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Service-Oriented Reference Architecture for Personalized E-learning Systems (SORAPES)

K. Palanivel
Computer Centre
Pondicherry University
Puducherry — 605014, INDIA

S. Kuppuswami
Dept. of Compute Science
Pondicherry University
Puducherry — 605014, INDIA

ABSTRACT
Nowadays, a lot of research involves in the area of e-learning with service-oriented architecture. In e-learning systems, the challenges are increase of the complexity and more interoperability between systems in distributed environment. The lacking is reference architecture in which by reusing web services, reusing learning objects and semantics, ontology, etc. A service-oriented reference architecture describes the essence of a software architecture and the most significant and relevant aspects. Hence, it is proposed to design reference architecture to personalized e-learning systems using Web services and service-oriented architecture. The objective of this paper to design service-oriented reference architecture for personalized e-learning systems (SORAPES) and validate the architecture. Some of the existing e-learning architectures that serve as the domain model for personalized e-learning system were considered, discussed in details and finally proposed a new architecture which is called SORAPES. The SORAPES was designed by re-using web services and learning objects. It is a layered architecture and highly-scalable for personalized e-learning system. This architecture was evaluated with a list of quality attributes.

Keywords
E-learning, Personalization, Reference Architecture, Service-Oriented Architecture, Semantic Web, Web Service, Ontology

1. INTRODUCTION
E-learning is defined as "learning where the internet or intranet plays an important role in the delivery, support, administration and assessment of learning". Weller describes "e-learning for the enthusiasts" as e-learning where the internet facilitates a two-way communication and encourages discussion, dialogue and community that is not limited by time and place [1]. The role of the educator is to facilitate dialogue and support of students in their understanding of resources. E-learning puts the control where it's needed, in the hands of learners, so that they can learn wherever and whenever it suits them best. It also gives new resources to instructors such as interactive multimedia, simulations and other emerging learning techniques.

In E-learning, instructors/ teachers in almost every field of study are trying, with varying degrees of success, to implement the concept of e-learning for their courses. Many groups of researchers have put effort into studying, surveying, designing and implementing programs to develop e-learning. Those efforts have shown that the new methods used in e-learning have the ability to be more interactive, provide a more convenient way to communicate between instructors and learners, and provide more suitable courseware for the learners. Despite such efforts many students, particularly among those learning through technology, drop out from their courses. The reason here is, here are different characteristics among students who come from different cultures and characteristics.

Personalized E-learning System (PES) is suggested as the next-generation e-learning system [2]. It is an online learning environment where the students are able to customize their learning environment based on pedagogical and personal choices. The student group is heterogeneous. To be able to individualize and differentiate e-learning to a heterogeneous student group, it is necessary to find and describe the heterogeneity factors of the student group. A holistic approach is necessary when describing the heterogeneous student group, avoiding that smaller parts not are viewed as more important than necessary. In the learning environment, students who come from different ethnic groups require different support.

1.1 Motivation Example
The example of personalized e-learning system is shown in Fig.1. E-learning lets learners and instructors/teachers participate in learning activities and access a wide range of learning resources, independent of place and time.

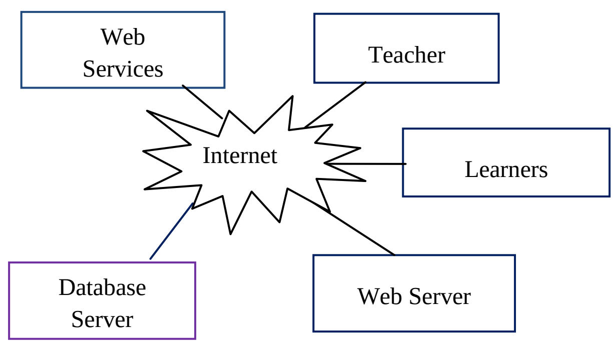

Fig 1: Motivation Example of E-learning System

As an emerging field, e-learning in the broad sense 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. An efficient way of developing new e-learning systems in which development work is done over and over again with re-using what was done in the past. In e-learning systems, the challenges are increase of the complexity and more interoperability between systems in distributed environment.

Job Habraken [4] stated that there is a shift in which learning technology applications such as learning management system (LMS) or learning content management system (LCMS) move away from being a monolithic application towards more flexible components that expose services accessible to other applications via a loosely coupled standards-based interface. The adoption of service oriented approaches should enable these applications to integrate with an enterprise wide e-Learning solution.

Li Qing Lau et.al. [16] also stated that a fully service oriented approach is still far from the norm. In this paper some initial steps have already been made towards a more service oriented approach, further research is necessary to understand the consequence when the reference architecture described in this thesis evolves to a SOA.

