SOA enabled e-administration for institutes providing higher education.

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ABSTRACT: *The integrative & collaborative value of SOA has benefited industry immensely. The same benefits can and should be provided to the field of Education, especially higher education. The problems of the education sector are:*

- *Lack of customer (student) & service orientation.*

- *Most processes are manual, and hence slow, inaccurate and inefficient.*

- *Processes are not flexible; hence institutions continue to adhere to age-old procedures, which have out-lived their shelf life.*

- *Departments operate in "silos", where the left hand does not know what the right hand is doing. This leads to inefficiency and a further drop in quality of "educational experience".*

These problems can be well addressed by the efficient incorporation of SOA in traditional or present education processes. This research paper argues that the problems arise because of disconnected & isolated processes and lack of communication between them. This paper focuses on how an 'Independent IT department' can manage and run a SOA enabled system to integrate all processes (services) together and make their communication possible. The paper will make the case that SOA has the features to integrate administrative processes of an educational institution. The paper will propose a smoothly coupled set of services which are SOA enabled, and demonstrate the potential to bring the convincing improvement in Academics processes.

Keywords: Business process, data virtualization, higher education, service provider, service consumer, SOA (Service oriented architecture), web service.

Introduction:

Non-systematic approach to the design of small business enterprise application system is the most significant source of data diversification and redundancy. This has a significant negative effect on the enterprise's ability to extract real-time, accurate information on the past, present and future, as well as forecasted business activities [8]. SOA (Service Oriented Architecture) is a concept rather than a specific technology. The notion of "service" has spurred major evolutions for both information systems and the Web. A software application is no longer considered a monolithic component; it can be divided into services that are smaller components defined by their function and accessible through well-defined interfaces and protocols. As a result, IT actors are using service-oriented architectures (SOAs) to remodel the information systems of many companies while the Web is increasingly becoming a programmable place. In both domains, developers build composite client applications to consume these services. Even boundaries between enterprise services and Internet services are vanishing. Using shared services and cloud computing solutions helps universities to create a collaborative and open environment, with low costs and efficient service management. The use of shared services between multiple departments or institutions facilitates the access of information technology (IT) and the

cost sharing. In addition, the use of Cloud Computing helps the virtualization of infrastructure, the service automation, increasing the availability and connectivity to end-users (Blinco et al, 2009). The use of services is simple, standards-based, and less expensive than other forms of integration. Our architecture brings these tools together as an Indivisual service [12]. This loose coupling enables SOA to offer clear benefits [1] and opens up new opportunities for organizations to become more flexible and responsive. However, this architecture brings challenges to Information Technology (IT) management and complicates Quality of Service (QoS) measurement precisely because of its loosely coupled nature. [15]

Introduction to SOA:

SOA is the form of organization of integrated enterprise application environment, characterized by supply, demand and usage of its distributed functions, implemented by services. It enables a concept of uniform tools for exposition, discovery, interaction and usage of individual business functions in context of fulfillment of the defined objectives. Growth of internet, electronic business , as well as supporting protocols and standards, particularly XML (extensible Markup Language), motivated development of technical solutions for exposition of business functions in a wider context, even publicly. Today, the primary tools for enterprise collaboration, as well as integration of its internal business functions, are web services – basis of SOA infrastructure. Basic standards for realization of web services are WSDL (Web Services Description Language) [5], used for definition of services.

Existing System:
Traditional existing systems in education sector are mostly process oriented where technology is mostly used for information management. The information, which system stores during various process executions is not shared to other processes, which leads minimal use of information and redundant databases. The existing system in general has a following architecture;
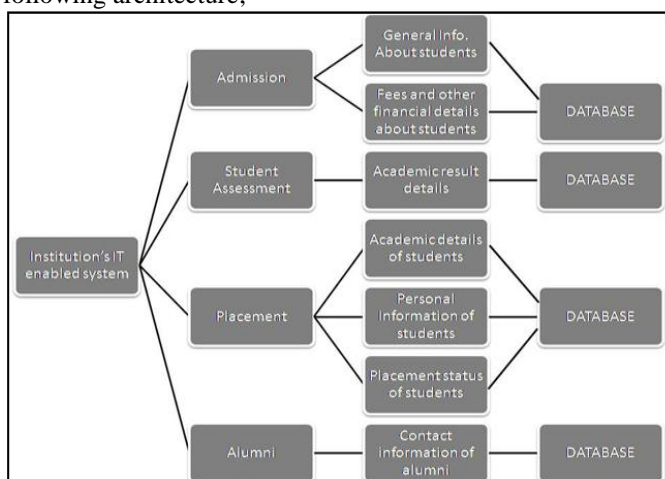
Fig 1: Usual Existing system of educational organization

