and children tracking and assessment and development of agent-based software architecture. Ngamnij Arch-int, et.al., [25] proposed a reference architecture for interoperating the existing e-learning system with the help of Web services and a metadata-UDDI model. This architecture described the exchanging learning data between e-learning systems in heterogeneous environment. As a future work, this paper focused on extension of other services, such as, the sequencing service, course management service, and assessment service, etc. K.K. Thyagharajan, Ratnamanjari Nayak [26] addressed the problems of automatically selecting and integrating appropriate learning materials for a learner using web services based on the learners initial knowledge, goals, preferences etc. This architecture consists of the learner model and adaptive content creation model. This approach is based on reusable learning objects describing a learning process as a composition of learning goals. Based on the learning goals as well as web services, services appropriate to achieve a specific learning goal can be selected, composed and invoked dynamically.Andreas Schmidt [28] showed how making learning solutions aware of the context actually affects their architecture and presented a showcase solution in the form of the learning in process service-oriented architecture. SOA supports instead of learning management demands for a new type of flexibility. This can only be provided with a state-of-the-art services-oriented approach. This paper concluded that as the notion of a personal learning environment is still emerging, it is too early to see a reference architecture for e-learning 2.0 developing. Dan Chiribuca, Daniel Hunyadi, Emil M. Popa [27] proposed a modular semantic-driven and service-based interoperability framework, in order to open up, share and reuse educational systems' content and knowledge components. The proposed architecture supports sharing and exchanging information between adaptive concept-based WBES include stand-alone, information brokerage, communication and services. In this paper specific efforts trying to fill the gap between adaptive educational systems and dynamic learning repository networks, by proposing service-based architectures for personalized e-Learning. Within the context of Semantic Web, there are several hot issues, which allow achieving this reusability, shareability and interoperability among Web applications.

**3.3 E-Learning Models**

Michael Derntl [15] proposed the Blended Learning Systems Structure (BLESS) model that introduces a layered architecture for decomposing the complexity inherent in the transition from courses to their effective support by learning technologies. In particular, BLESS was intended to act as a reusable framework for decomposing complex blended learning processes into smaller, more tangible and reusable learning activity patterns that may subsequently be used to guide blended course design and effective use of learning technology.Minu [16] proposed three layered adaptation model gives all most all learner contexts in a standardized way, which improves the efficiency of learning process. The design solution provided a three layered architecture based on learner's characteristics, which is divided into three layers such as conceptual layer, logical layer and physical layer which helps to improve the efficiency of learning process.Abhishek Singh [17] presented a new model for e-learning using cloud computing for cost effectiveness and support of education and learning management systems. This model will be benefitted for every student and staff, where lots of collaboration and scalability of data is needed in e-Learning. Academic has different departments and many semesters where lots of students want to access the computing a need for highly scalable up-to-date hardware and software is must. Cloud computing has the capacity of elasticity and scaling which is perfect for such an environment.A layered model for e-Learning design, that was first introduced by Suzuki [18]. This layered model is proposed as a frame of reference for clarifying the purposes of various instructional design (ID) techniques and models and to illustrated how they can be meaningfully organized in terms of purpose and impact. This organizational structure has several benefits: it clarifies the relationships among the various design activities in e-Learning development, it can provide guidance to e-Learning designers, and it can help managers of e-Learning development who must coordinate a team of designers. Michal Šimún [19] described a proposal of three main parts of adaptive web-based application – domain model, user model and adaptation model that we designed for the course of programming learning. They employed Semantic Web technologies in order to be able reuse existing educational materials and add a semantic layer responsible for personalization.Fayed Ghaleb [20] presented the Semantic Web-Based model for our e-learning system. In addition we present an approach for developing a Semantic Web-based e-learning system, which focus on the RDF data model and OWL ontology language. We demonstrate the effectiveness of this approach through several experiments using different type of courses taught in Qatar University. The feedbacks of both teachers and students were highly promising. Zhifen Cheng [21] propose an extensible development SOA-based platform that facilitates implementation of e-Learning systems. The platform has applied a service-oriented framework and model-driven architecture into the analysis, design, implementation and integration of e-Learning application, and makes e-Learning systems to be flexible and scalable enough to meet changing, complex and dynamic business requirements. It also supports the distance learning system in the complex processes and the integration of various learning resources services, which uses Web services technology and .NET Framework 3.0.

