Semantic Web Services: An Empirical Methodology to Security

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Abstract: ***In today's modern era, the Semantic Web is progressing at a tremendous speed. The Semantic Web services have opened new possibilities through which any one can avail various services. But if these technologies are not properly protected, then their use can put users in danger. Many people have to face difficulty in assessing the security hazards allied with Semantic Web services. Many Web services such as e-commerce stores various types of data on their database servers. These database servers are distributed across the globe. The e-commerce may use the unalike assortments of database for storing different information. Web services such as e-commerce have to handle assorted types of data. Unalike Web services like e-commerce have to handle assorted types of data. A single database program will not be suitable for storing and processing mixed types of data as it will increase the processing overhead and ultimately reduce the performance of the web service. So there is need arises to define an apposite subclass of databases for each document type.This paper insinuates a set of databases for each type of documents stored on an e-commerce platform. An exertion has been made to define a proper set of database programs for a web service such as e-commerce that adequately manages the requirements of a particular type of data. The tryouts have been steered for an e-commerce Web service for weighing the efficacy of the proposed approach. The results shows that if well-structured database has been used for a Web service such as e-commerce then response can be very quick and chances of packet loss will also be very low. If network attacks such as DoS and man-in-the-middle attack exist within the request, the performance of the Web service severely affected. A network attack may lead to the more chances of packet loss. The paper also delineates the impact of network attacks on web service performance.***

Keywords: Semantic Web, Security, Polyglot Persistence, NoSQL, E-Commerce

I. INTRODUCTION

Web services have been identified as the major technique in providing a flexible solution to commune with the heterogeneous application system. Since they can interact with heterogeneous software systems, Web services have fascinatedattention from many distributed app designers and developers.The increasing number of distributed software applications has been published in the form of Web services on the Internet. Semantic Webamenitiesare autonomous sectionalapplications that can be broadcasted, located and applicable to the entire Web with a searchable and inventive interface to provide a given consumable functionality over a given network using some standard protocols [1].

Semantic Web services computing have enabled development of such Web services, which have been developed using various programming languages, or were deployed on different computing platforms for different systems and heterogeneous networks.

Semantic Web technologies provide mechanism to find products that are best suited for explicit requisites of a particular user.Procuring and hawkingproducts, performing business activities and rolesusing the Internet is known as Electronic Commerce (E-commerce). The key functions involved in e-commerce are electronic fund transfer and online transaction processing.

According to the requirement of discrete businesses, other work is also included in e-commerce.The spread of Internet services and the increase in their quality have endowedsubstantivelyto the triumphof electronic business [2].Amalgamation of Semantic Web with e-commerce provides benefits for both sellers and consumers.

Most of the e-commerce stores have listed millions of products for sale online.Each product comes with various product characteristics such as picture, size, color, style, price and so on. An e-commerce platform stores many types of data (i.e. shopping cart, inventory, full order, etc. In addition, each product requires a personaldatabase that stores information related to that product. Similarly, category data, shopping cart and session data, inventory and item price data, login data, transactional data and financial data should also be well organized.All of them include numerous data on e-commerce Web store. The popularity of e-commerce business has increased due to its unrestricted nature. Users can shop anywhere and at any time using e-commerce. They can also pay their purchases through the online payment system [3].

All types of data available in e-commerce storefront are required to be stored and processed.If the e-commerce app stores all types of data in one database, then there is a lot of data conversion needed to make the format of the data uniform. Since, heterogeneous types of data are stored and processed in an e-commerce store, so it is necessary to use the appropriate database system to store each type of data.So, an e-commerce application must use the appropriate database for each type of data that they store.The concept known as Polyglot Persistence states that instead of using the same database, different databases should be used to store different types of data [4].This paper analyzes the effect of using the well-structured and messy database approach for a Web service. It provides aarcaneintuitioninto the effect of how a well-structured database can portentouslyimproves the performance of a Web service.

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The result also shows that the well-structured database approach is fartherstalwartand productive than messy database approach. Apart from that, efforts are made to show the effect of network attack on the pursuance of the Web service.

