Limitations of Service Oriented Architecture and its Combination with Cloud Computing

Syed Mohtashim Abbas Bokhari, Umm-e-Habiba, Farooque Azam, and Muhammad Abbas

***Abstract*— Service Oriented Architecture (SOA), is most frequently used term, but people do not have deep knowledge that what Service Oriented Architecture actually is. They get confused and relate it with cloud computing. In the last few years, cloud computing has grown into one of the emerging technologies in IT industry. The cloud computing is dynamically scalable resources, where SOA is the concept of loosely coupled services. Each service is independent of the other; together they can form a complete system. This paper gives an overview of cloud computing and SOA and also proposes a solution that SOA should be merged with cloud to eliminate the SOA limitations. Combining cloud with SOA will enhance the availability and reliability of SOA and will reduce its messaging overhead.**

***Index Terms*— cloud computing, service oriented architecture, SOA, service oriented cloud computing**

I. INTRODUCTION

Different documents have varying definitions of Service Oriented Architecture (SOA) [1]. From the architectural point of view, service is defined as "A way of accessing system functionalities or any individual function. Some standard interfaces are used to access these capabilities and there also exist some predefined rules for accessing these services which are stated by service description". D. Krafzig et. al. [1], defines a service in terms of its elements and as an organization for the advancement of structured information standards (OASIS). SOA is based on loosely coupled software pieces; each software component provides individual service. The fundamental idea of SOA is loose coupling and encapsulation. Although SOA does not include cloud architectural style, but in order to get maximum benefits from SOA we have to merge service oriented architecture with cloud computing. This will help us to overcome the limitations of SOA.

The basic concept of cloud is rapid delivery and scalability of resources. Resources offered by cloud computing are dynamically scalable and another advantage of the cloud computing over traditional computing is its low cost and location independence.

Syed Mohtashim Abbas Bokhari, Umm-E- Habiba, Dr. Farooque Azam, Dr. Muhammad Abbas and Dr. A. N. Naqvi, National University of Science and Technology, NUST. Email: mohtashim_abbas@yahoo.com

Google, Microsoft and Amazon are most popular IT giants to provide cloud computing. By using cloud computing, enterprise can reduce its capital expenditures along with other advantages like increased scalability, reduced maintenance and installation overhead. Moreover, cloud computing enhances location transparency and virtualization of resources.

Many definitions of cloud computing exist. This paper is comprised of an overview about cloud computing and service oriented architecture. Some limitation of SOA has been discussed to eradicate.

II. A SURVEY ON SOA

A. Defining SOA

One of the promising styles for the development of enterprise application is SOA. Through SOA different components of developing application can be integrated. Business Functionalities which are delivered via SOA are self-describing and independent of any platform [2]. Service oriented architecture also provides shared mechanism for these business functionalities in a flexible way.

Knorr and Rist [3] defines SOA as a stand alone framework. By using this framework services are built, implemented, organized and merged in pursuit of rapid development and flexible IT infrastructure. Moreover, these services should be interoperable, which means different applications must be able to work together in order to exchange data and functionalities especially at run time. [4]

New functionalities can be added to existing applications or can be maintained, but very less research has been carried out on SOA maintenance tools. Some dynamic approaches have been proposed by a few groups that aid understanding SOA in terms of collective data [7] [8] [9]. This data can be collected by running system either in a test environment or by deploying it in an environment in which it has to run. Analysis of the collected data is carried out. It can be a powerful approach, but may become difficult while dealing with large system.

From engineering and enterprise point of view service oriented architecture comes with the following benefits:

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• **Language independent integration:** The services in a service oriented architecture use the XML (extensible markup language) standard. It focuses on the conversion of data generated by a specific component in XML format and passing it to the other component. The language in which data is generated, is not considered.

• **Reusability of components:** SOA is based on the concept of loosely coupled components; once these components are developed they can be used separately. The services of these components can be used with proper assurance of reliability and security.

Further, these services can also be combined together to obtain a new system with higher capabilities which is often referred as a "orchestration."

• **Rapid development of applications:** The service offered by components which are getting developed using Service Oriented Architecture; meet some business requirements of an organization.

These blocks can be used separately and later on when the rest of the building blocks are developed, these can be integrated rapidly.

