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Quality Attributes: Confronts and Interdisciplinary Orientation of Service Oriented Architecture

Aradhana Negi[1], Manreet Sohal[2]
[1]*Department of Computer Science, Guru Nanak Dev University, Amritsar*
[2]*Department of Computer Engineering & Technology, Guru Nanak Dev University, Amritsar*

Abstract: ***Service-Oriented Architecture (SOA) is the pedestal structural design for all the Internet based services. The popularity of this architecture is its promising feature of providing application functionality in distributed environment using call and use strategy. The other technical feature of SOA includes interoperability, loose coupling, agility and reasonable cost. The mounting significance of SOA encourages the concept of Quality Attributes in Web Service Life Cycle where publish-find-bind process benefits Web Service Provider as well as Web Service Requester. As this structural design is not platform dependent so industry persons and researchers are moving towards more interesting interdisciplinary solution to get the benefit of interoperability and integration feature of SOA. The prime goal of this paper is to sum up the interdisciplinary trends and confronts related with SOA Quality Attributes.***

Keywords**: Quality Attributes, Quality Metrics, Quality-of-Service (QoS), Service Oriented Architecture (SOA).***

I. INTRODUCTION

The most intricate task during application development is to transmute the specification of requirement into application architecture. For productive application architecture, non-functional requirements must be regarded along with functional requirements of the system. Service-Oriented Architecture (SOA) based on Service Orientation paradigm also considers the Quality Attributes as critical and inseparable aspect for its successful implementation. Service Orientation is a popular designing strategy in Software Engineering that exposes system capabilities to the end-users or to other applications as a service [1]. Moreover, an essential element of SOA is the concept of service where a "service is a goal-oriented reusable software component that represent a business or operational task" [2] and discoverable via networks. These Services simplify the design of the mobile systems and can be cloned as well as made moveable like software agents. In the past ten years, voluminous research work has been published regarding the implementation of SOA.

The literature directly or indirectly emphasizes the Quality Attributes along with the functional requirements for its success. "A Quality Attributes requirement such as those for performance, security, modifiability, reliability, and usability has a significant influence on the Software architecture of a system" [3] and improvement of such supplied Quality Attributes can attract further users [4]. Analysts, developers, architects, providers and consumers have the main role in developing, implementing and deploying the desired services under Service-Oriented Computing. The objective of this paper is to address confronts and interdisciplinary research trends of SOA Quality Attributes. With this stated aim, current paper is organised in four sections. Section II introduces Quality Attributes of SOA. Section III discuss confronts with SOA Quality Attributes whereas Section IV presents the interdisciplinary research trends of SOA Quality Attributes. Lastly section V concludes the paper.

II. SOA: QUALITY ATTRIBUTES

Quality Attribute is the lineament of Software system that affects its quality and describes the non-functional requirements of the system. It deals with various aspects of a system like architectural aspect, technical aspect, business-related aspects etc and enhances the beauty of system. The value-oriented output of Quality Attributes is also being considered by SOA to ensure the full realization of this architectural design. SOA has been extended beyond its demarcation [5] whereas initially it was just an asynchronous document-based message exchange approach that was chiefly meant for alignment of business applications and IT infrastructure but now this concept has been used for the larger set of distributed systems with more expectations for quality attributes [6].

SOA Quality Attribute illustrates that how SOA affirm non-functional requirements of the Service-Oriented system. In order to achieve organizational goals and to meet the customer needs, these quality attributes must be satisfied by the architecture of the software. "Achieving quality attributes in service-based systems is critical […] because service-based systems lack central control

and authority, have limited end-to-end visibility of services, are subject to unpredictable usage scenarios and support dynamic system composition" [7].The sum of Quality Attributes is known as Quality-of-Service (QoS) and are measured by the Quality Metrics. Quality Attribute requirements may vary from one business to another and from one customer to another customer. QoS can be evaluated using various criterions such as performance, reliability, security, availability, accessibility, maintainability etc. Till now many quality models have been proposed for Quality Attribute classification. A systematic mapping of quality models has been done by [8], they consider 47 different quality models from 65 papers. The current is considering ISO 25010 Software Product Quality standard for the description of SOA Quality Attributes (see Fig. 1). ISO 25010 quality model has eight main characteristics named as: Functional suitability, Portability, Usability, Performance Efficiency, Compatibility, Maintainability, Reliability and Security with 31 other sub-characteristics.

