Investigations on Implementation of Content based Routing e-ATM Windows Communication Foundation Services using NET Technique

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Abstract—*Authors have proposed to design, develop and implement a prototype research electronic automated teller machine Windows Communication Foundation service to study the loads, performance and scalability of the service. One Master service is designed to authenticate a particular user to access methods and redirects the query for solution to executing service agents. The system is developed by using C# programming language, Internet Information Service web server, Microsoft Structured Query Language database server using Visual Studio.NET framework. To study its different performance metrics, the e-ATM service has been tested by deploying it on Mercury Load Runner. We present the prototype architecture, testing procedures and statistical analysis of the system performances.*

1. INTRODUCTION

Web Service (WS) offers a set of standards and technologies that an organization can interact with other platforms. WS is a software component designed to support interoperability within machines interaction over a network and interfaces, described in a machine processable format [1]. WS is empowered by (a) Extensible Mark Up Language(XML), the messages are sent over network in an XML format, (b) Simple Object Access Protocol (SOAP), an standard protocol to specify how XML documents are exchanged over Hyper Text Transfer Protocol (HTTP) or Message Oriented Middleware (MOM), (c)Web Service Description Language(WSDL), offers a metadata description of request and response parameters for interfacing (d) UDDI(Universal Description Discovery and Integration), the directory where WS services are registered and discovered in the internet. WS is a software component comprised of specific business methods that is published, described and invoked over diverse networks using Extensible Mark Up Language (XML) based on open standards [2]. Service Oriented Architecture (SOA) paradigm is used as the solution for developing distributed application architectures. SOA is an architectural strategy that empowers the business-IT alignment taking three enterprise components viz. technology, people and processes [3]. Microsoft released a SOA based Windows Communication Foundation (WCF) as part of the .Net Framework 3.0 by integrating the existing technologies into a single API in the form of WCF services. WCF is a unified framework for implementing, configuring and deploying distributed SOA applications using a set of classes placed at the top of the .NET Common Language Runtime (CLR). The existing different distributed technologies like ASMX, .NET Framework remoting, Microsoft Enterprise Services and Microsoft Message Queuing (MSMQ) are unified in one umbrella of WCF. Client can access loosely coupled services through the use of WSDL irrespective of platform from which the service is hosted. WCF supports many advanced WS-Security specifications as WS-Security, WS-Reliable Messaging, WS-Automatic Transaction, WS-Secure Conversation, WS-Trust etc. WCF .NET facilitates the development of distributed and interconnected applications based on SOA [4]. WCF has been designed to provide manageable approach to distributed computing, interoperability and service orientation in varied systems maintaining security and reliability of services [5]. The WCF service has composed of three components to a simple job of message communication with a client in SOA model, namely: (i) Service Class that implements service as a set of methods, (ii) Host Environment, the service can be hosted in Console Application, Windows Service, Windows Forms Application or in IIS, (iii) Endpoints, the messages are communicated via service and client endpoints. WCF is a unified technique for design and developing SOA architecture [6]. It interacts with other systems using SOAP messages as defined in WSDL, exchanges message using HTTP or HTTPS protocols in XML format. Service registry based on UDDI standard is used to publish and discover WCF services [7].

1.1 Related Work

Marckus and Bernd elaborated a Service Oriented communication concept using WCF particularly designed for industrial applications in a production environment of a central Manufacturing Information System (MIS) database [4]. They presented an overview of some design aspects and base service sets of WCF by factual implementation of the service oriented concept for industry software applications.

Hou et al suggested that WS performance can be improved by optimizing SOAP messages, adopting suitable methods and opined that the XML parsing, de-serializing and serializing are the most time consuming phases during SOAP messages exchanges and that effect the WS performance in a large scale [6].

Mostafa et al illustrated a three-tier security system architecture based on WCF using database security policies [8]. They suggested that applying WCF services to a set of novel algorithms can control and provide efficient, flexible and secret sharing communication between database users, database administrators and super database administrators.

Bora & Bezboruah presented an experimental study on hierarchical SOAP based WS implementing WS-Security policy [9]. In this investigation 8 virtual users (VU) were used for testing the service, employing security encryption, signature and both. It was found that the response time with security, encryption and signature is more than without security implementation and thus established that the response time with security policy is more than the response time without security implementation.