Reference architecture addresses this issue by reusing contents from different domains to design the views of the reference architecture. Reference architecture provides guidance for the development of new versions of architectures to e-learning systems [3]. An important step in creating reference architecture to e-learning systems is its design.

1.2 Problem Statement

In E-learning, when a course has only a manageable size of e-learning users, simple client-server architecture will sufficient. As the number of users grows, however, the course might require a large-scale e-learning system to handle a potentially large number of concurrent, geographically distributed users and support a large database of e-learning materials.

The problem statement of this research paper is to design service-oriented reference architecture for personalized e-learning system with scalability in mind.

1.3 Solution to the Problem

The solution is to investigate and design Service-Oriented Reference Architecture for Personalized E-learning Systems using Web Services and SOA. SORAPES architecture supports more scalability and more reusability to especially personalized e-learning systems. SORAPES puts the control where it's needed, in the hands of learners, so that they can learn wherever and whenever it suits them best. It provides managers with the capability to monitor the progress of learners and assess course effectiveness. Adding more instances of a system to SORAPES to fulfill new scalability requirements has a negative impact on the on the cost and the maintenance of the solution. By using reference architecture to e-learning systems, a customer has the benefits of an e-learning system and the developer can provide; a better return of investment. Reference architecture provides a faster deployment of technology and a flexible technology base.

1.4 Research Methodology

This research has aimed to propose a SORAPES. Thus, producing this reference architecture needs some knowledge and investigation of existing approaches [6]. The steps of this stage are as literature review, analysis of requirement, design, logical deployment architecture and verification. *In literature review*, some background on E-learning, Web Services, SOA and reference architecture is studied. The purpose is to understand the basic concepts and current approaches for SORAPES. Furthermore, the survey on existing architecture and related issues to support SORAPES is provided. Then the requirements that are needed for designing SORAPES are identified. It examines SORAPES can support all those requirements. Based on the above requirements, a SORAPES is proposed. In order to develop a SORA in an enterprise, the components of the proposed SORAPES should be applied on the proposed logical deployment architecture. It analyzes all requirements needed for this case study.

The research paper is structured as follows. *Section 2* describes the theoretical background of this paper such as PES, SOA, Web Services, Web Service Notifications, etc. Literature review was done in *section 3*. Various architectures of personalized e-learning using SOA and Web Services were identified and studied. *Section 4* describes the architecture of SORAPES. The description includes the requirements, various components. Identified several quality parameters and applied to evaluate the architecture. Finally, section 5 concludes the paper and provides recommendations for future works.

2. BACKGROUND DETAILS

This section introduces information about personalized e-learning systems and introduces the concepts of Web services, Service-Oriented Architecture, Web Service Notification and reference architecture.

2.1 Personalized E-learning Systems

A personalized e-learning system should fulfill certain needs and requirements in a field of increasing demand for effective, fast and pedagogically correct learning experiences. PESs create, operate and administer on-line learning activities. They also create and deliver questions and tests for learner assessments. They support collaboration between users. All e-learning systems administer virtual, distributed learning experiences where learners are geographically scattered and communicate via the Internet. An e-learning system is considered to be adaptive [28] if it is capable of: monitoring the activities of its users. Adaptive e-learning system can be described as personalized system, which beside contents discovery and assembly, is able to provide adaptive course delivery, adaptive interaction, and adaptive collaboration support [7].

E-learning is an area which can benefit from semantic web technologies. The possible uses of Semantic Web technology for e-learning are pull, interactive, non-linear, symmetric, continuous, distributed, personalized and dynamic [8]. The services and semantic worlds come together in two ways. The first is that services provide a semantically rich description of their functionality in order for applications to reason about them in the same way as they reason about data on the semantic web. The second (which is complementary to the first) is that the applications that use the data from the semantic web could actually be services themselves. Semantics and Web service technology can be employed to achieve personalization in e-learning system and as a consequence to improve e–learning effectiveness dramatically.

2.2 Web Services

A Web Service [10] is a software system designed to support interoperable machine-to-machine interaction over a network. Web Services expose only their interfaces to the public. Such an interface can be completely described using a Web Service Description Language (WSDL) document that characterizes the Web Service interface in terms of operations that the Web Service provides, messages that are exchanged to do so and data types that are used to construct those messages. An important characteristic of Web Services is that implementation details of the systems are hidden behind the interface. The consumer is aware that certain functionality is provided, but the internals on how this is done are abstracted behind the Web Service interface. Consequently, this involves that the actual functionality could be implemented in an arbitrary programming language and running on arbitrary platform.