The paper is organized as follows. Related research in the field of e-commerce and Semantic Web is illustrated in section II. Methodology of research work has been given in section III. Section IV briefly describes the result and discussions of the study. Finally, the conclusion and future work is given in Section V.

II. RELATED WORK

HerminioGarcía-González, José Emilio Labra Gayo and MPuertoPaule-Ruiz [5] have described a new educational tool that relies on semantic Web technologies to teach text content.A research review related to the belief in the virtual world and semantic Web based on social network analysis has been reviewed in [6]. Largescale data has been analyzed within a virtual world by exploring the flow of trust in different layers of social networks with the help of Semantic Webtechnologies.The problem of knowledge base has been studies using semantic integration with crowd intelligence [7].The authors have proposed a hybrid framework for KB semantic integration considering the semantic heterogeneity of KB class structures.In [8], a method has been proposed by matching the semantic service based on word embedding thatimproves the efficiency of the service discovery.Two types of semantic services such as event-recognition and event-handling services are specified about the events and the words are matched through the evaluation of equality which is organized with word embedding.The framework has been proposed for effective search of suitable services by including information from social media [9]. The authors have insinuated a framework using various methods for measuring four social factors like semantic equality, popularity, activity, decay factor on data collected from Twitter. Y. Huang, Y. Chai, Y. Liu, and J. Shen[10] haveproposed the next-generation platform for e-commerce, which includes people, enterprises and administrative departments. Every person, enterprise and administrative department has a personal portal to do information synchronization, issue supplies, satisfy demand and fulfill social interaction. A mining-oriented sentimental equality analysis approach is followed to discover the similarities and trust of the users in the e-commerce system [11].A block-based generalized autonomous transaction settlement system for e-commerce is given in [12]. Data mapping approach based on polyglot persistence has been proposed in [13]. In the cloud environments, a mediated-based component has been proposed to successfully execute complex queries on many data stores [14]. The authors [15] have laid a hypothetical framework to separate the physiognomies of fraud transactions, which include personal and indicators that are related to transaction

III. METHODOLOGY

Database is one of the oldest techniques used in computer systems. Database Management System (DBMS) offers modernized relational plans that are well designed for transactional applications as well as non-related systems and are the only streaming-oriented technologies for faster analytics [16].Users have a diverse collection of DBMS technologies that meet their needs for online, social, mobile, analytics, embedded, real-time and cloud applications. During the last decade, alternate forms of databases (for example, NoSQL) have emerged, which were born for the excessive use of internet leviathans such as Yahoo, Google and Facebook.Today, social media, e-commerce, mobile computing and internet off things are becoming ubiquitous and simultaneously creating huge amounts of data. Data is not only in large amounts, but also includes velocity, it means that the data is changing at very fast speed and includes diversity, which means that it includes both systematizedand amorphousdata. Therefore, developers are looking for a different way to store and access data faster.In today's scenario, it becomes necessary to use different databases to store different types of data.

A. Disparate Data Storage Necessities

Traditional RDBMS provides anexpedient tactic to store and access data based on a predefined structure that can be generalized to optimize storage and performance.Although RDBMS was first conceived in terms of transaction systems, but they have also been successful for analytical applications and Online Analytical Processing (OLAP). RDBMS also has some inherent shortcomings such as it is not found to be feasible to use RDBMS in transactional and analytical applications.

But in some cases the use of relational databases such as data related to social services, transaction data and processing of e-commerce data becomes very expensive and complex [17]. For the bygonefeweons, other forms of NoSQL (Not Only SQL) and other non-relational databases have emerged as useful alternatives to RDBMS [18]. These databases become very popular alternatives of RDBMSso that their alleged rigidity and performance situation can be avoided.

NoSQL database handles unstructured data, emails, documents and social media content easily and efficiently [19]. NoSQL provides efficient storage access to process large data. NoSQL is a great option for database storage because the NoSQL database server can be easily extended and can be imitated on a different database server efficiently.Using a single database for all types of data can usually make any application non-executable because there are different types of data, such as transaction data, session information, data about the customer's searching pattern, and information about the products purchased by them etc [20]. RDBMS gives good results when applied there where different data relationships exist. RDBMSs performance decreases if the data is unstructured or the volume is large.