• **Taking advantage of existing systems:** In service oriented architecture you can define the services of existing system and set standards. With the help of service oriented architecture, we can integrate new systems with the older legacy systems and by doing this, no need to rewrite a new system. It will save capital expenditure a well as time. Hence, the organizations will have no overhead of developing new systems from the core.

There are many reasons for adopting service oriented computing [10] in enterprise environments. Simply, services provided by service oriented computing are reusable and it is flexible to integrate new services.

However, this technology inherently depends on client/server architecture, thus does not fit in the general environment [11, 12]. The main cause is, services are not available continuously due to the poor conditions of channel strategies for saving power and locations.

B. Limitations of SOA (service oriented architecture)

SOA is not suitable for deployment in the following scenarios:

- ✓ When an application is a stand alone entity, where you don't have to integrate different components and an application which is not distributed.
- ✓ An application which does not require call based or message passing mechanism.
- ✓ An application which does not provide full functionality or does not work as a complete system instead serve as a component and have limited scope.
- ✓ An application that has short living time span.
- ✓ An application which is tightly coupled, where loose coupling is not recommended or to consider it would be pointless.
- ✓ It is not recommended to use SOA in a homogenous application environment. For example, if all applications are built using the same platform like J2EE components, then in order to integrate these applications it is not feasible to use XML over HTTP.
- ✓ Service oriented architecture is not suitable for applications which are based on heavy data exchange. For example Maps, in which a lot of geographic data handling is involved.

Table 1 lists some shortcomings of the service oriented architecture.

TABLE I.
SOA SHORTCOMINGS AND IMPACTS

Shortcomings	Impact
Exponential increase in connections	Increases burden on sever and management overhead due to transmission control protocol.
XML format messaging	Messages are large in size due to which more bandwidth and resources are consumed.
Reliability	Due to multiple points of failure, it is hard to determine the reliability of each point. Software debugging can affect both client and server side.
Scalability	It's hard to add a new application or require additional development.

III. A SURVEY ON CLOUD COMPUTING

The cloud computing model deals with dynamically scalable resources. Mostly, cloud computing is reflected as utilizing some resources as a service to perform different computations; these resources are provided over the network. Cloud computing actually diminishes the net

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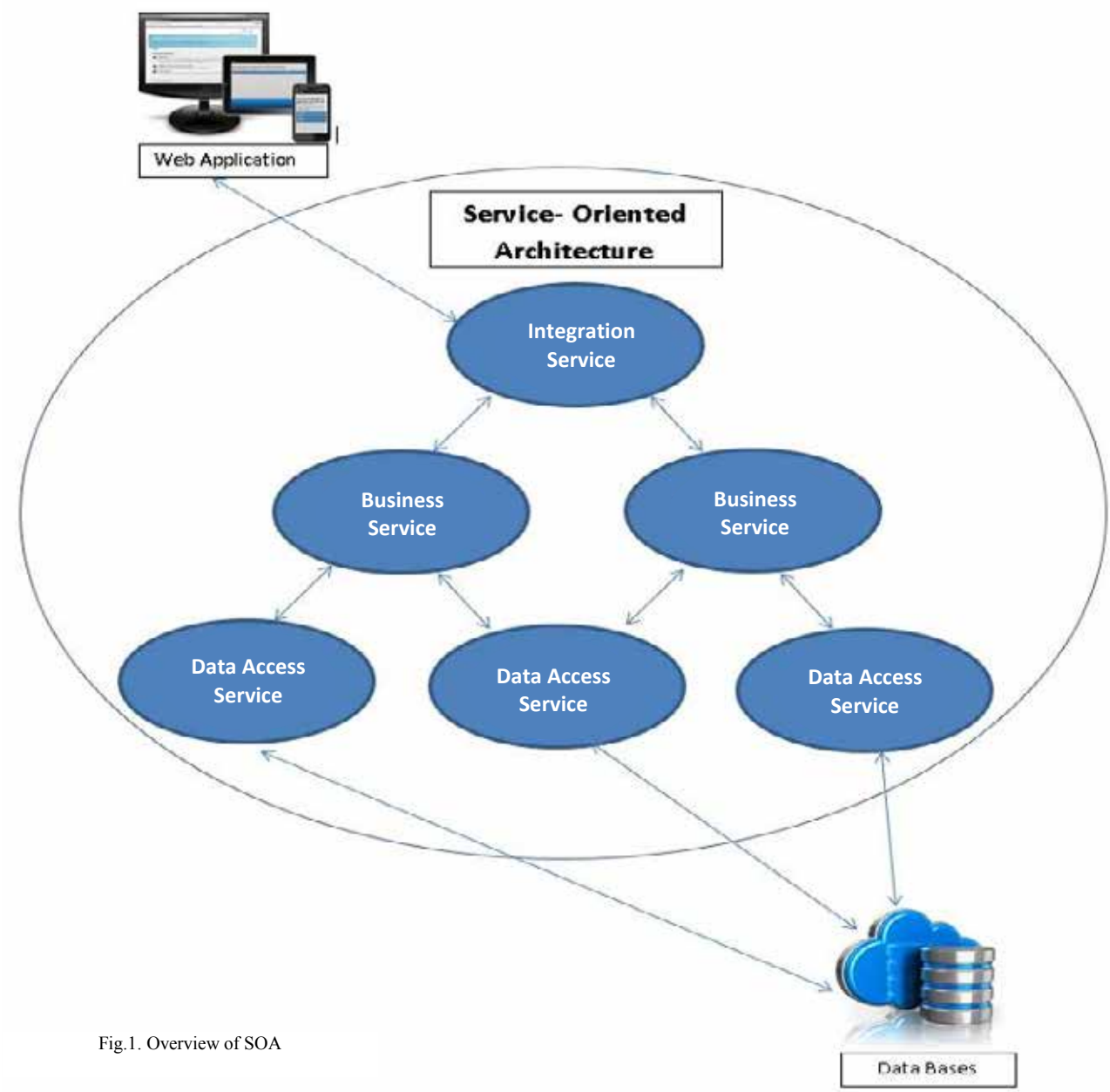