The existing E-learning architecture/systems have major drawbacks because of their limitations in scalability, availability, distribution of computing power and storage system, as well as sharing services and information between users and organizations contributing in these systems. In this context, based on SOA, reference architectures have been proposed to support the understanding, development, and standardization in the development of service-oriented E-learning systems.

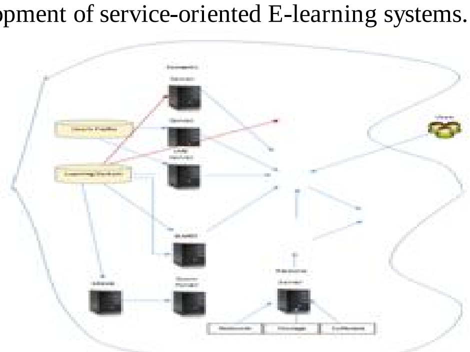


**Figure 3**: Motivation Example for E-learning Systems

The reference models/ architectures provide a comprehensive set of capabilities to ensure that the web services can be built, deployed, accessed, delivered and managed. Each of these capabilities are supported by the appropriate standards, technologies and tools. Furthermore, reference architecture should also offer best practices and provide a list of selected technologies that should be employed during development and deployment of software to a production environment.

## 4. PROPOSED REFERENCE MODEL AND ARCHITECTURE

The following section discusses how distributed technologies like Web Services can play a functional role in improving e-learning infrastructure.

### 4.1 Motivation Example

To motivate the contribution and to exemplify the solutions, it first introduces a simplified real-life scenario, namely personalized e-learning system in distributed environment. Figure 3 shows the proposed Web-based E-learning system (WBELS). Here, the users are connected to the E-learning Portal server through internet and utilizes learning contents through web browsers. All the others servers like Service Registry, Authentication, Notification, Cache, Application, Learning System, Semantic, Management, etc. are connected to each other via Internet. WBELS can provide facilities such as personalization, learning forums, digital libraries, virtual labs, authoring services, virtual classes and many others.

### 4.2 Web Service-based Computing Model

Web-based / On-line learning is learning via the Web. In this type of learning a learner is connected to the internet and utilizes educational contents through web browsers. The learners can obtain a class lecture from e-learning services. Learning Management Systems (LMS) can provide learning contents, search of contents and course management methodologies. The major advantages of online learning are that it is accessible anytime and anywhere. A learner does not only see course material in the form of a web page. E-learning can provide facilities such as personalization, learning forums, digital libraries, virtual labs, authoring services, virtual classes and many others. E-learning technology needs support from distributed internet technologies that can drive it over the World Wide Web (WWW).

Web Service is a technology that has been developed to provide various types of services over a web. The main advantage of using a Web Service Technology is cross-platform communication. As far as implementation is concerned both use common standards and protocols, such as Simple Object Access Protocol (SOAP), Extensible Markup Language (XML), Web Service Description Language (WSDL) and Universal Discovery Description & Integration (UDDI).

In a web service-based computing model, both clients and the web service providers are unaware of implementation details. If the client wants to consume a web service, it has to go through four stages - directory, discovery, description and data. Figure 4 presents a Web Service infrastructure.

i. In stage 1, a client is searching for a Web Service. Directories services such as UDDI provide a central place for storing published information about Web Services. The client searches a directory and finds a URL.

ii. In stage 2, a client sends a request for service description documents. The server returns the discovery document that enables the client to know about the presence of a web service and its location.

iii. In stage 3, the client sends his request for a particular web service. The service description is sent by the server in XML format which specifies the format of the messages that the web service can understand.

iv. In stage 4, the client requests the XML web service and is enabled to utilize it. The server sends the required response to a client.

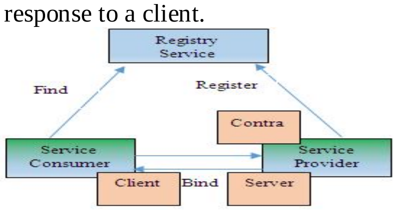



**Figure 4**: Web Service-based Computing Model

To enable communication between disparate systems web services use open wire formats. Open wire formats are the protocols that can be understood by any system that is capable of supporting common web standards, such as HTTP and SOAP.