Scalability is an imperative consideration for apiecee-commerce platform. E-commerce sites are very rich with content. They stores diversified product information, rich images, session information and login info, shopping cart information, order information, customer information and seller information.

They have to sustain stable availability and execution of e-commerce application across the globe for millions of people of geographically distributed shoppers and customers.

B. Dispersed Database Approach

Polyglot persistence implies using disparatedatabase systems inwarda specific application domain with each system dealing different serviceable and non- serviceable requirements [21]. In a Web service environment such ase-commerce, a single database would not sufficient to attain heterogeneous data requirement. Instead of using the same database to sustainassortedtypes of data, it should be saved in groups of different databases. An e-commerce Web service will have to handle unalikevariationsof data such as shopping cart and session data, completed order data and their transactional and tracking data, inventory management data, customer social graph and their buying and searching pattern data, product catalog data, analysis and reporting data etc. Thus, it is not feasible to store all these data in a single database. In this paper, disperseddatabase methodologyhas been pursued for storing diversified information available on an e-commerce platform. The proposed approach uses the combination of traditional RDBMS with NoSQL databases for storing e-commerce data. The need of a particular type of database type for specific requirement has been shown in table I.

IV. RESULT AND DISCUSSION

In this approach, different databases have been propositionedfor different work purposes. As avowederstwhile, the use of samedatabase to handle all types of data may produce processing overhead. So, there is need to use different database for each type of data that a Web service such as e-commerce may handle. Keeping in mind these considerations, the well-structured database design has been followed for a Web service for handling dispersed data available on that Web service. A test database has been used from Badhalia Gems, an e-commerce Web service that provides online shopping of stones.

Table- I: Database requirement

Functionality	Issues	Database Kind
User Sessions, User Activity Log, Social Media Analysis	Prerequisite of speedy retrieval for read and write operations, writes high volumes of data on multiple nodes and does not necessity to be enduring	Key-Value type database
Transactional Data, Reporting Data,	Needs Transactional updates, Tabular data, SQL interface works fittingly with reporting tools.	RDBMS
Product Log data, Shopping Cart data	Oodles of read operation and sporadic write. Products form natural accumulates, Highly accessibility amid manifold whereabouts. Can unify erratic writes.	Document
Recommendations and Suggestions	Fast link traversing between friends, product purchases and ratings.	Graph

Table II: Sample well-structured database

Purpose	Database
Transaction Management	RDBMS
Product Management	Mongo Db
Cart Management	Cassandra
Product Search	Elastic Search

The Web service provides various services such as creating user account, managing user account, search for a product, adding product into cart, product order, order management, payment, product information and modification etc. The table II summarizes the database used in the Web service.

For example, MySQL [22] database has been used to create a new user, find existing user, update user's information and payment made by the user for their order. MongoDB [23] has been used for maintaining product catalog, Cassandra [24]has been used for managing cart information and Elasticsearch [25] has been usedfor searching the correct product queried by the user.

The SOAPSonar [26] simulator has been used to tryout the effectiveness of using the correct database for various types of data stored on the Web service. The Web service has 1000 user and each user generating at least 10 queries from each database. After analyzing the result, it is found that using the right database for correct data is more fruitful in executing the query fromthe database. In this case, the response is very fast from the database when there is a heavy or small kind of database and there is no attack within the network. The fig.1 shows the findings after analyzing the simulator result.The result clearly shows there are very small numbers of packet loss for each type of database queries submitted by the user.