Aziz et al. performed a study on detection techniques of XML rewriting attacks in WS [10]. They investigated and analyzed limitations of three detection techniques viz. Policy-based approaches, the inline approaches and string-based approaches. Inline approach can overcome the pitfall of the policy-based approach. However the policy-based approach is also not efficient due to its high complexity that takes long calculation time in order to determine the structural information.

2. THE PROPOSED WORK

The objective of the proposed work is to implement a prototype research electronic automated teller machine (e-ATM) Service using WCF technology to study the load, performance and scalability of the service. The WCF Service has three tier services as presented in Fig. 1, namely: (i) the e-ATM, a client application (ii) Master WCF Services where users are authenticated and, (iii) WCF Computing agents (WCFC) to execute Business Logic (BL) methods. The authenticated user's query parameters are redirected to the content service agents for BL solutions. The Mercury LoadRunner, a software testing tool is deployed to perform the load and performance test on the proposed model.

3. THE METHODOLOGY

The prototype research e-ATM WCF Service has been developed including all facilities that a bank ATM provided to a customer using C# language, Microsoft Internet Information Server (IIS) as Web Server and the database is designed by Microsoft Structured Query Language (SQL) 2005, and MS Visual Studio 2012 as integrated development environment (IDE). A client application has also been developed to invoke the service in the same environment. The database size used for testing the WCF Service is 10,000. The data base is prepared with a user ATM, Card No, PIN, and Balance as an existing bank customer available from a bank. The proposed system has been tested for 5, 10, 15 numbers of virtual users (VU) by deploying it on Mercury LoadRunner to evaluate the performance metrics of WCF WS. The statistical analysis is done over the recorded data to study various aspects of the e-ATM WCF service.

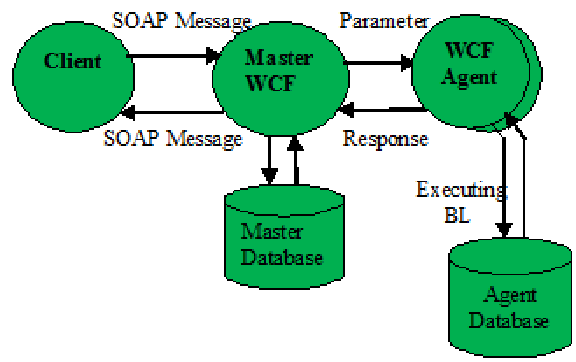

Fig. 1: The proposed e-ATMWCF Architecture

4. SOFTWARE SPECIFICATIONS OF E-ATM WCF

The WCF service has been developed using C Sharp(C#), an object oriented language integrated into .NET environment which has seamless access to WCF and operating system (OS) for the window platforms. The HTTP, XML, and SOAP are the technologies which make the WCF interoperable in different networks. The software specifications for the proposed work are: (a) IIS as Web Server, (b) MS SQL as database server (version 2005), (c) Microsoft Visual Studio 2012 as IDE, and (d) Internet explorer as Web Browser. The WCF Service and the client application of e-ATM have been run on a remote 64-bit Window 2008 R2 server with the configuration: Server Intel(R) Xenon(R) CPU E5620, speed: 2.4 GHz; RAM: 8GB and hard drive: 600GB. The Service script and the LoadRunner software were run from remote windows XP desktop PC with the hardware specifications: (i) Intel(R) Pentium (R) Dual CPUE2200; (ii) Processor speed: 2.20GHz; (iii) RAM: 1GB and (iv) Hard drive 100GB.

4.1 The System Architecture

The three-tier e-ATM WCF service architecture is presented in Fig. 1 (Client Application, Master WCF and executing BL WCF agent). The presentation layer (PL) contains the graphical user interface (GUI) and presentation code. The programming model Web Forms is used for developing the client application. The server executed Web Forms generate Hyper Text Markup Language (HTML) pages which control the forms, text boxes, submit buttons used for capturing user data and send parameters to WCF Service. The master WCF performs the authentication of user and authenticated user's parameters are forwarded to the concerned computing agent WCF, where the BL methods are prepared to compute the user request and responses are sent back to the client application.

5. DATABASE PLANNING AND SYSTEM TESTING

The database prepared for the proposed WCF service has three separate components, namely: (a) ATM Master contains the users Card No, Users Name and PIN and the two computing service agent, (b) ATMC and (c) ATMCh each contains the user Card No, Users Name, PIN and Balance etc.