In the current system there is less reusability and sharing of information. The business processes are not very well defined and which obviously leads to poor business

outcomes. The fundamental challenges with the current system are;

- The existing applications and the IT organization itself operate in silos. As shown in Figure 1, this environment currently relies on a point-to-point integration architecture, which is costly, time consuming and rigid when the business requires change.[9]
- There is distributed and isolated database management.
- The organization lacks an end-to-end development methodology and governance, which is sorely needed to support the re-use of existing application components as flexible services across the organization.[9]

Often, these systems in most of Indian academic institutes have grown organically, rather than in a structured manner, in order to respond to rapidly changing business needs. This organic process inevitably results in a set of information silos, disconnected and seemingly unrelated to each other. And yet much of this information is in fact related, and, if integrated and leveraged, can deliver tremendous value. [18] The challenge for the enterprise is to achieve data, business, and process integration rapidly, cost effectively, and incrementally while ensuring immediate and ongoing benefits.

A Service oriented approach:

SOA is a key enabler in terms of delivering the kinds of streamlining and efficiencies described above. It replaces the traditional point to point linkages between systems by separating data, and the tasks and business processes that use the data, into separate service layers. In simple terms it turns the traditional 'spaghetti' of point-to-point integration into more of lasagna. Service Oriented Architecture (SOA) is a business-centric IT architectural approach that supports integrating your business as linked, repeatable business tasks, or services. With the Smart SOA approach, you can find value at every stage of the SOA continuum, from departmental projects to enterprise-wide initiatives.
SOA establishes an environment that promotes reuse on many levels. For example, services designed according to service-orientation principles are encouraged to promote reuse, even if no immediate reuse requirements exist. Collections of services that form service compositions can themselves be reused by larger compositions. The emphasis placed by SOA on the creation of services that are agnostic to both the business processes and the automation solutions that utilize them leads to an environment in which reuse is naturally realized as a side benefit to delivering services for a given project. Thus, inherent reuse can be fostered when building service-oriented solutions. [18]
While designing and deploying the SOA one thing which is emphasized

A service-oriented architecture has some key advantages, including:
- **Opportunities for reuse.** Reusing existing services, rather than copying code or implementation, enables faster time to solution.

- **Published interfaces.** The service is made available and its interface is explicitly and precisely described.
- **Formal definitions.** The provider and consumer understand and accept the rules of interaction.
- **Abstraction.** All aspects of the service implementation are hidden from its user.
- **Functional relevance.** Functionality can be presented at a granularity that is appropriate and useful for the consumer.

All of the above benefits give increased agility to cope with changing conditions and requirements, increased visibility into current operations by identifying and encapsulating key business functionality, and reduced complexity, risk, and cost of integrating systems. [18]

A business oriented approach with SOA (Proposed solution for better business outcome):

Looking at the existing system we can easily find out the loopholes and missed out business components. The foremost important step towards successful implementation of SOA is identification of business processes. SOA is a set of services which are well aligned with the business policies and desired outcomes.[10]
In above figure it can be seen that, each business process has multiple business functions which together can be treated as business process [21]. For example; Course management is one of the essential business processes in any educational organization. Nut understanding various business functions which collective make this business process needs to be defined well. Each business function has a expected outcome and in turn the outcome of one business function can be given as a input to another business function and in such a way all business functions together results into a business process.
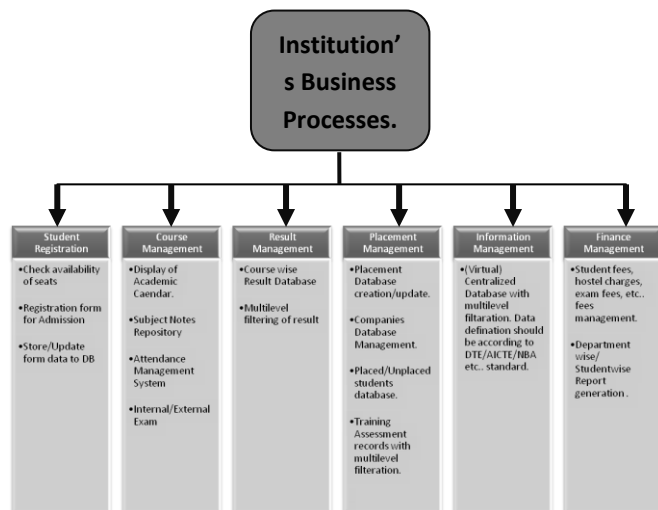
Fig 2; Business processes for higher education institution

Let's define the components of SOA;
- Service – A component that is well-defined, self-contained, performs a specific function and does not depend on the context or state of other services.