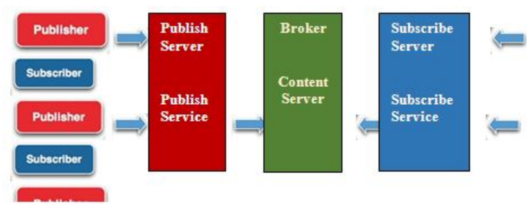
### 4.3 Publish/subscribe Model

Publish/subscribe systems implement the content-based subscribe/ publish/ notify interaction style and provide loose-coupling between the content publishers (teacher) and content consumers (learners). One of the features that distinguishes publish/subscribe from other interaction styles is its inherent multipoint communication style. A published notification is replicated and delivered to all interested parties in the push-based style.The publish/subscribe interaction model enables asynchronous communication between information publishers and subscribers. The publish/subscribe model involves two types of entities: publishers and subscribers. Publishers are content sources that publish notifications and subscribes are content destinations that subscribe to a number of notification types using the publish/subscribe service. The publish/subscribe service provides the management of subscriptions, and storage and dissemination of published notifications. It is an intermediary between the referentially uncoupled and anonymous publishers and subscribers. The interaction between publishers and subscribers is achieved through the mechanism implemented by the publish/subscribe service that matches subscribers' subscriptions with published notifications, and delivers the matching notifications to the interested subscribers. Currently, the publish/subscribe systems use three different schemes for subscriptions: subject-based, content-based, and type-based subscriptions.

• Subject-based subscription. Subject-based, or topic-based subscriptions classify each notification as belonging to a particular subject, i.e., topic. A subject is used to characterize and classify the published content and can be regarded as a logical connector between publishers and subscribers. Subjects can be arranged in a hierarchy.

• Content-based subscription. The content-based subscription offers a more sophisticated and flexible subscription scheme with increased expressiveness. It enables subscribers to define properties of notifications they are interested in. The content-based subscriptions enable subscribers to describe the properties of notifications along multiple dimensions ensuring flexible and subscriber-centric notification filtering.

• Type-based subscription. The type-based subscription scheme is a static classification scheme which resembles the subject-based approach. Subscribing to a type implies that a subscriber receives all notifications of the class implementing the type and also all notifications of its inheriting subclasses: In other words, a number of classes may conform to a single type.The distributed publish/subscribe service architecture solves the scalability problem and offers the means to design a fault tolerant system. However, the design of a distributed architecture is more complex than of a centralized solution, and it introduces significant communication load due to the exchange of control messages between system brokers. Hence, it is necessary to adjust the employed publish/subscribe system design to traffic requirements of the actual application setting.




It is identified Web Service-based Computing Model and Publish-Subscribe Model as the most essential for Personalized E-Learning Systems

### 4.4 Proposed Reference Model/ Architecture

The proposed reference architecture using Web Service-based Computing Model and Publish-Subscribe Model appears in Figure 6. In proposed architecture learner/users connect to ELWPS server. The ELWPS respond to Web requests and execute application code, like the Web portal server and Application servers of the traditional three-tiered architecture. Rather than connecting directly to a centralized database server, however, the Application servers forward database requests to the database server. The database requests are sent from the ELA server to the Database/ Storage server. This architecture is just one example architecture in which a proxy, cache and database can be used. The proposed shows an architecture in which the application code is executed locally by each end-user, perhaps within the Web browser on the end-user's computer. In this environment, the Database/Storage server might exist outside the organization of the CEL server, through internet. In proposed architectures, existing application code can be modified to use the Database/Storage server with only minimal effort.