The WS methods are dynamically searched and invoked. The performance analysis of a WCF service depends on identification of parameters, influence of a service, selection of efficient testing tools and techniques [11]. The Mercury Load Runner, a testing tool is used to test the e-ATM WCF Service. The Load Runner can produce real sense VU to stress the system and retrieve information from components database servers, and web servers. The obtained results are analyzed in detail to find out the causes of performances of the system, source at http://en.wikipedia.org/wiki/HP_LoadRunner.

For parameter setting, a user is set for a think time of 30s in a transaction and average steady-state period of 300s is set for all the experiments during testing. We follow the various steps for testing the application which are presented and discussed elsewhere [13].

5.1 Testing Parameters and Responses

The parameters set for testing are: (i) think time that a user waits between performing successive actions, (ii) work load intensity measured in terms of gradually increasing VU and, (iii) the network speed, which specifies the bandwidth (BW) of a network.

By creating load and gradually increasing stress on the application, we can monitor how the application performs in real time and its potential bottlenecks. During testing we monitored: (a) the response time in seconds, (b) the throughput in bytes/s and (c) the number of successful VU allowed for transaction.

6. RESULTS AND ANALYSIS OF WCF SERVICE

The experiment has been carried out for 5, 10, 15 VU with maximum BW of 128kbps. The reason behind for using 5, 10 and 15 number of VU is that higher the number of VU increases the performance overheads of the server [9]. The test case for deposit operation in the e-ATM WCFS is given in Table 1. Each test has been performed for 30 times for statistical analysis and the responses for 5 minutes duration of load is considered. The entire performance tests are conducted with a ramp up schedule with 1 VU operating for every 15s. After completion of steady state set value for 300s, VU are phased out simultaneously. Observing the variation of the Load Runner parameters, it is seen that the response time is steadily increasing with the increased number of VU as presented in Table 2, i.e. for VU 5, 10, 15, the average value of response time 5.6119s, 11.2238s and 16.8367s respectively. The average value of hits/sec 2.52987, 5.0597 and 7.58956 are closely varied with the increased VU. The average throughput values 3255.4341(Byte/Sec), 6510.8681 (Byte/Sec) and 9766.3022 (Byte/Sec) are also closely varied with the increased number of VU. During testing we have seen sudden rise and fall of response time, hits/sec and throughput values. This may be due to database or irregular release of server resources including memory for the concurrent request of VU.

Table 1: Test case for executing the methods of the WCF

Step	Operation	Executed Outcome
1	Open URL http://server/eatmWCFMaster/Default.aspx	Client application will be displayed for users required input. (a) Enter user card no in text filed (b) "submit" button
2	Enter PIN number and Click "Submit" button	Passed the user input parameter to master WCF for validity checking for existing users in SQL database at http://server/eatmWCFMaster/PINcheck.aspx
3	Main page for operation is displayed	Response to successful verification of input parameter at http://server/eatmWCFMaster/Welcome.aspx 1. FAST CASH 2. DEPOSIT 3. BALANCE ENQUIRY 4. FUND TRANSFER 5. CHANGE PIN
4	Computing agent WCFC is invoked on execution of Main page options.	For a selected option, particular WCF is invoked and updated SQL database accordingly.

Table 2: Testing results for select operations in WCF

Scenario	VU	Record parameter	Average value
Select Operation	5	Hits/s Response Time(s) Throughput(Byte/s)	2.52987 5.6119 3255.4341
	10	Hits/s Response Time(s) Throughput(Byte/s)	5.0597 11.2238 6510.8681
	15	Hits/s Response Time(s) Throughput(Byte/s)	7.58956 16.8367 9766.3022

Table 3: Bin and frequency

Response Time		Hits/Sec		Throughput	
Bin	Frequency	Bin	Frequency	Bin	Frequency
10.715	1	3.902	1	5021.113	1

10.9502	10	4.1978	2	5403.91	2
11.1854	4	4.4936	3	5786.787	4
11.4206	6	4.7894	2	6169.623	5
11.6558	3	5.0852	15	6552.46	15
>11.6558	6	>5.0852	7	>6552.46	3

6.1 Analysis for Response Time, Hits/s and Throughput

We have recorded repeatedly 30 samples using 10 VU and divided them into 6 classes, based on their range. The class width and range for hits/sec, throughput and response time are given in Table 3.