SOAP [11] is an application-level protocol based on XML used for data exchange and remote procedure call in distributed applications, usually for accessing Web Services. Due to its XML- based design, SOAP is platform and programming language independent. SOAP messages are transmitted embedded into or on top of other application-level protocols such as HTTP, SMTP or JMS.

The Web Service Description Language (WSDL) provides the possibility to completely describe a Web Service interface through the use of an XML document that conforms to an XML Schema as defined by the WSDL specification [12] of the W3C. WSDL provides machine-processable information on how to interact with a given Web Service to a Web Service consumer application. Since the Web Service is fully described by the WSDL document, it is possible to generate client code for interaction with a given Web Service by using the definitions given in the WSDL document.

The Universal Description Discovery & Integration (UDDI) [13] specification defines a Web Service registry that allows possible Web Service consumers to dynamically discover Web Services that provide a certain service. While WSDL describes the Web Service interface, UDDI allows the discovery of the Web Service interface by clients. The UDDI registry is actually a Web Service itself and makes use of WSDL to describe its interface. The main purpose of the UDDI registry is to allow client applications to dynamically discover Web Services that provide a required service. The use of UDDI allows the client applications to discover a replacement for failed Web Services.

Web Service Notifications (WSN) [14] is to allow Web Services to notify other interested entities of events that have occurred inside the Web Service. In the basic form of the publish-subscribe interaction pattern, a Web Service publishes a topic of events to which other interested entities may subscribe. Occurrence of an event inside the publishing Web Service then triggers the Notification of subscribed entities. Additional to this basic form, Web Service Notifications may also involve an intermediary Web Service, called a Notification broker that may introduce additional features and enhanced scalability to the Web Service Notification architecture.

2.3 Service-Oriented Architecture

SOA [9] is an architectural paradigm for designing and building distributed system on the basis of loosely coupled, interacting services. Since SOA is concerned with the architecture of a distributed system, it is neither tied to nor targeted towards a specific problem domain. The central concept in a Service-Oriented Architecture is the service, which defines a mechanism that enables access to capabilities through a predefined interface. Services are discovered dynamically when needed, rather than being hardcoded into service consumers. Dynamic discovery of services is realized through use of the so-called publish, find, bind pattern. This mechanism makes it easy to dynamically add, remove, replace or relocate services as needed without further modification of service consumers. For example adding extra services for load balancing or replacing faulty services are scenarios where this can be of importance. Web service and SOA is depicted in [3].

2.4 Reference Architecture

Reference architecture provides better return on technology investment; enables faster deployment of technology; and provides a modular and flexible technology base. Documenting a software architecture means to describe or specify all the architectural elements, diagrams, models decisions, rationale and anything else that concerns the architecture [4]. The architecture documentation serves as a means of communication between the different stakeholders of the system where a stakeholder is someone who has a vested interest in the architecture. The documentation's use could vary depending of which stakeholders are involved in the communication. Designers of other systems use the documentation to define the set of operations provided and required for technical compatibility. The architecture documentation serves as the bases for system analysis such as the analysis of quality attributes of the system.

Service-Oriented Reference Architecture [15] helps organizations adopt new service-oriented computing by mapping this new architectural approach to business processes, technology initiatives and overall business and IT transformation. The reference architecture simplifies and accelerates the service-oriented architecture solution development to enable the organization.

3. LITERATURE REVIEW

This section describes the architectures and models that are considered to investigate SORAPES.

Li, Qing Lau, et.al. [16] provided an overview of e-learning system development with respect to a layered reference architecture. This architecture includes the Internet infrastructure layer, the conceptual/modeling layer, and the application layer. The internet infrastructure layer main functionality is to address such scalability issues. The conceptual / modeling layer /ML provide high-level tools for supporting e-learning application development. Let's look at student modeling and personalization, an example research issue for the C/ML. User models is essential to e-learning systems, giving students learning continuity, tutors evidence of students' progress, and both a way to personalize students' learning materials to their abilities and preferences. At the application layer, all different types of e-learning applications are developed. 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.