Fig.1. Overview of SOA

expenditures. And also there are many other benefits that can be availed by the utilization of cloud computing. It decreases hardware costs, maintenance cost, and installation overhead with an access to hardware and software in the cloud.

Moreover, It promotes agility, scalability and reliability of resources. Locations and devices are independent, low cost, automatically adaptive and sustainable [14, 15].

There are three unique layers of cloud depending on the type of resources as shown in Fig. 2.

A. Software as a service (SaaS)

It is the top most layers that provide users a ready application. It makes sure that the user would easily use internet host's software without using customer's resources like installing and running the applications on the customer's local computer. The user pays on the basis of effective usage. Every data item has a Read Lock or a Write Lock as in SaaS and there is a mechanism for distributed cloud and convergence coherence [5].

SaaS has two types of servers:

- The Main Consistence Server: MCS
- Domain Consistence Server: DCS

The security of MCS is most important because control over environment may vanish if MCS gets damaged or compromised.

B. Platform-as-a-service (PaaS)

It is the second layer that contains an environment for software execution. The PaaS application server

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could be one that permits developers to deploy a web based application without purchasing or setting up their actual servers. The goal of this model is to provide protection of data which is very important in such circumstances where we consider storage as a service. When there is less space we face the problem of outrage from cloud environment. To ensure the load balancing service, it is significant to deliver security against outage. The data needs to be encrypted because of the security reasons on a platform. For Instance platform-as-a-service is Google App Engine that permits user to set up dynamically scaled web applications using Java or Python.

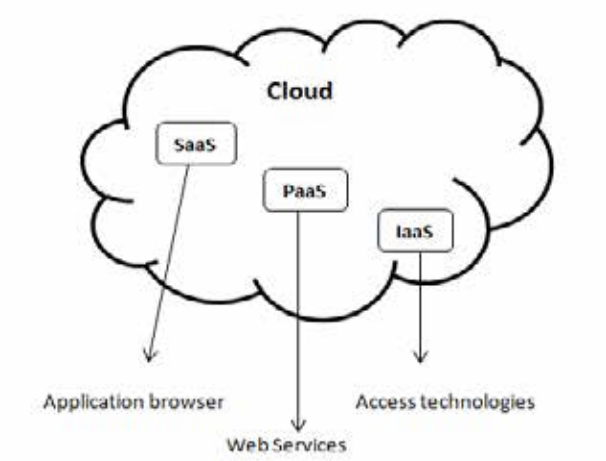

Fig. 2. Three basic services of cloud

C. *Infrastructure-as-a-service (IaaS)*

This layer shows the sharing of hardware resources for execution of services, classically uses the Virtualization technology. Through this approach many users can use resources that are available and resources can be increased on demand. The resources in IaaS are virtual machines that are to be managed. A controlling framework is needed to control when a virtual machine is created and used. This avoids unauthorized access to user's perceptive information.