To determine the distribution of response time, hits/sec and throughput, we plot the obtained parameters in histogram as shown in figures 2-4 respectively. It is observed that the response time is right skewed, hits/sec is left skewed and the throughput is left skewed and according to the data distribution in the histograms, the applied data distribution is normal.

However, the histogram has drawbacks that it is possible to draw different conclusion based on the prepared bin size for the histogram [14]. So, we plot the same parameter in normal probability plot to determine the normal distribution of the recorded data as shown in figures 5-7 respectively. The data plot in the graph would be close to linear if the data are normally distributed. It is seen in the graph that the data points track a straight line which predicts that the data distribution is a normal one. The average R^2 value of hits/sec is 0.984, response time(s) is 0.921 and throughput value (Byte/Sec) is 0.971 which means that more than 90% data are concentrated near the linear line.

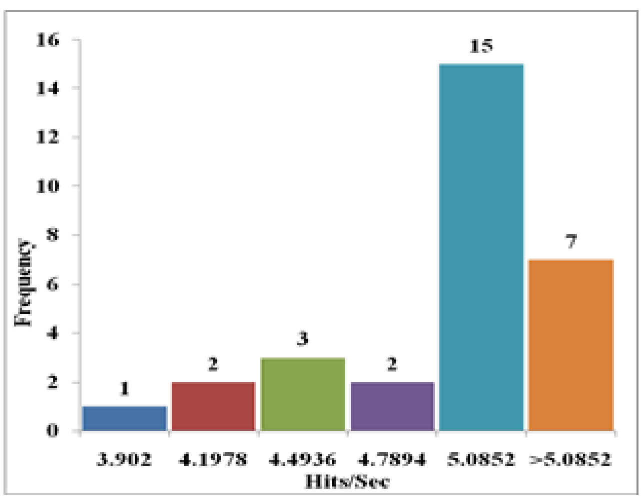

Fig. 2: Histogram of hits/s

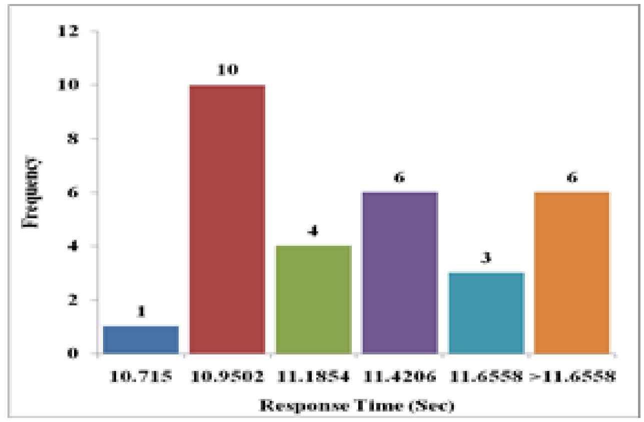

Fig. 3: Histogram of response time (s)