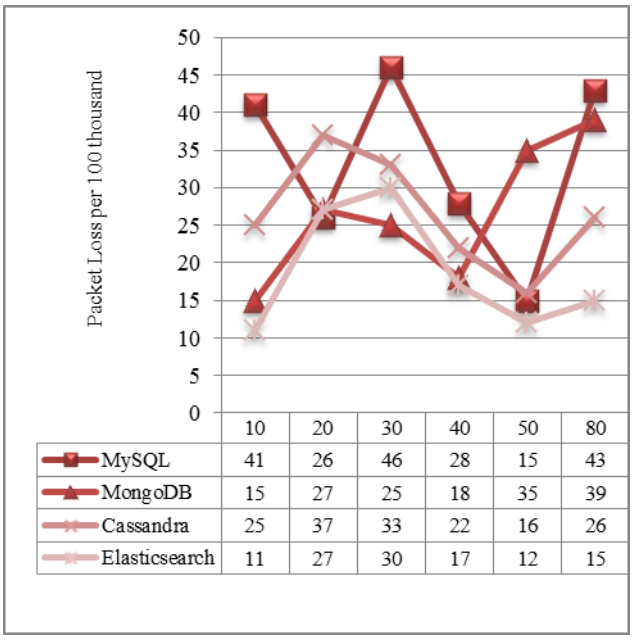

Fig. 1.Users (in thousand) Vs Packet Loss for Well-structured Database

Table- III: Sample Messy Database

Purpose	Database
Transaction Management	Mongo DB
Product Management	RDBMS
Cart Management	Elasticsearch
Product Search	Cassandra

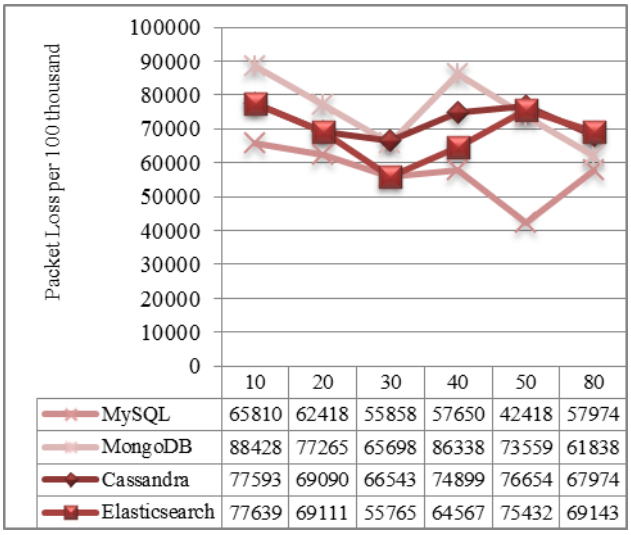

Fig. 2.Users (in thousand) Vs Packet Loss for Messy Database

In another scenario, when using the messy database design the result varies very significantly from previous result. For example, For example, MongoDB database has been used to construct a newfangled user, find existing user, update user's information and payment made by the user for their order. MySQL has been used for maintaining product catalog, Elasticsearch has been used for managing cart information and Cassandra has been used searching the correct product queried by the user. Table III shows the sample databases.

In this case when the user generates any type of query to find the data, the user gets a reply after executing the query from the database with some delay or mostly negative feedback. In a situation, assuming that the products are placed in RDBMS and the product does not have structure data, the storage will be very difficult. If a network attack is also available in this situation, the database has no chance of obtaining accurate results from the server. The results are exhibited in fig. 2. It is clearly shown that the effect of using messy database design is drastic over the recitation of the Web service and number of packets loss also increased immensely. Now, it is said that the use of well-structured database has been proven to be more effective compared to using unstructured databases for a Web service.

A. Attack Injection

User can generate POST, GET, UPDATE, PUT requests through Web service interface. Each time a database has to be hit by a query that is object oriented or a database query