D. *Deployment methods of cloud computing*

Mostly cloud computing is implemented using one of the four ways: public, community, hybrid or private cloud as shown in Fig. 3.

Public clouds: In public cloud networks, third parties provide different services and service providers then control those services. It is the concern of a service provider to install and handle the services and to make sure that the user can access these resources under the policies or standards set by the service provider. It is not necessary that a user gets all the resources to use, some resources may be provided without charging any fee while additional resources may be offered against a predefined amount that the user has to pay if he wants to use these resources.

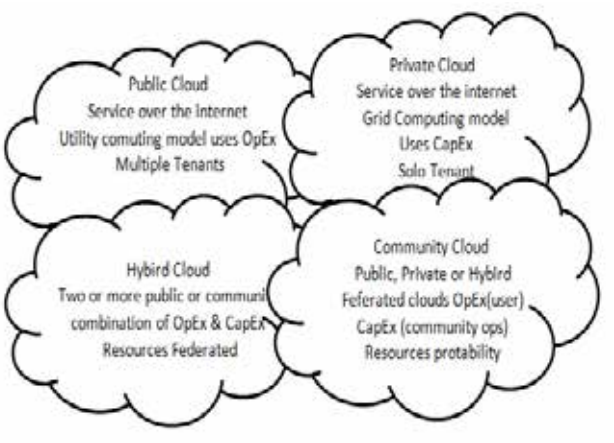

Fig. 3. Implementation methods of cloud computing

Community clouds: Community clouds are clouds in which access is provided to only defined members. They are also similar to a public cloud except when we consider the community; it means that they are outside the sphere.

Hybrid clouds: These types of clouds hold some characteristics of public clouds and some of private; therefore we can say that it is a cloud that possesses a mixture of the properties either belong to a public or a private cloud. The responsibilities related to the organization are frequently distributed among the providers of the cloud and the enterprise; this generally turns out to be a problem. This infrastructure of cloud is more operational in handling processes of critical nature. Because the user can store his important sensitive data in a private cloud and use public cloud for common normal routine services.

Private clouds: These types of cloud are used mostly in the enterprises; they use it as proprietary networks mostly for exclusively using the organization. In a private cloud, enterprise is responsible for maintaining the cloud and providing security to it. Key responsibilities also include the issues that concern legal and regulatory conformation matters. The security of private cloud is much more important than public clouds.

Cloud Computing comprises of particular characteristics & realizations that has a lot of advantages as compared to different other forms of outsourcing. Cloud proposes the properties listed in Table II.

IV. CLOUD AND SOA OVERLAPPING

SOA and cloud computing have some common characteristics. The overlapping of SOA and cloud computing is shown in Table III.

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TABLE II.
CHARACTERISTICS OF CLOUD

Characteristic	Description
Self-service On demand	IT is available on demand without having any sort of manual intervention and is used as a service
A broad network access	The service is prepared to be offered through the network, regardless of user's end device. The connection must have to have sufficiently high performance along with availability for that service.
Resource pooling	The provider ensures the compulsory resources available to numerous consumers utilizing several technologies like virtualization & multi-tenancy.
Rapid elasticity	The resources that are required can be provisioned frequently and made them free when no more needed without any manual intervention
Measured Service	A service which is spent should be measurable regarding resources. Like so, consumption-based billing develops. It is known as "pay as you go" / "pay-per-use." too.