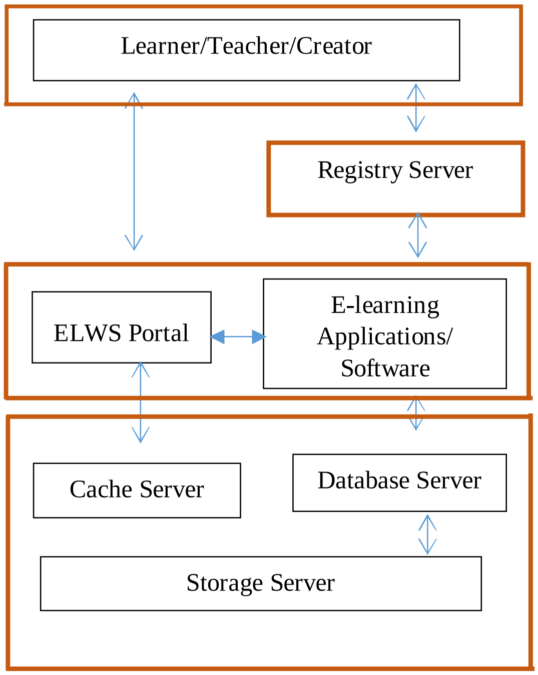



**Figure 6:** Architecture Reference Model

This proposed architecture allows us to address the challenges listed in Section 1.3. Because the CDB server contains a master copy of the database and all updates are forwarded to it, the content provider maintains control over their data. Update notifications are immediately published and delivered using publish / subscribe system, so new requests reflect updates as they occur. Here use of a simple query result cache rather than a more complex representation requires minimal processing within Database/Storage, enabling strategies to reduce end-user latency and control data privacy with encryption in the cache. Finally, the database/storage can be implemented as a middleware service providing the same interface as a typical database.

To provide scalability the proposed architecture exploits several key properties typical of Web applications:

(1) the database queries and learning objects updates are often simple and do not involve complex data relationships, and

(2) the range of database requests executed by a given Web application is often limited by a small, fixed set of query and update templates in the application code.

This above properties enable us to exploit foreknowledge of the Web application and its data to improve scalability for the range of requests an application actually executes. The proposed architecture contains query result cache, the publish/ subscribe infrastructure that closely relate to its scalability, query notification, message notification, etc..

There is lot of challenges in this above example as the number of users/resources grows instead of having a manageable size of e-learning users/resources. Some of the challenges are given below:

- Provides a flexible e-learning system in distributed environment.
- Support interoperability between hardware/software.
- Delivers appropriate performance using scalable architecture
- Delivers incremental value rapidly that add levels of sophistication over time.
- Needs to be adaptable e-learning architecture.

The challenge for e-learning is creating scalable technologies that support an arbitrary number of learners/users with a personalized learning environment and accessing and managing vast amount of learning objects. A normal simple client-server architecture will not suffice. So, it requires a large-scale e-learning system to handle a potentially large number of concurrent, geographically distributed users/resources and support large database of e-learning materials.

Hence, it is proposed to use service-oriented approach and publish/subscribe model in personalized E-learning system. Service-oriented approach differs from the more general client/server model in its emphasis on loose coupling between software components. SOA is an architectural style that allows the construction of applications that reuse distributed functionality of heterogeneous application landscapes.

**Extended Reference Architecture**

The proposed architecture is an extended architecture of SORAPES [30] is shown in Figure 7. It is a scalable and layered architecture [8]. The key capabilities of the reference architecture are defined in the service provider components.

The requirements that should be supported by extended SORAPES are both *functional* and *non-functional*. They have an impact on one another. The non-functional requirements for the design and implementation of SORAPES are availability, performance and security requirements are very essential and they should be described well before starts with the investigation and design of e-learning architecture. The functional requirements are scalability, flexibility and interoperability.

The services required for extended SORAPES are E-learning, Security, Proxy, Cache, Storage, Notification, Query and Semantic. All the above identified services are registered in the services registry. The registry manager can either start/restart or stop the services.

The design uses layered web application architecture [31] and it shows that the architecture of SORAPES. The presentation layer handles the interaction between learners/users and the systems that comprise the business logic layer. It consists of an HTML based browser user interface and displays information to the user and interpreted commands from the user into actions upon the business logic layer components. This service layer consists of all the services defined within the SOA. The specification provides consumers with sufficient detail to invoke the business functions exposed by a provider of the service. The service specification includes a description of the abstract functionality offered by the service similar to the abstract stage of a Web Services Definition Language (WSDL) description [5]. This information is not necessarily written using WSDL. The Application layer serves as supporting components of the learning services and do not communicate directly with the presentation layer. It accepts requests from the presentation layer and need to be able to respond to those requests. The responsibility of database layer is storing persistent data. The communication should be where a component sends SQL requests to data sources and data sources sends responses back to components.