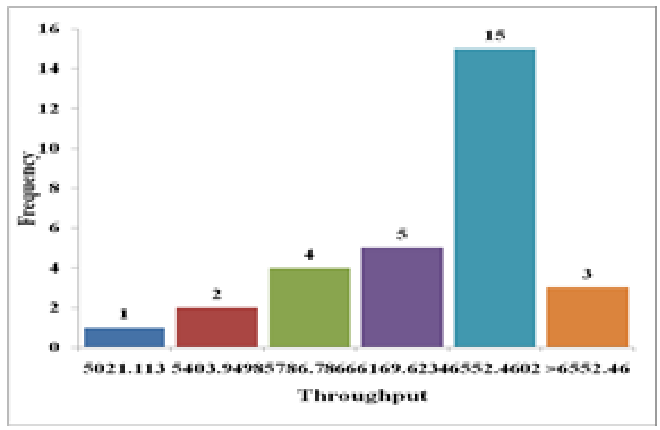

Fig. 4: Histogram of throughput

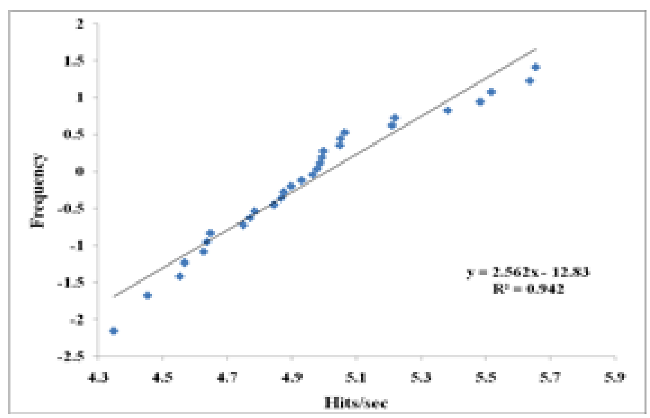

Fig. 5: Normal probability plot hits/s

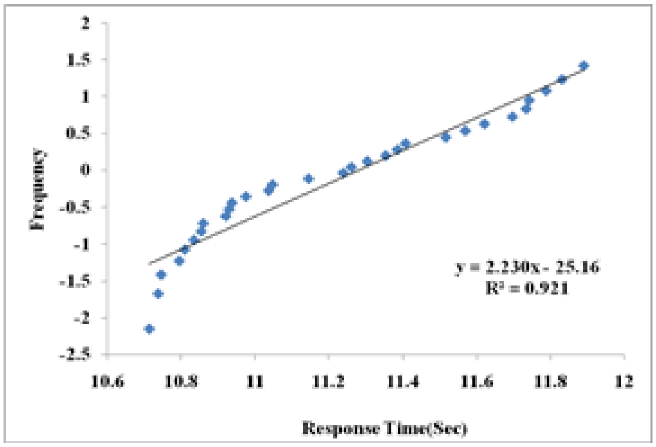

Fig. 6: Normal probability plot response time (s)

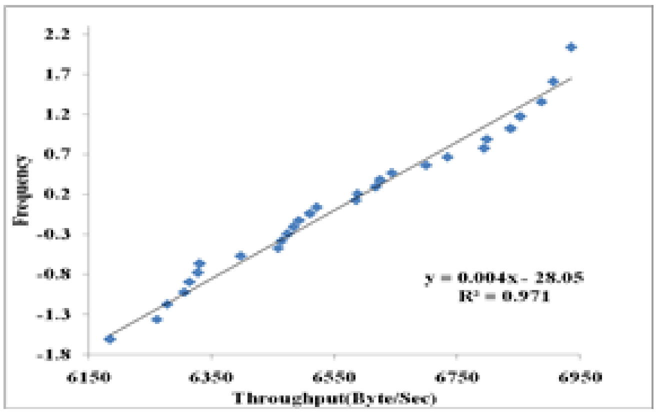

Fig. 7: Normal probability plot throughput

7. PERFORMANCE EVALUATION AND DISCUSSION

The objective of the proposed work is to design, develop, implement and investigate the overall performance of e-ATM WCF service using .Net technique and ascertain the normal distribution of the data. It is observed during the test at VU 5, 10 and 15, the average value of response time is 5.6119s, 11.2238s and 16.8457s respectively which indicates that the response time is gradually increasing with the increasing number of VU.

We have also conducted a comparative study of ASMX service and WCF service. It is observed that the average response time for 5, 10, 15 VU in ASMX WS are 9.008s, 19.8011s and 28.7027s which sharply increases with the increased number of VU. While in the WCF service, the response time is 5.6119s, 11.2238s, and 16.8457s which is gradually increases with the increased number of VU. We have seen that the response time in WCF service is less than the ASMX service which proves that the WCF Service is faster than the ASMX service.

The data distribution in the Histogram we see that the response time is right skewed, hits/sec is left skewed and the throughput is left skewed which is self explanatory that the applied data distribution is normal. In the normal probability plot we observed that the average R^2 value of hits/sec is 0.984, response time(s) is 0.921 and throughput value (Byte/s) is 0.971 which means more than 90% data are concentrated near the linear line that established data are normally distributed. These outcome implies the strong evidence of robust and scalability of the WCF Service to communicate with large number of real sense VU.

8. CONCLUSION AND FUTURE WORK

We present here the implementation of a prototype research e-ATM WCF service to study its various performance parameters. For this, the e-ATM WCF service was tested by deploying it in Mercury LoadRunner testing tool by increasing VU concurrently. We have observed in this study that the average response time, hits/s and throughput values were gradually increases with the increases of VU and sometimes values were seen gradully increased and decreased. This may be attributed to database or irregular release of server resources including memory for the concurrent request of VU.

