ABSTRACT

Electronic web sites have been rendering useful services to organizations ever since the inception of WWW (World Wide Web). Internet has changed the way organizations plan and achieve business goals. Businesses in every conceivable field started relying heavily on web applications to promote sales and services and reach global audience.

The last decade has witnessed increased usage of enterprise web applications that bestow on immense benefits to both consumers and service providers. Banking, insurance, healthcare and other domains are exploiting the technologies associated with electronic super high way in order to have competitive edge in the global economy. Electronic commerce and net banking are widely used web applications in the real world.

Quality and performance of such web applications play a pivotal role in their sustenance and business continuity. Users of web applications are too good to lose concentration when the applications exhibit mediocre performance. They expect rich user experience in terms of quality and performance. There are some desirable attributes such as response time, throughput, fault tolerance, scalability and availability. In these response time, throughput are performance attributes and fault tolerance, scalability and availability are quality attributes. These attributes can improve quality and performance of web applications. A web application with robustness, quality and performance can
attract new users and retain existing ones.

Many attempts were made as found in the literature to provide various architectural and design patterns to improve quality and performance of web applications. For instance, architectural patterns such as MVC (Model View Controller), JEMSF (Job Evaluation Model Specific Framework), OOHDM (Object - Oriented Hypermedia Design Model), PAC (Presentation Abstraction Control), SMT (Simultaneous Multithreading), PCMEF (Presentation Control Mediator Entity Foundation), ISPWAD (Internet Security Provider Web based Application Design) etc. The common thread identified in these architectural patterns is that each framework is focused on certain aspects of design of web applications. From the analysis of these architectures it is understood that there was no comprehensive architectural pattern with underlying design patterns for improving response time, throughput, fault tolerance, scalability and availability of web applications.

Proposing and implementing such architectural pattern with design patterns is the important problem to be addressed. Towards this end, in this thesis, a novel architectural pattern named eXtensible Web Application Development Framework (XWADF) with underlying design patterns is proposed and implemented that could improve performance of web applications in terms of response time and throughput. The architectural pattern is extensible and in fact improved incrementally.

Two case study web applications known as Hospital Management System (HMS) and Library Management System (LMS) are considered to
demonstrate the usefulness of the proposed architecture. Moreover a “Refactoring Algorithm” is proposed to help refactor existing web applications to take advantage of the proposed architecture. The architecture is evaluated using Response Time and Throughput metrics.

Afterwards the XWADF is enhanced by incorporating design patterns to make it fault tolerant (FT). This is achieved by proposing two FT design patterns namely Fault Tolerant Exception Handling Pattern (FTEHP) and Fault Tolerant Security Pattern (FTSP) and adding to them to XWADF. Aspect Oriented Programming (AOP), which is a new programming paradigm for separation of concerns, is used to implement these design patterns.

FTEHP takes care of faults pertaining to common runtime errors while FTSP is on top of SSL for fool proof security. Two case study web applications known as Hospital Management System (HMS) and Library Management System (LMS) are considered to demonstrate the usefulness of the proposed enhanced architecture. A “Fault Tolerant Refactoring Algorithm” is proposed to help refactor existing web applications to take advantage of the proposed enhanced architecture.

Similarly the XWADF is enhanced by proposing and incorporating design patterns for promoting reliability attributes such as scalability and availability. Scalability is determined in terms of response time and throughput. Two case study web applications known as Hospital Management System (HMS) and Library Management System (LMS) are considered to demonstrate the usefulness of the
A “Scalability and Availability Refactoring Algorithm” is proposed to help refactor existing web applications to take advantage of the proposed enhanced architecture.

Hence the architectural pattern and its enhanced patterns are evaluated using metrics pertaining to response time, throughput, fault tolerance, scalability and availability. The methodology used to apply the architecture includes two case study web applications refactored to adapt XWADF and enhanced XWADF and evaluation of the architecture with respect to performance and quality attributes. The results revealed that the proposed architectural pattern and its enhanced patterns are comprehensive and can improve quality and performance of web applications by promoting response time, throughput, fault tolerance, scalability, and availability.

As the empirical results are encouraging, the proposed architectural pattern can be used by web application developers to leverage quality and performance advantages. Developers can use the Refactoring Algorithms to convert existing web applications to comply with the proposed architectural pattern.

This will bring about consistency besides making web applications fault tolerant, scalable and available in the real world. Another important feature of the architectural pattern is that it is extensible. In future new design patterns can be proposed and implemented as underlying patterns in the architectural pattern XWADF. This makes the XWADF more robust and adaptive to technology changes in future.