III.SOA: CONFRONTS

It is widely admitted that SOA is a mature concept but, still a big ground is left to cover. Various challenges are associated with Service foundation, Service composition, Service design and development [9]. Further, efforts are required to address these challenges and ensure that SOA fulfils the desired quality level while implementation. Broadly the challenges colligated with Quality Attributes can be seen as 1) Strengthen the attributes, where quality is positively affected 2) Reduce the negative impact, where quality is degraded by other associated attributes and factors. Priorities of these challenges must be decided by respective implementing organizations. Here, confronts are described in accordance with ISO 25010 Software Product Quality. Functional suitability, Portability attributes are intentionally left because they are indirectly covered by Usability.

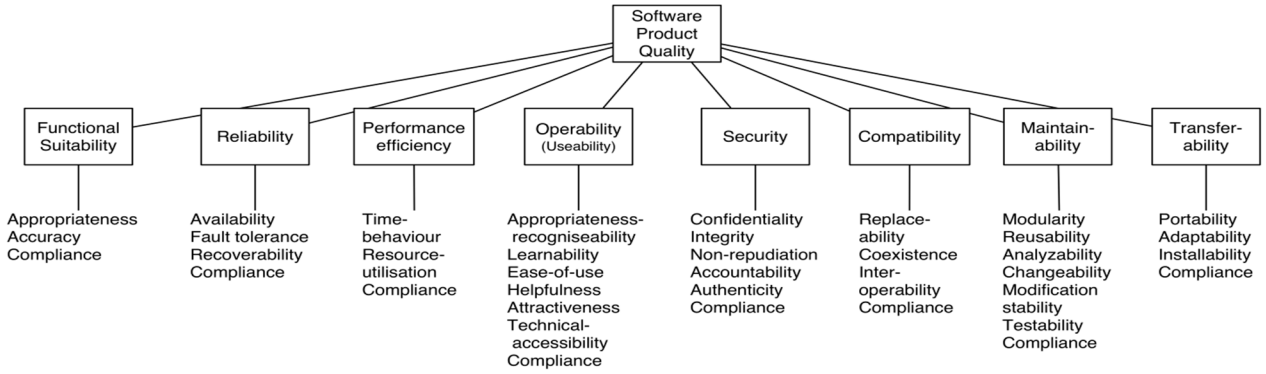

Fig. 1 ISO 25010 model for Software Product Quality [10]

A. Performance Efficiency

It describes the performance goodness of a service and can be evaluated using commonly known metrics like throughput, latency, complexity, execution time, bandwidth etc. With increasing complexity of services, the performance of the service system deteriorated [11-12]. The biggest challenge with performance attribute is to minimise the negative effect of other attributes over it. O'Brien [12] found an open issue about requirement of performance model which can run in a highly complex runtime environment and problem performance parameters for that model.

B. Compatibility

This comprises two sub characteristics: Co-existence and Interoperability. Co-existence concerns with the degree to which a service system can be integrated with other service and perform well under shared resource policies whereas Interoperability deals with technical and operational freedom from platform dependency feature and facilitate users to invoke and compose services seamlessly. Efficient Service composition and orchestration are understudied areas for these attributes. Co-existence and Interoperability of mission-critical applications (healthcare, stock trading, and air traffic control) [12], Semantic modelling of QoS category and need of matching algorithm between desired and supplied QoS [14] , interconnection of heterogeneous physical devices (using RFID technology, WSN) [15] [16]are significant allied confronts.

C. Usability

It is the measurement of user's experience about services. This is the only attribute which directly capture the customer's satisfaction and ultimately enhances the reputation of service and service provider. The hotspots for usability attribute are Quality of Experience (QoE) [17] and Quality of Protection (QoP), development of QoS-aware middleware, QoS negotiation protocols, QoS

monitoring, Mapping global to local SLAs, Automatic QoS controller algorithms, Self-Managing system for QoS, Workload forecasting [18].

D. Security

Security is always a prime concern for a Software system. Security is largely important for SOA because of its decentralized and loosely coupled nature where distributed machines interact with each other. National Security Agency (NSA) consider Injection Flaws, XML Denial of Service issues, Insecure Communication, Information Leakage, Reply Attack Flaws, Insufficient Authentication, Inadequate Testing, Insecure Configuration, Insufficient logging as SOA Web Service Security Vulnerabilities [19]. Issues like dynamic trust relationship between service composing partners, Balanced Security mechanism [20] can advance SOA implementation. Nine factors that complicate SOA security have been described by [21].

