

Software Defect Prediction Using Selenium Framework – A Case Study

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Abstract: For testing the web based application the optimum and efficient tool available in the current scenario is Selenium Open Source. Various types of software testing can be performed this tool across the browser tool. This testing tool can be used without any limitation depending of the browser type. Using various components of Selenium testing tool, we can formulate the same as a framework which can be used to test the web application and other software automatically. In this paper we explore the various models of Selenium which can be used to test a web based applications or ecommerce portals.

Key Words: Selenium, Web Application, Testing Tools, Framework.

INTRODUCTION

To ensure that the software developed is as per customer requirement, defect free, every effort needs to be put by the developer to achieve this principal objective. Testing of software can be performed by following two methods: (a) Manually and (b) Automatically. In the process of manual testing the tester needs to test each functional scenario practically and report for any error which is more of personal oriented. This process if much time consuming and more complex in nature [1]. In order to save time, reliable and repeatability of testing methodology, we need to use automated testing tools for testing of software applications. Testing of developed software manually by testing professional became outdated, and the state of art in testing technology is automating the test process

Testing of software is a process by itself and which is used to find defects, bugs, key parameters and reliability. Key parameters of testing a software can be defined as [2]:

- (a) Performance: The quantum of time required to complete the testing task or activities of a software product that was developed.
- (b) Quality: The stated implied needs of the requirement are fulfilled by the functionality and features available in the developed software.
- (c) Security: To ensure that the software developed can withstand the malicious attack, risks from hackers and crashing during critical execution.

LITERATURE SURVEY

“Database testing using Selenium Web Driver – A Case Study” by V. Neethidevan, G. Chandrasekaran, International Journal of Pure and Applied Mathematics, Vol 118, No. 8, P 559-566. In this work, the authors had discussed in brief regarding the testing methodologies and identified Selenium Web Driver as an effective tool for the testing of web based application database in comparison with other open source available.

“A Literature Review Study of Software Defect Prediction using Machine Learning Techniques” by Feidu Akmel, Ermiyas Birihanu and Bahir Siraj, International Journal of Emerging Research in Management & Technology, June 2017. In order to enhance the software quality, various quality metrics such as software testing, CMM and ISO standards were elaborately studied in this paper. The authors suggest that software defects prediction can effectively improve the testing efficiency of software and provide guideline for resource allocation, time and cost. For the error prone modules, they suggest that the software testers should spend more resource and time.

“Testing Using Selenium Web Driver”, Paruchuri Ramya, Vemuri Sindhura and P Vidya Sagar, IEEE 2017. Ideally this paper emphasizes on the use of Selenium Web-driver for testing of web application and to establish the usage of this tool in amalgamation with other tools like the Maven, TestNG, etc.

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This Web driver based tool provides an user friendly approach to test software and improve the process of testing quality.

Automation of test process is one of the finest and easier approach for performing testing on any software. The principal advantage of automating the test process is, we can reuse the software and maintenance and documentation of entire test scripts up-to-date easily. It was emphasised in this paper that

Selenium Web Driver can be used for automated web application testing and it is very proficient, unpretentious and precise results can be obtained.

SELENIUM THE STATE OF ART TESTING TOOL

Selenium is a state of art testing tools having various components having different approach to support automation of testing process. Ideally one or more tools are focused by the testing professions aht meets most of the system requirement.

However, understanding and having knowledge of all the tools available in Selenium will help in expertise for optimum and ideal usage of this tool for software testing. The complete set of tools available in Selenium framework, will help in automating the test process of web based applications and user defined software of all types [3].

This tools helps in identifying user interface elements, comparing, locating and to analyse the achieved result with the expected one. The key feature of Selenium tool is, the support for implementing the test of diversified web browser platform without any bottleneck.

Selenium is poised with various tools for software defect prediction having precise role for each one. The architecture of Selenium is as given below in Fig.- 1