Ngamnij Arch-int, et.al., [17] proposed a reference architecture for interoperating the existing e-learning system with the help of Web services and a metadata-UDDI model. This architecture consists of multiple layers, namely web client components, learning services integration centers, meta-UDDI and learning service providers. Web User Components consist of learners, and content authors (i.e., teachers and instructional designers) whose serve as the learning service requesters. The web client components communicate with learning service integration center in a Web-based environment. Learning Service Integration Center is a local SCORM compatible LMS and serves as a learning service broker which obtains the user requests from web client components and subsequently invokes the corresponding services to serve the user requests. Metadata-UDDI is designed and incorporated as a core component of the middle tier in order to cope with the service name conflicts provided by different service providers. The metadata-UDDI contents are systematically implemented by means of flexible XML data model. Learning Service Providers consist of existing distributed LMSs located at different educational sites. This tier aims to provide various kinds of services, such as, the user registration, user profile updating, course registration, learning courses, versioning of learning objects [27], and content discovery services. This metadata-UDDI model is designed as a core component of the architecture and provided the service information for generating the lightweight communication protocols between heterogeneous e-learning platforms. As a consequence, the semantic service heterogeneity is eliminated. An XML-based data model is employed to manipulate and express the metadata-UDDI contents. The inherent flexibility of XML technology permits system-wide interoperability suitable for a Web-based environment. The interoperating of existing e-learning systems is a challenging issue in e-learning systems. This architecture described the exchanging learning data between e-learning systems in heterogeneous environment.

K.K. Thyagharajan, Ratnamanjari Nayak [18] 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. The learner model contains explicitly modeled assumptions that represent the characteristics of the learner which are pertinent to the system. The system can consult the learner model in order to adapt the performance of the system to each learner's characteristics. Learner modeling allows the system to personalize the interaction between the learner and the Content. The Adaptive Content Creation and Presentation is the customization of course content to match learning characteristics specified by the learner model.

Instead of providing a learner with static data, the approach is based on fulfilling learning objectives based on a dynamic supply of services. 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.

Dan Chiribuca, Daniel Hunyadi, Emil M. Popa [19] proposed a modular semantic-driven and service-based interoperability framework, in order to open up, share and reuse educational systems' content and knowledge components. It focused on content creation by proposing ontology-driven authoring tools that reflect the modularization in the educational systems, maintain a consistent view on the entire authoring process, and provide wide (semi-) automation of the complex authoring tasks.

The proposed architecture supports sharing and exchanging information between adaptive concept-based WBES include stand-alone, information brokerage, communication and services. Stand-alone, component-based independent WBES using their private subject domain ontologies. Information brokerage bureau where all applications are registered. Services to support systems communication, including ontology-related services, e.g. for ontology mapping. Communication bridges between the systems supporting standardized transport mechanisms and a common interaction protocol.

The problems faced by the current approaches inflexible and not efficient. Also, the existing systems are difficult as there is no common reference architecture, nor standardized approaches. Thus, there is an increasing need for efficient support environments for the designers and builders (authors) of adaptive Web-based e-learning systems. 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. The Semantic Web offers more intelligent access and management of the Web in-formation and semantically richer modeling of the applications and their users. Within the context of Semantic Web, there are several hot issues, which allow achieving this reusability, shareability and interoperability among Web applications.

Ruben Miguez, Juan M. Santos, and Luis Anido [20] 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. The deployment of such a system, based upon Standards and Specifications for Learning Technologies, facilitates the development and integration of ICT tools. It supported early childhood education processes, encourages parents' involvement and fosters the cooperation between families and practitioners.

This paper identified services into three different tiers where each one relies on functionality provided by services at bottom layers. Infrastructure services layer provides end-to-end transaction and communications functionalities. Common services layer provides a broad range of cross-domain functionalities (e.g. authorization, format conversion, group management and so forth). Domain services layer provides the domain specific functionalities as student assessment, school blogging, children's portfolio management, specialist consultation, and so on. Agent layer provides high-level functionalities to developers (e.g. Planner or Recommendation systems). Final applications are made up of agents that collaborate and exchange different information in order to fulfill some particular system functionality. This paper presented a reference model to facilitate personalized learning and children tracking and assessment and development of agent-based software architecture.

Andreas Schmidt [21] 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. Reference Architecture for Context-Aware Learning Support Systems consists of external information layer, infrastructure layer, adaptation layer, end-user application layer. The external information sources could be sources for eliciting user context information, but also sources for providing learning material. The infrastructure layer provides the basic services like user context management service and ontology service. The learning coordination layer subscribes to the user context management service, makes use of the learning support services and initiates activities in the two remaining layers. The adaptation layer is responsible for translating interventions by the learning coordination layer into application-specific actions and user context information into adaptation parameters that accompany the actions. The main task of this layer is to provide context-aware interfaces to end user applications that can be context-aware, but usually are not.

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.

4. ARCHITECTURE: SORAPES

This section describes the architecture of SORAPES that includes services identified and functions various layers. Finally it evaluates the architecture using some quality attributes.