E. Reliability

Reliability is the actualization of required functionality of a service understated condition. The most challenging area under reliability is Optimized Fault Tolerance strategies, Data provenance during dynamic composition, SLA (Service-Level Agreement), Service monitoring, Self-Configuration, Self-Healing [18], Adaptive Metric Measurement for Service Monitoring [22], Automated Governance and Multi-Organizational Implementations [6].

F. Maintainability

Modularity, Reusability, Modifiability and Testability are the prime sub-characteristics of this attribute. The biggest challenge with SOA maintainability attribute is to update a service in a highly complex runtime environment. A very little research work has been done in maintainability field.

IV. SOA :INTERDISCIPLINARY ORIENTATION

Service-Oriented Architecture follows additive approach and it is extended from its existing boundaries to take benefits of QoS. The valuable features of SOA make it possible to use this design patterns for interdisciplinary research, keeping this idea in mind this part key outs the major interdisciplinary research trends in brief.

A. Employing SOA In Healthcare Solutions

Decision Support System for diseases diagnosis is considered as one of the major application area of SOA. The healthcare solution emphasises on Clinical decision support [23], Neuron based molecular communication [24], and Healthcare ecosystems using SOA like HL7 based healthcare information exchange system [25]. Availability and Security attribute is of prime concern in this case so, further research is being done for healthcare information security.

B. Developing Environmental-Based Applications

Another growing interest of SOA researcher moves towards environmental issues and solutions. Flood forecast from numerical weather prediction [26], Remote sensing product generation system for geostationary operational satellite [27] are the new trends in recent years.

C. Quality Evaluation and Management

To ensure the satisfactory use of SOA, research is continuously being done on quality enhancement. Monitoring frameworks, Quality parameter evaluation using Fuzzy model and Agents [28], Zigbee [29], Hybrid diagnosis [30] and Bayesian diagnosis [31], Fault configuration [32], SOA design defects on quality attributes, QoS-aware workflow in different environments (e.g. virtualization environment, real-time environment) are evolving trends in SOA Quality evaluation and management.

D. SOA-IoT

IoT (Internet of Things) is the vast network of communicable sensory heterogeneous devices. “SOA is considered a good approach to achieve interoperability between heterogeneous devices in a multitude way” [33-34]. In SOA-IoT, services are provided through serviced Internet [35], and “it allows applications to use heterogeneous objects as compatible services” [36]. Further, research will focus on designing of an SOA for IoT with quality attributes. Some other interest move towards SOA for Wireless sensor network, Network improvement strategies, Things-as-a-service oriented architecture.

E. Self-Adaptive SOA System

As SOA deals with Machine-to-Machine interaction with services therefore, it is very important in dynamic networking to recover network crash, temporarily link failure etc. Self-adaptive, Context-aware and Semantic-based nature of service system will be able

to handle such circumstances in a network. Although, it is hard to implement Self-adaptive SOA system along with quality attributes but, still researches are moving on this path using new SOA approaches like [37] [38]. Further, efficient strategies are required to make SOA Self-adaptive.

F. Using SOA for Business Automation

SOA implementation's very basic idea was business and IT infrastructure alignment but, now this limit stretched to real-time Industrial automation [39], chain-based business alliance formation [40], Business process execution [41], Financial sectors like e-banking [42] and e-resource planning.

G. Cloud Computing and SOA

The core architecture supporting Cloud environment is SOA. One of the future directions for SOA is Cloud Computing [43]. Cloud computing is using the concept of everything-as-a-service, where it considers quality oriented service computing [44] for better performance. SOA is being extended towards private cloud computing as a service [45] which will give a new direction to cloud computing.

H. In Traffic Management System

For the real time Traffic Information System, Web Services are being utilized to get the better road traffic information [46]. The plug-and-play feature given by SOA made it possible to use a service over the Internet. In [47], authors have proposed a multi-agent based Traveller Information framework for publicising, finding, discovering and execution of the road traffic Web Services. The institution of Civil Engineering Research, Hokkaido and Joint Research Group [48] 2003 have initiated the use of SOA based architecture for receiving road related information including local tourist information and weather information.