TABLE III.
SOA AND CLOUD COMPUTING OVERLAP

Cloud Computing	Overlap	SOA, Web services
Software as a Service (SaaS)	Application Layer Components/Services	System of systems Integration focus
Utility Computing	Network Dependence	Deriving consistency of integration
Terabytes on Demand	Cloud/IP Wide Area Network (WAN)-Supported Service Invocation	Enterprise Application Integration
Data Distribution in Clouds	Leveraging distributed service assets	Reasonably mature
Platform as a Service	Producer/Consumer model	Implementing Standards (REST, SOAP, WSDL, UDDI, etc.)
Different Layers of the Stack		

These are the most common characteristics shared by SOA and cloud computing. And major overlaps between these occur in the top most layer of the cloud where software services and application components are available. A common concept shared by SOA and cloud computing is service orientation. [16] Many types of services are accessible by users on the network.

Cloud computing can considered as an outsourcing or resources in which an enterprise can purchase dynamically scalable resources from a cloud provider. For an instance, if an organization requires a large data store unit, online data storage can be automatically allocated from cloud as required by the organization.

Cloud computing is a much broader concept than SOA, It covers the whole stack starting from the top most application layer to the hardware. However, SOA is only restricted to software, but it is often implemented as a standard for a web service.

V. PROBLEM STATEMENT

SOA has many benefits, but there exist some limitations as well. The very first problem that SOA encounters is messaging overhead. SOA uses an XML messaging format, which is not efficient enough. The corresponding XML format of actual information in the message is much higher. XML takes time to encode and decode which also increases processing overhead and latency. Some automated tools produce XML that tends to have more errors. It also involves network latency because it takes time to pass a packet of data from one spot to another. And the available network bandwidth limits the transactions.

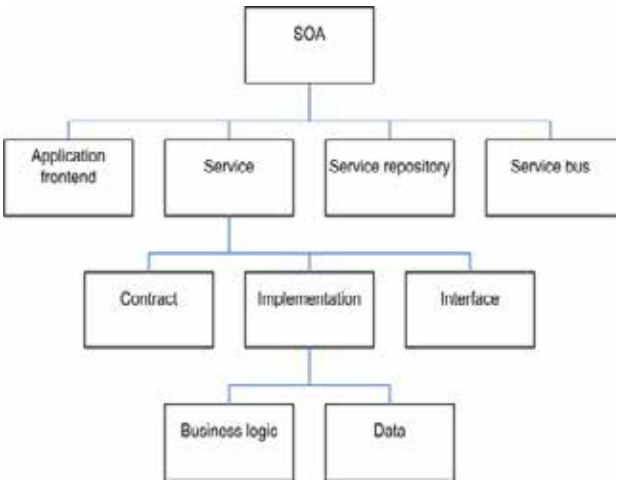

Fig. 4. SOA infrastructure

Fig 4. Depicts the SOA infrastructure. Although programming in SOA is easy, but it is difficult to find either you have done it properly. SOA uses message passing technique, more messages mean more processing overhead which may lead to the connection throttling. If a server goes down and later on when the server comes back it may hit with many concurrent requests. It exposes concurrency issues which are rarely tested. The overall performance of the system is crucial and the latency of the service requests is not affordable. Due to loose binding of SOA components it finds an error at runtime.