- Service Provider – The provider of the service who publishes its service description in the service directory.
- Service Consumer – The consumer of the service who accesses the service by looking up the directory.

- Directory – The directory of services which contains the description of all the available Services. [11].

The 3rd step in implementation of SOA is choreographing the services. All the defined services are connected to each other by Enterprise Service bus. All the business processes which are connected with each other not only shares the information but also can be reused at times for various interdependent executions. For example academic eligibility of students will not be calculated by Placement service but the academic service can be used to feed this information to placement service and then placement service will decide whether the student is eligible for placement or not.

Web service design and implementation:

Our approach consists of four generic steps (see Figure 1a, next page) to provide Web services to business partners:
- identify the required business functionalities,
- implement the corresponding services,
- expose these services to external partners, and
- Design a client (Web) application.

We divided each step into smaller tasks that cross-domain actors, or experts, support. For example, identifying business functionalities requires the knowledge of business users and back-end experts. These actors will then formalize the business needs according to the systems' capabilities.
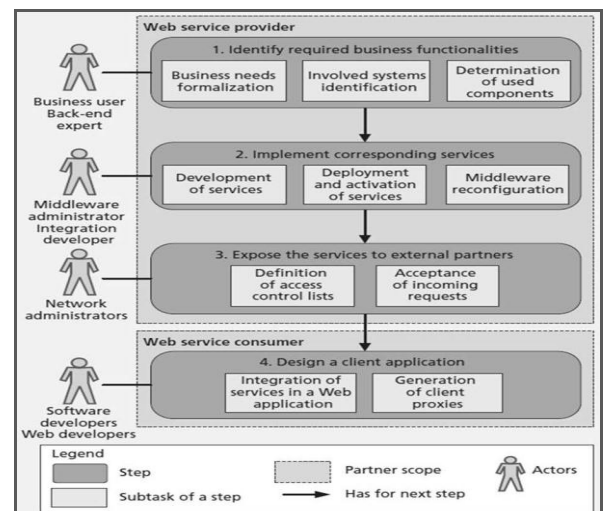
Fig 3: Web service design methodology

The network policies will be imposed in a way where each service will have access to each other services. The web service development and further process can be decomposed into 4 layers as below;

While creating web services we have to keep the purpose in mind; that is reusability. For example, Login service which will be created in such a way where all the users of the system like student, teaching staff, placement staff etc. will

use the same login service. Take another example of Information service which is comprised of many small integrated web services. Consider 'Data mapping service' where each user will be seeking information in different format, from different set of tables and relational databases and with varying privileges. The web service will have a mapping mechanism where each user will be able to view and retrieve the data in desired format through common service. [19]

Each service will have a set of many web services integrated to serve a purpose. And each web service can be accessed by other services provided the access specifier is set to public depending upon the level of confidentiality of service for the system.

The solution can be categorized into following steps;

- **Identification of business processes.**

    Educational institute has many business processes which are defined above and in turn each business process has many business functions. Defining both business processes and functions builds the plinth for efficient SOA framework.

- **Defining business processes, policies and expected outcome.**

    Business processes needs to be defined well so that they can be easily and smoothly developed as a service. Services should include all the business functions and interdependency metrics. SOA has various services and all or some of those services communicate with each other, while implementing communication base for services business policies and rules must be imposed clearly and effectively. One of the most important aspects of SOA success is about getting desired outcome and which can be accomplished only if services and their inter-communication are abide to business policies and rules.
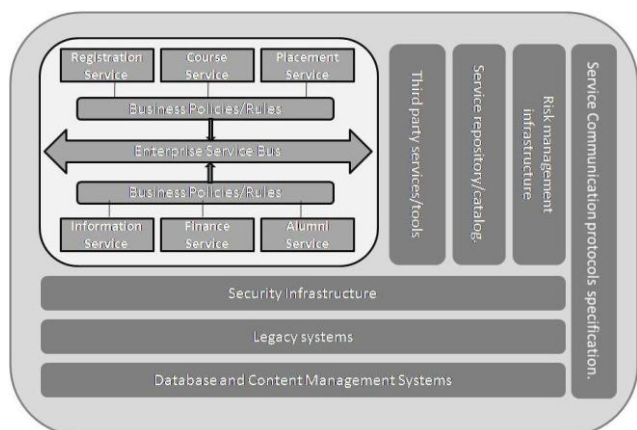
Fig 4: Proposed framework for SOA enabled system for higher education institute

- **Service creation.**

    Service Creation involves the creation of flexible, service-based business components. In cases where there are no in-house applications that can be service-enabled to fill identified gaps, the team will either develop new services from scratch or select services from third-party vendors [8]. In nutshell, Service creation is all about design, development and implementation of services in SOA.