SORAPES is a layered architecture that consists of presentation layer, service layer, application layer, database layer. The *presentation layer* gives a single port of entry for the users and handles the interaction between the users and the different components in the business logic layer. Here, the access to the components in the business layer is based on a user personalization. The *business layer* is responsible for all the work an e-learning system is supposed to do. It provides functionality such as mail, authentication, etc. The *services layer* utilizes the capabilities of the application server. It is composed of stateless functions that expose high-level business functionality. The *database layer* is responsible for the communication with the databases of the different components in the business layer.

4.1 Services Identified

The services required for SORAPES are search, reporting, offering, registration, user account, authentication, integration, notification, messaging, etc. and their functions are explained below:

The *search service* (search.wsdl;) handles search requests from the learners or users and sends messages to the portal that meet the passed specifications. The *registration service* (register.wsdl;) registers or unregisters learners and instructors for a virtual learning. The service also updates the existing registration information. The *integration service* (integrate.wsdl;) allows learners to register for specific events and producers to publish certain events that reach a specific number of learners. The *security service* (security.wsdl;) handles authentication, authentication and confidentiality. The *reporting service* (report.wsdl) handles the result reports of a completed learning offering. The *notification service* (notify.wsdl;) can handle subscriptions of learners that cannot receive Notification messages sent by versioned Web services[29]. Notifications may therefore be propagated through e-mail or instant messaging. The Notification service should be generic that produce Notifications. The *repository service* (reposit.wsdl;) provides access to learning objects [26], and documents. This repository stores just the metadata and a link to a physical resource.

The *ontology service* (ontology.wsdl;) provides open and declarative access to a shared conceptual model forming the basis of the services' interaction and background knowledge needed for adaptive behavior. Via a centralized ontology service, a loosely-coupled architecture becomes possible without losing a high degree of semantic coherence. The *user account service* (useracct.wsdl;) handles LMS requests to create modify or delete user account information in the collaboration system. It stores collected user information and provides a consistent view on it, abstracting from contradictions, uncertainty, and outdated information. This service needs to provide both a declarative query language for query-response interaction and a subscription facility for asynchronous notification. The identified services are registered in the services registry. The registry manager can either start/restart or stop the services.

The end users of PES could have different roles. In a typical e-learning system, they are learner, instructor, manager, training administrator, administrator, author, etc. The end-users are interested in the functionality such as the ability to register learners to a course, the ability to create new courses, the ability to report on the progress of direct reports or the ability to launch a course. End-users would like to have a seamless experience if it comes to the usage of the different components of the solution.

4.2 Requirements

E-learning systems need to be able to support and manage a blended approach in its learning activities that incorporates all types of learning, including traditional classroom training, online course delivery and virtual classroom training. To achieve this, a broad range of functions is required. The requirements that should be supported by SORAPES are both *functional* and *non-functional*. They have an impact on one another.

Many E-learning systems focus on satisfying functional requirements as given below. The SORAPES comprises many functions like analysis/ reporting, content, collaboration, assessment, etc. They are tightly integrated and provide the information for e-learning. The *Analysis/ reporting* provide extensive tracking of all activities within the system and standard reports. The *content management* provides functions to handle and manage content and users throughout its lifecycle, from creation through publication and revision to archive. The *collaboration* provides virtual classrooms, video conferencing and wikis, blogs, e-mail, discussion threads. The SORAPES has the capabilities to integrate with the e-mail and calendaring applications. The *assessment* provides the facilities to create deliver and manage assessments and record the result for a learner. It also provides the facilities for administrators to monitor the progress and performance of their direct reports.

The non-functional requirements for the design and implementation of SORAPES are presented below. 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. *Availability* must be robust enough to serve the diverse needs of thousands of learners, administrators, teachers and instructors simultaneously. The *performance* is the ability of the components that comprise the solution to provide a response in a timely manner. The performance is expected that all users of the solution consistently enjoy good performance. *Usability* is especially important for the end-users of an e-learning system as they are responsible performing day to day tasks using the solution.