V. CONCLUSIONS

This paper presents the challenging issues and interdisciplinary trends related with SOA Quality attributes. The unique integrationist approach of SOA has been presently used in many application areas. Along with the vast opportunities of growth, SOA Quality Attributes are facing some serious confronts which if not careful managed, will definitely not only reduce the Quality-of-services but also the popularity of this design pattern.

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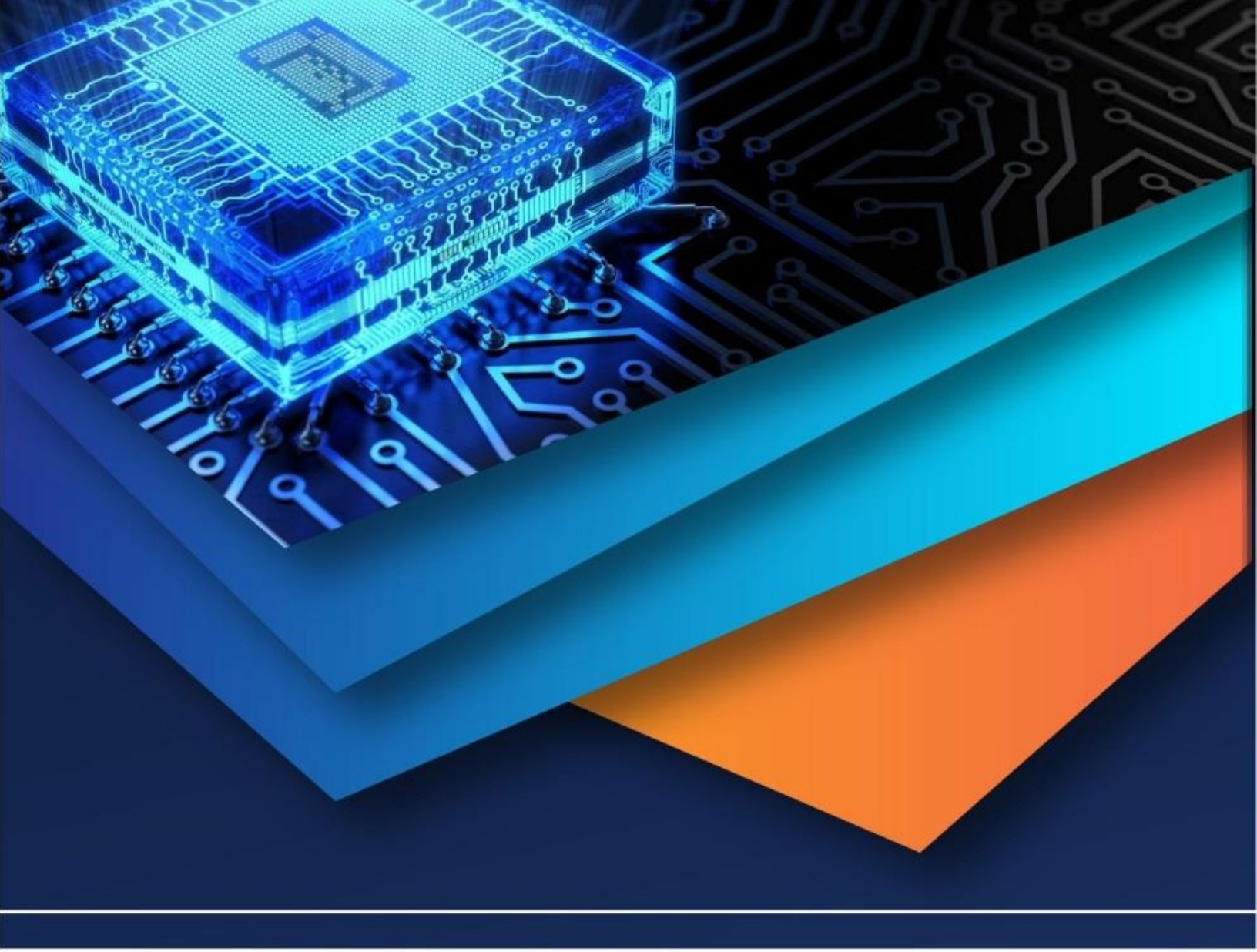

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