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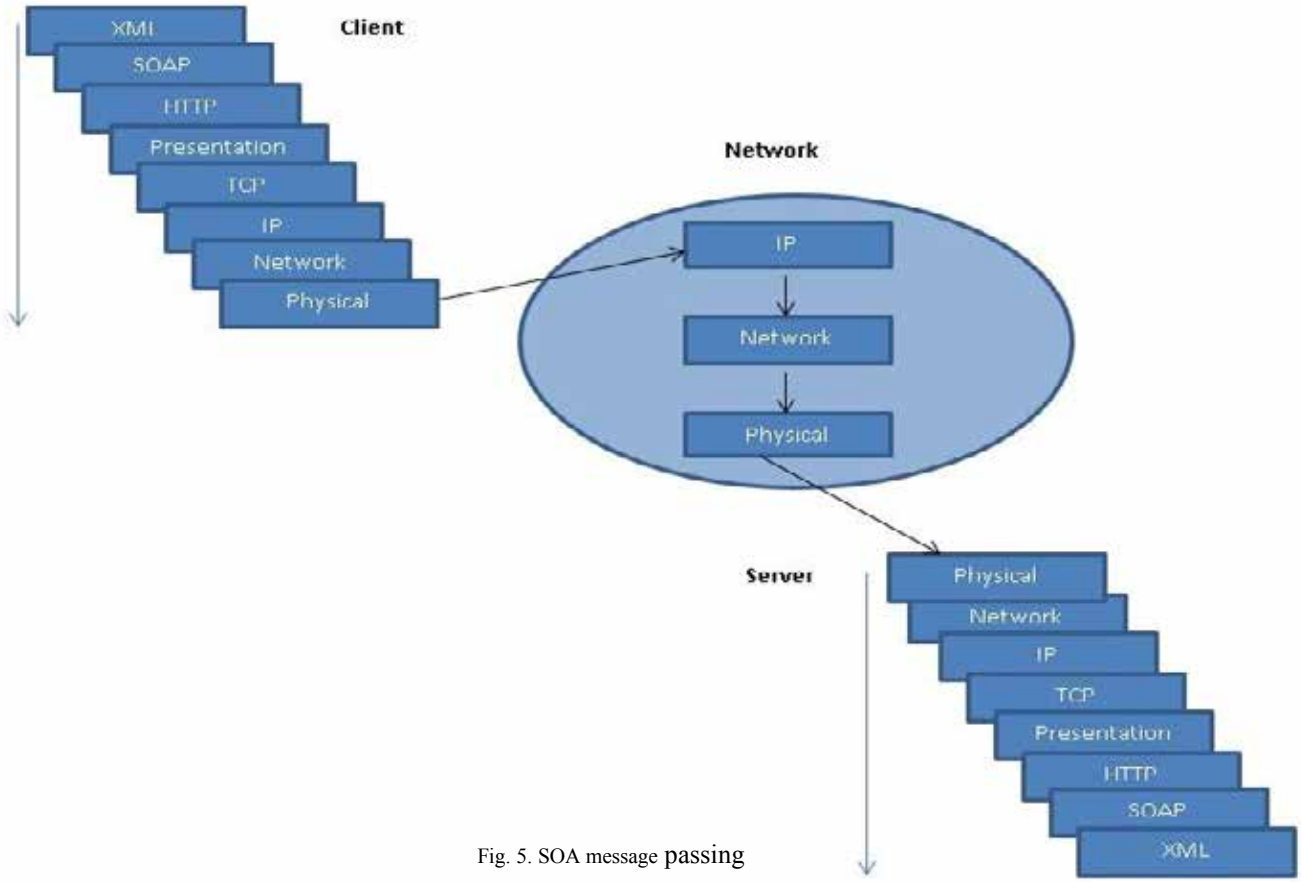

Fig. 5. SOA message passing

As shown in the Fig 5. SOA has multiple points of failure. Any other system which is connected via SOA has points of failure. System infrastructure also has multiple points of failure.

It is not always feasible to use service oriented architecture because when you try to optimize the SOA it requires extra development, design and infrastructure which raises costs. Sometimes you cannot change your system due to insufficient details and if your system does not adopt new changes you will lose your business values. [6]

VI. PROPOSED SOLUTION

To some extent service oriented architecture and cloud computing are related. Service oriented architecture provides an architecture pattern that helps in creating and guiding solutions for business. While the cloud computing offers highly scalable, dynamic resources and flexible platform for service oriented architecture. SOA and cloud computing, hence, can exist at the same time, backing and balancing each other. One of the major advantages of cloud computing is, running the same query on multiple servers, that results low communication overhead. Cloud computing and SOA are reciprocal [13]. In this paper, a combination of both is proposed. So, anything that happens in the service oriented architecture environment will be sent as an event to the cloud. An event may be data transaction or a service request by a user. A request can be for any hardware resource or data. Moreover, by using service oriented architecture with cloud messaging, the overhead can be reduced. It will be easy therefore to add new service to application and resources will also become more scalable.

VII. CONCLUSION AND FUTURE WORK

The paper proposes a solution to one of the limitation of SOA. It uses the XML format for message passing which consumes more bandwidth of the network. The paper illustrates the overlapping point of cloud and SOA. Combining Cloud with SOA, considering the common points, will increase the reliability, availability of SOA and will reduce its messaging overhead. We intend to implement this solution to SOA web based architecture as our future work.

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