An e-learning system should allow only authorized usage contents, resources and back-end functions. The system should also provide its services to legitimate users. End-users require that their privacy is protected by the system and that they have access to the functionality and courses they want to use. The

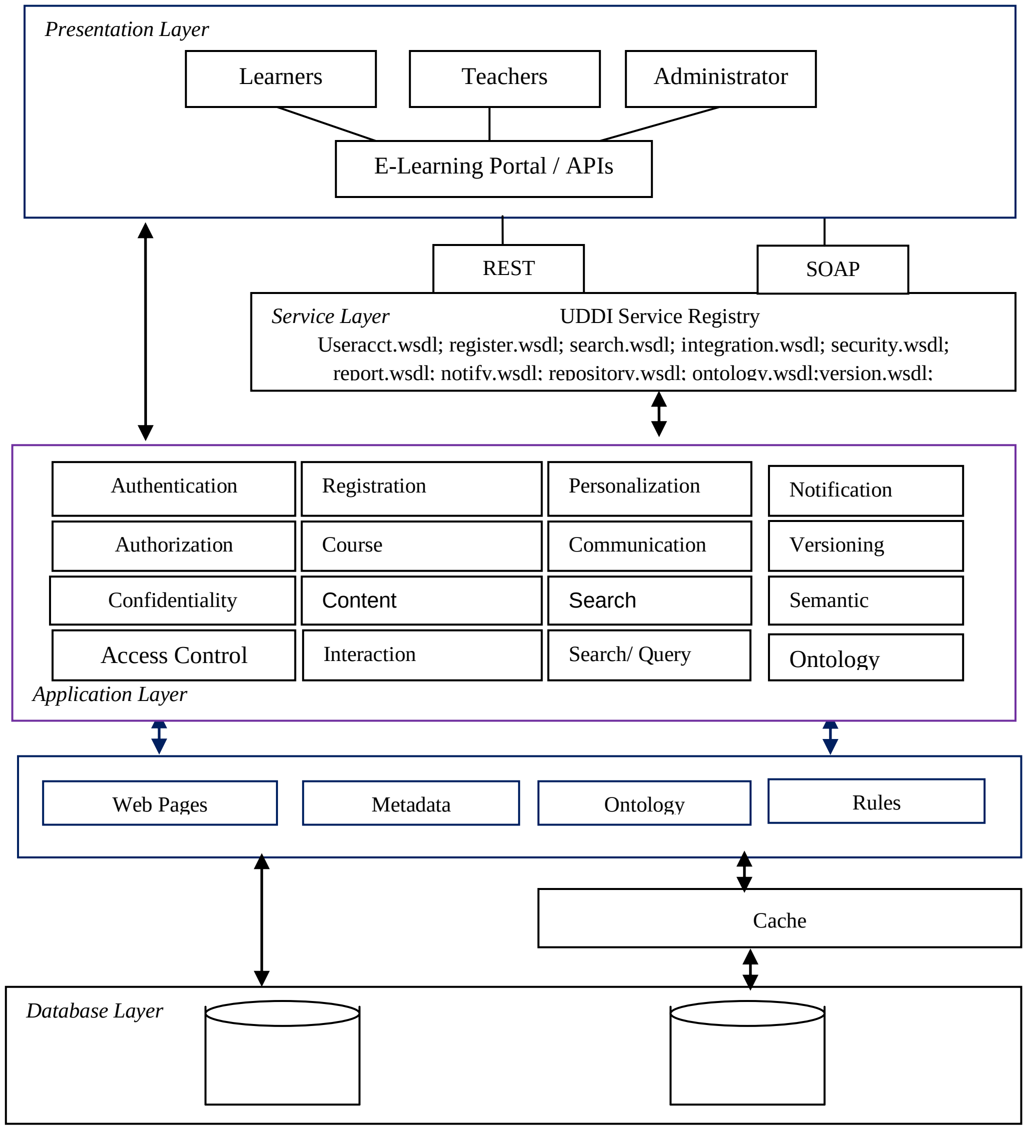

Fig 2: Service-Oriented Reference Architecture for Personalized E-learning System

scalability deals with short term growth and long term growth. The infrastructure of an e-learning system should be able to expand or scale to meet future growth, both in terms of the volume of courses and the number of the learners. The *Flexibility* is concerned with the ability to change the functionality of an e-learning system because of changing requirements of the customer. Changing functionality should be possible to add, remove or change components to the solution without being forced to rebuild the complete architecture of the solution. *Interoperability* requires industry standardization of formats, protocols, services and the ability to exchange data and request functionality. It is required in PES, such as content and user management. E-learning system always needs upgrading and maintenance. Maintainability is the ability to upgrade quickly and cost-effectively.

4.3 Layered Architecture

The design uses layered web application architecture [22]. Fig. 2 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.