- **Service connectivity and communication protocols.**

    Service Connectivity links people, processes, and information within the business and the extended enterprise through a gateway or Enterprise Service Bus. The solution enables the Account Open process to access multiple channels, access back-end applications, federate organizational units, and provide business-driven service availability. SOAP is used as a transport layer between services seeker (consumer) and service provider. While SOAP is the default mechanism for Web services, alternative technologies accomplish other types of bindings for a service.

    In some scenarios, however, a service may have to invoke many other services to fulfill service consumer's original request. Simple scenarios involve a given service extending the original request to one or more services. However, complex scenarios can involve recursive invocation of multiple services and, in some extreme cases, inter-dependent invocation of multiple services—which could result in a deadlock. So proper service orchestration should be done to ensure smooth execution of service and accurate response to the client/customer/consumer.

- **Data Virtualization**

    Not unlike the system virtualization that is streamlining infrastructure management and enabling cloud computing and on-demand resource allocation, data virtualization enables applications and information analysts to work with data at a level of abstraction appropriate for an application, business process, or enterprise view, while at the same time supporting seamless, controlled access to existing data sources. Virtual views of data may access an existing source, combine data from multiple sources, and resolve semantic differences. As an authoritative source of information, these new business artifacts ease the reuse of data, giving the enterprise tremendous agility for adapting to changing strategies and requirements. Large cost reductions and increased operating efficiencies can be achieved because existing data sources and services can be repurposed and reused, avoiding the need to build ever more data store silos to serve ever-changing communities of interest with changing requirements. The process of crafting these views of data also facilitates the discovery and potential elimination of redundant or duplicate data stores. Finally, integration can be accomplished in less time, and with fewer resources, particularly if the solution makes use not

only of the data resources in the enterprise, but of the metadata describing them.

- **Use of legacy systems and their integration method.**

  SOA is known for optimum use of resources in terms of service reusability, similarly while creating the services, optimum use of available resources makes SOA more cost effective. Traditional ERP components and tools can be integrated to reduce the cost of SOA development. While integrating legacy system to newly created services the major challenge is to setup the communication environment, where old system which is developed on old outdated platforms and services which are created on updated technology should be able to communicate correctly.

- **Security and risk management mechanism.**

  Security and risk management infrastructure always needs to be at place especially for real time operation services. Tools and firewalls like IBM DataPower, RACF (Resource Access Control Facility), TFIM (Tivoli Federated Identity Manager) etc can be used to make SOA secure and risk free.[17]

The use of Cloud Computing in higher education must be analyzed both in view of benefits, as well as in view of the risks and limitations. After the analysis, one or more models of Cloud Computing may be selected. The decision must take into account the real needs and be aligned with the academic institute strategy. In (Mircea, Andreescu, 2010) is presented a strategy for adopting Cloud Computing. The strategy includes five stages, with emphasis on the

evaluation of data and processes/functions/applications in academic institutes based on some key criteria. The proposed model takes into account the university's architecture and criteria such as mission, availability and importance of applications and also the data's mission, sensitivity, confidentiality, integrity and availability. The results obtained are encouraging and support the use of Cloud solutions in academic institutes.

Fig. 4 depicts the framework of SOA enabled e-administration for academic institute. The components which are required to construct and define SOA themselves are unit system. Various services which are mentioned in diagram are in set of multiple web services in themselves. The infrastructure like security, databases, legacy systems etc. constructs the foundation for SOA implementation.

Conclusion:

Adopting SOA in the higher education helps solving the adaptability problems and facilitates the use of shared services and the sharing of costs. The proposed solution will increase efficiency and effectiveness of the e-learning and e-administration in terms of reusability, interoperability, accessibility and modularization. Also, the solution will facilitate the creation and use of new learning environments while providing cost savings for education institutes. Service oriented approach surely result in optimum se of resources and information. The concept of data virtualization will help in information standardization. Academic institutes which are providing higher education in India are struggling to serve students which are actually the customers with agile and accurate system. SOA enabled academic administration system will surely improvise not only the functionality but agility of the existing system.

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