The data distribution in the Histogram shows that the response time is right skewed, hits/sec is left skewed and the throughput is left skewed implied the normal distribution of data. In the normal probability plot we observed that the average value of R2 is more than 90% that is data are concentrated near the linear line which proves the normal distribution of data. From the above obtained results we can infer that WCF service is robust and scalable to communicate with large number of real sense VU.

We have also performed ASMX web service testing, deployed in Mercury LoadRunner testing tool for a similar application and observed that average response time of ASMX service is more than the average response time of WCF at varied VU. So, we can conclude that WCF is faster than ASMX service.

As part of the future work we propose to carry out a detail investigation on reliability of WCF Services within specified time frame under certain selected conditions.

9. ACKNOWLEDGEMENTS

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REFERENCES

[1] W3C, World Wide Web Consortium: http://www.w3.org/TR/ws-gloss/

[2] Siew poh Lee, Lai Peng Chan, Eng Wah Lee. "Web Services Implementation Methodology for SOA application",

Proceedings of Industrial Informatics, IEEE, pp. 335-340, doi: 10.1109/INDIN.2006.275822, 2006

[3] Jayashetty Shirees and M Kumar Pradeep., "Adopting Service Oriented Architecture increases the flexibility of your enterprise" at http://www.infosys.com/consulting/soa-services/white-papers/Documents/adopting-soa-increases-flexibility.pdf, 2006

[4] Markus Stopper and Bernd Gastermann. "Service Oriented Communication Concept based on WCF.NET for Industrial Applications", *Proceedings of the International MultiConference of Engineers and Computer Scientists*,Vol III , 2010.

[5] Mistry, M., Khanna, S.V. "Importance of WCF in Web Applications for Searching Products", *International Journal of Advanced Research in Computer Science and Software Engineering*, Vol. I, Issue. I, 2011.

[6] Hou Zhai-wei, ZHAI Hai-xia, and Gao Guo-hong . "A Study on Web Services Performance Optimization", *Proceedings of the Third International Symposium on Electronic Commerce and Security Workshops*, pp.184-188, 2010.

[7] Ahmad, Md Tanvir, Alam, M. Afsar, Alam, Shah Imran. "SOA Approaches Analysis and Integration with Emerging GUI", *International Journal of Innovative Research in Science & Engineering*, Vol. 2, Issue. 4, 2014

[8] Mostafa, Mohamed A., Aziz, Mohamed H. A., El-henawy, Mahomoud I."Integrated Database Security System Architecture based on WCF Services", *Journal of Internet Technology and Secured Transactions*, Vol. 1, Issues ½., 2012.

[9] Bora Abhijit, Bezboruah Tulsi. "Investigation on Security Implementation and performance Aspects of MedWS: a Hierarchical SOAP based Web Service", *International journal of Database Theory and Application*, Vol.7. No.4 .pp.169-188, doi: http:/dx.doi.org/10.14257/ijdta.2014.7.4.13, 2014.

[10] Aziz Nasridinov, Jeong Young Byun and Young–Ho Park. "A study on Detection Techniques of XML Rewriting Attacks in Web services", *International Journal of Control and Automation*, Vol.7,No.1,pp.391-400, doi: http:/dx.doi.org/10.14257/ijca.2014.7.1.35, 2014

[11] Medhi, Subhash, Bezboruah, Tulsi. "Investigations on implementation of e-ATM Web services based on .NET technique", *International Journal of Information Retrieval Research*, Vol. 4 Issue. 2, pp. 41-56, 2014

[12] Loadrunner(2015).Retrieved from http://en.wikipedia.org/wiki/HP_LoadRunner.

[13] Kalita M. & Bezboruah T. "Investigations on implementation of web applications with different techniques". *IET Softw*, Vol. 6, Issue. 6, pp. 474–478, doi:10.1049/iet-sen.2011.0136,2012

[14] Kalita.M & Bezboruah T. "Investigations on performance testing and evaluation of PReWebD: A .NET technique for implementing web application", *IET Soft.*, Vol. 5, Issue. 4, pp. 357-365, doi:10.1049/iet-sen.2010.0139, 2011