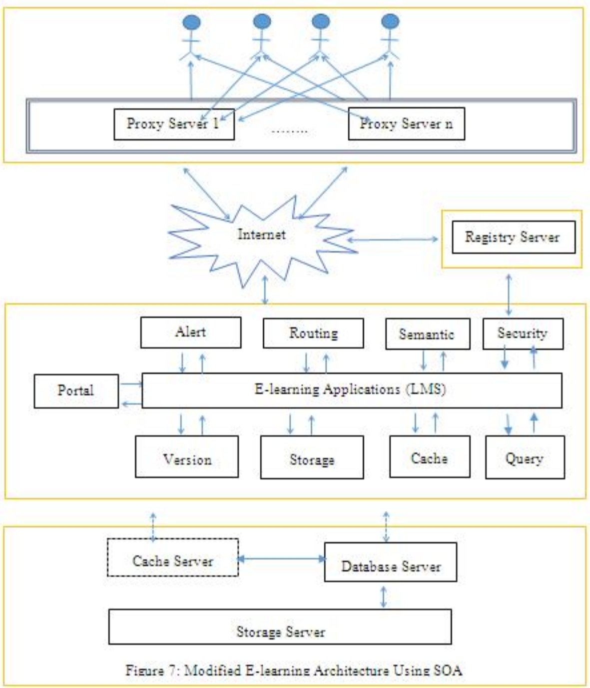



**Figure 7:** Modified E-learning Architecture Using SOA

**Evaluation of SORAPES**

SORAPES is a highly scalable architecture as and when number of users or learners grows. It is evaluated by some of quality of attributes such as scalability, availability, usability, flexibility, security, performance, etc. These quality attributes should fulfill, based on an experience-based assessment ~~[5]~~.

- Interoperability – It satisfy by providing file transfer, publish-subscribe and WSN.
- Reusability - It achieves either internal or external.
- Redundancy - It is added redundancy and multiple instances.
- Flexibility – It is satisfied by implementing server architecture with the core functionality.
- Maintainability – It is fulfilled by adding the requirements for availability, performance, scalability and redundancy.

Security implement in the architecture provides mechanisms for the authentication, authorization and accountability of learners/ end users. SORAPES could be vulnerable to attacks because no extra security measures are implemented for uploading content other than what out-of-the box available in each system.

**Technical Challenges**

Several technical challenges remain in producing reference architecture of E-learning system. They are presented below:

- In the presentation layer, the E-learning portal prototype adopted generic Web portal frameworks.
- The lack of commonly accepted e-learning ontology frameworks in discovery and semantic composition is a major obstacle for the implementation of the application layer.
- The primary barrier in the service layer is the very limited number of online interoperable E-learning services available. Many services are heterogeneous.

## 5. CONCLUSION AND FUTURE WORKS

As an emerging field, e-learning has attracted increasing attention from both industry and academic sectors. To facilitate development of successful e-learning systems on open Internet platforms, we need scalable technologies that support an arbitrary number of users while providing them with a good learning environment. The service-oriented approaches enable personalized e-learning system into an enterprise wide e-learning system. SORAPES supports e-learning system development in a world of growing e-learning technologies.

In this paper, reference architecture using Web services and SOA to e-learning system is investigated and designed. This reference architecture is designed and described for e-learning domains. It identified the essential the functional and non-functional requirements. The reference architecture described the requirement for interoperable, adaptable, semantic web, and personalization in which a user can easily search for learning content. Finally, this reference architecture was validated with specific quality attributes. The benefits and drawbacks of this approach need to be addressed from a number of different perspectives, including performance, availability, user experience, security and development and maintenance cost. The reference architecture is not complete but is work in progress.

However, a learner is difficult to find learning content in a context and a learner's search result only returns what they need. This indicates that a more flexible architecture and model for of learning content is needed and this is proposed for the future work. There are more issues in developing and deploying e-learning systems will emerge, especially in view of the field's diversity and interdisciplinary nature. Expectedly or unexpectedly, e-learning might entail life-long research as much as it facilitates life-long learning's. Future work includes automating more learning activities that can be achieved via mobile devices and integrating them into current LMS.

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