4.3.1 Presentation Layer

The presentation layer may offer multiple user-interfaces where each user interface displays all or part of some of the application data. The primary function of the portal is to manage the presentation tier of the application. As the presentation is generally based on entitlements, there is a need to support this capability. The *Portal presentation* provides the skins/ templates/ skeletons/ style sheets etc. for each of the application teams. This should also include some sample applications to jumpstart the application developing, including leveraging the portal navigation capability, both for vertical navigation bars as well as horizontal tabs. *Personalization* such as portlet layout and background template selection is provided by the Portal during this phase. *Centralized login-In* enables the enterprise to provide a seamless user experience by not requiring multiple logins.

4.3.2 Service Layer

Exposed services reside in this layer; they can be discovered and invoked or possibly choreographed to create a composite service. This layer contains the contracts (service descriptions) that bind the provider and consumer. Services are offered by service providers and are consumed by service consumers (service requestors). OA requires services to be coarse-grained, loosely coupled, and standards-based. The *service producer* publishes the service to the service registry which is leveraged by the service consumer for runtime binding. The *service registry* also acts as the system-of-record for the predefined business policies which could be used at runtime for enforcement of these policies. The primary function of this service manager is to manage, monitor and report on all the services enterprise wide. It manages and ensures that the service level is maintained enterprise wide.

4.3.3 Application Layer

An *assessment module* enables authors to create surveys, formative assessments and summative assessments for delivery via the web and performs storing, retrieving, deleting and updating assessments functions. A course module is stored in the learning management and the actual physical files of the course are stored in the learning management database. The learning management uses its MOODLE/SCORM interface to launch online content from a learning management database and sends status updates back to the learning management using the interface of the learning management.

A communication module creates and manages sessions including asynchronous and synchronous communication. It supports synchronous communication like video conferencing, virtual classrooms, application sharing, shared white board and asynchronous communication like wiki, blog, discussion groups, e-mail group, etc. The Interaction module performs file transfer, messaging and publish-subscribe functions. The file transfer processes that take place between systems. E-learning systems use a publisher-subscriber that connects the sending components with one or more receiving components. It delivers a copy of the message to each of its output channels where each output channel has a message endpoint that allows the receiver to read the message only once. The publish-subscribe model publishes the different events that take place between the systems. A *notification* is responsible for sending, retrieving and forwarding notifications from the different components that comprise the solution. *Security* provides identification and authentication, access control and database access. The identification and authentication for an e-learning system must satisfy a set of requirements often set by the security department of a company. The function of identification and authentication is to recognize an end user and validate the end user's identity. An e-learning system in which we have to manage a large number of end users, information types, functionality or a large variety of resources we need a way to control access these elements.

4.3.4 Database Layer

In Database component module, the elements are the database interfaces of the systems that comprise the application server architecture. This describes the database interfaces of the core applications of learning environment. Here, the challenge is sharing of database. E-learning system stores data that are accessed and modified by the learning components. The learning components can store and retrieve their persistent data by calling an appropriate method on the database layer. The learning components are often designed using object technology and relational databases.

4.4 Search Component

E-learning portal applications need to present data in a tabular format to the users. The functionality provided by the search component [24] is dynamic query generation based on user input, sort order, joins, etc. There are multiple ways to invoke the query service. All of them are supported by the SOAP protocol. Based on the service description and the SOAP protocol, new client interfaces can be easily built according to users' preferences. Learners want search the learning object related to Computer Science, then they have to type 'Computer Science'. By activating the link on the query interface, it obtains the extra services exposed by other providers. The way to access the service is by an embedded URL like http://www.pulearn.edu.in/soap/search.jsp. Fig 3 illustrates the architecture of search component of SORAPES.

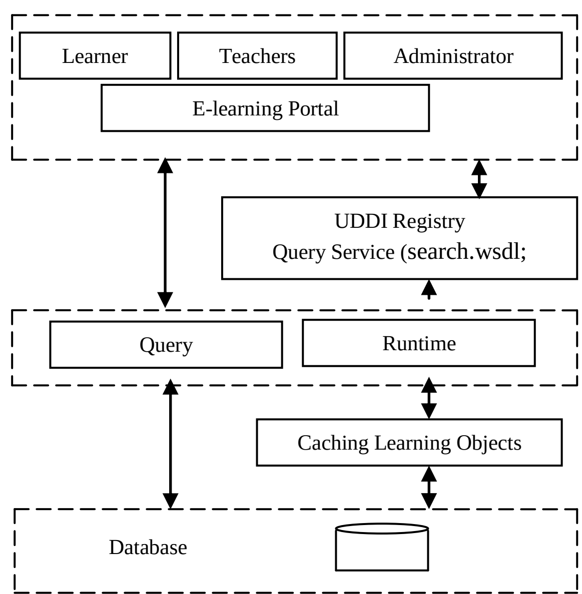

Fig 3: Search Component of SORAPES

4.5 Web Service Notification Component

This notification [23] provides a single notification client to all applications, support synchronous and asynchronous interface to the Notification Engine and also provide capability to send notification through multiple channels. The interface to the various channels could be developed as required for providing the business capability. The Notification minimizes the knowledge of different notifications produces in order to facilitate a loose coupling of services. Fig 4 illustrates the architecture of search component of SORAPES.