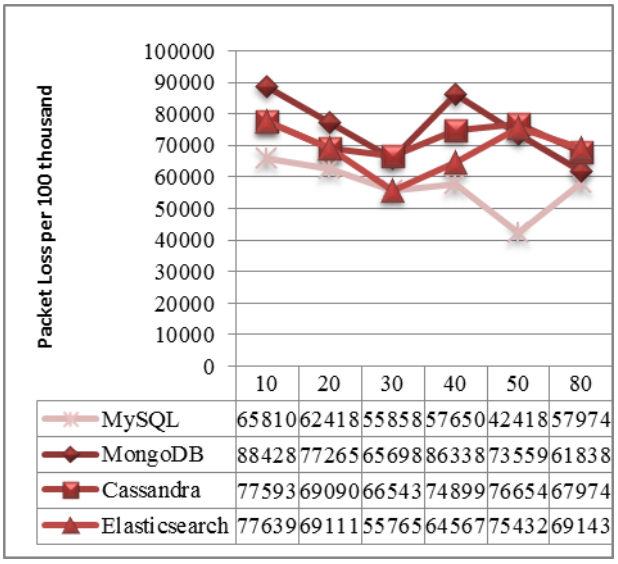

Fig. 3.Users (in thousand) Vs Packet Loss for Well Structured Database with DoS attack

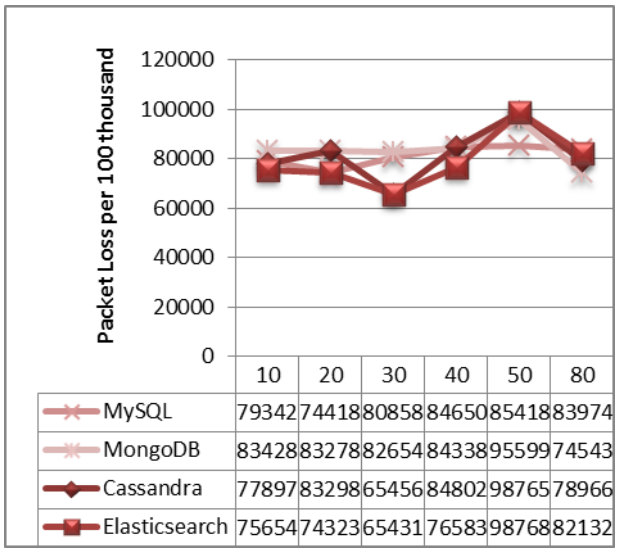

Fig. 4.Users (in thousand) Vs Packet Loss for Messy Database with DoS attack

to execute the user's request. User requests always travel through a network to reach the Web service server. In the network, the request submitted to the Web service server in the network can have significant opportunities for attack. Such network attacks can be of two types. The first type is passive, it is when sensitive information is examined and monitored, potentially compromising the security of enterprises and their customers or active, in which the information is replaced by a hacker or completely destroyed. The effect of the attack has been analyzed by including the DoS attack in the request submitted by the user to the Web service. The result clearly indicates that packet loss increased heavily for both type of approach i.e. structured database and messy database. Figure III clearly indicates that when user generates query for a well-structured database, the number of packets that were lost has increased significantly compared to previous result. So network attack can change the

response time of the well-structured database radically by affecting the overall performance of the Web service. Figure IV portrays the effect of network attack on messy database. In earlier result, the messy database already has more number of packet forfeitures. After including network attack within a database request, the number of packet forfeitures also escalated profoundly.Thus, the network attacks are affecting the performance of the Web service by increasing the number of packet loss and response time.

V. CONCLUSION AND FUTURE WORK

This paper dissects the effect of well-structured database approach against the messy database approach used within a Web service. The experiments are conducted on SOAPSonar simulator to depict how a well-structured database enacts a vigorous role in the performance of a Web service. Results clearly show that when well-structured database design has been followed in storing the Web service data, the numbers of packet that are lost during the transmission are very few and response time is also very low. On other side, if messy database design has been followed, the large number of packets are lost during the transmission and response time either too high or user will receive negative retort from the server. Thus, well-structured database design certainly enhances the functioning of the Web service comprehensively and diminishes theleeway of negative response.The swayof a network attack has also been analyzed by including a DoS attack within a user-generated request. The impact is analyzed for both well-structured database design and messy database design. The results suggest that the network attack increases the number of packetforfeitures.The network attack also substantiallydiminishes the performance ofWeb servicefor well-structured database design as well as messy database design. A future goal is the development and implementation of an algorithm to reduce the impact of network attacks on user requests. The efficacyof the insinuatedalgorithm will also be tested and evaluated to reduce the impact of network attacks in the near future.

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