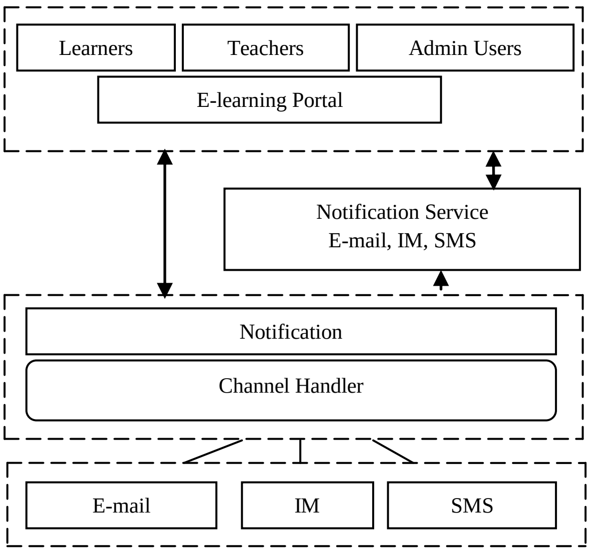

Fig 4: Notification Component of SORAPES

4.5 Security Component

Security component offers authentication, authentication, access control and confidentiality [25]. The *authentication* handles the authentication requests sent to the LMS. It is passed log-on credentials for a user and returns an authentication certificate. *Authorization* follows authentication and that is, once a user or system has be authenticated. Authorization means making a decision about whether an authenticated or even an authenticated identity is allowed to access a resource. The *confidentiality* is the security service for ensuring non-disclosure of sensitive information traveling through untrusted communication networks or at rest, such as in data stores, volatile memory, and so on. Information at rest includes security, user, and application information. It is commonly rely on ton cryptographic techniques such as encryption. Fig 5 illustrates the architecture of security component of SORAPES.

4.6 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].

Adding redundancy and multiple instances to SORAPES has a negative impact on the cost and the maintenance of the architecture so there is a trade-off made between the availability and performance of the system. Usability is a quality attribute that is difficult to evaluate SORAPES because it concerns the user interface and is mostly subjectively assessed. Flexibility is satisfied by implementing server architecture, with the core functionality of SORAPES like content management module, assessment module, versioning module and collaboration module. Interoperability is also satisfied by SORAPES that provides file transfer, publish-subscribe and web service notification. Maintainability in SORAPES is fulfilled by adding the requirements for availability, performance, scalability and redundancy. These quality attributes have a negative impact on the maintenance of SORAPES because more systems need to be supported. The 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.

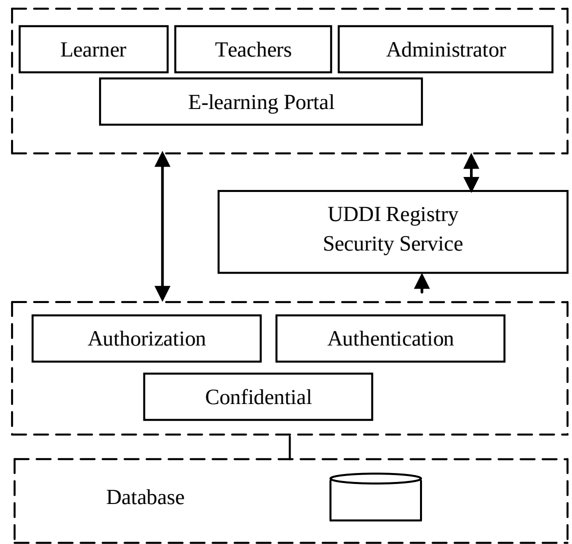

Fig 5: Security Component of SORAPES

5. CONCLUSION & FUTURE WORKS

The service-oriented approaches enable personalized e-learning system into an enterprise wide e-learning system. In this paper, reference architecture to e-learning system is investigated and designed using Web services and SOA. Some of the common services such as ontology, management, semantic web, authentication, registration were identified and considered in this architecture. 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. This reference architecture was validated with some specific quality attributes. The reference architecture is not complete but is work in progress. 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.

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.

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