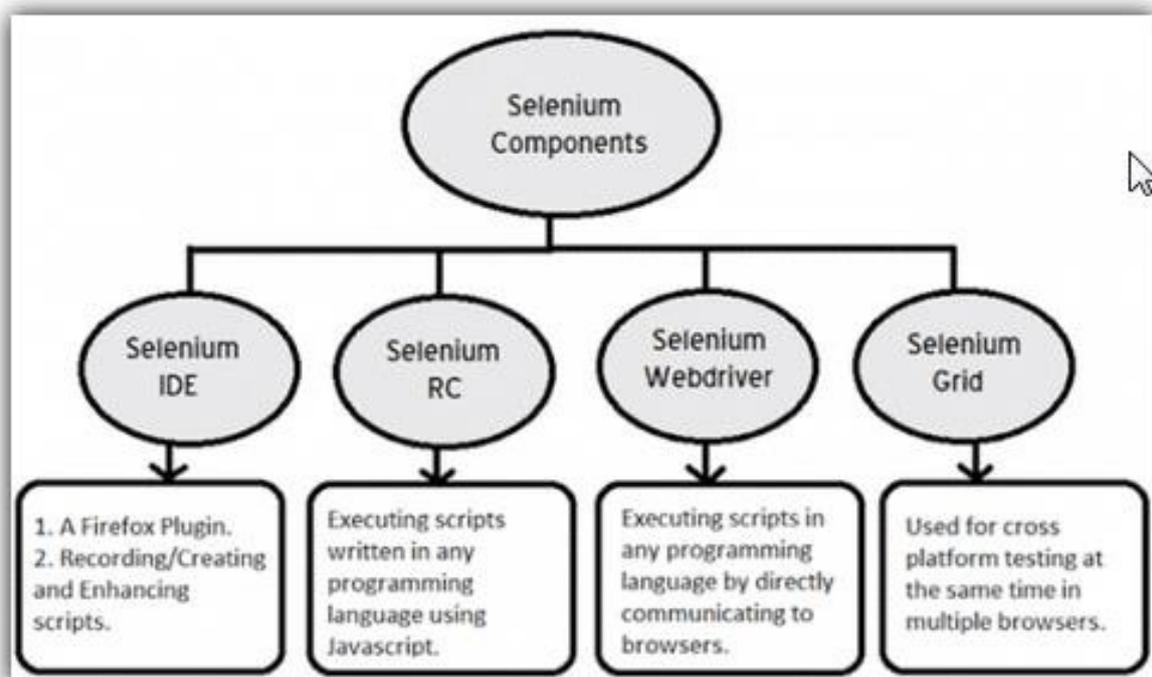


Fig.1: Selenium Architecture

Brief explanation of various tools available in Selenium framework are explained as below :

SELENIUM RC OR REMOTE CONTROL

Selenium Remote Control normally called as RC is one of the leading testing tool for many decades for the testing of software projects. This test tool helps to write automated Web application UI test in any programming language against any HTTP website which uses the Java Script enabled browser. Selenium RC was the main testing tool for defect prediction of any software till the emergence of Selenium Web Driver which is more powerful and efficiency as compared to RC. The following Fig - 2 represents the brief architecture of Selenium RC.

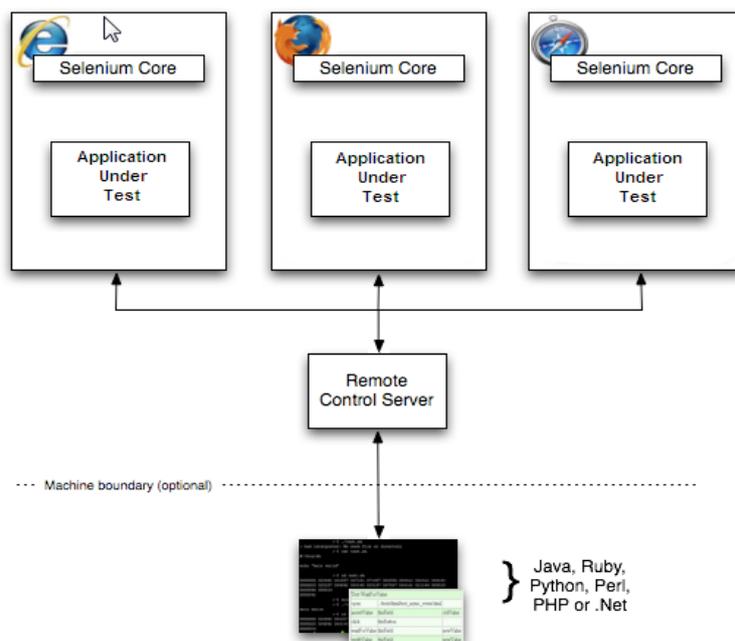


Fig. 2: Selenium RC Architecture

The usage of Selenium RC is slowly deprecated, not actively supported and in the more of maintenance.

SELENIUM IDE

Selenium IDE (Integrated Development Environment) was developed by Shinya Kasatani during the studying phase of Selenium Core. During this phase, he apprehended that we can extend the JavaScript code for creating an integrated development environment (IDE). This IDE can be which can be wrought out into Mozilla Firefox for better testing and defect prediction. This tool is a prototype one, which can be used for test scripts building for Firefox and Chrome. This tool can provide an interface which can be very easy to use in the process of software testing automation. The architecture of Selenium IDE is as given in Fig. – 3.



Fig. 3: Selenium IDE Architecture

Using this tool can help in providing easy-to-use, to record the testing scenario and the feature of playing back the testing scenario. It also provides easy usage even persons who have no programming expertise.

SELENIUM WEBDRIVER

The latest addition to the Selenium toolkit is the Selenium WebDriver. It is a powerful framework automated web testing process which helps to execute the testing methodology across boundaries of web browsers. Automated web testing scripts can be developed through this framework which will be more flexible and powerful than any other open source available in the current scenario [4]. This framework supports the browsers like IE, Safari, Opera, Google Chrome, Firefox, Phantom JS, etc. While comparing with Selenium IDE, this tool can be used for writing customized test process using the programming languages like Java, .Net, etc. The following Figure shows the programming architecture of Selenium WebDriver:

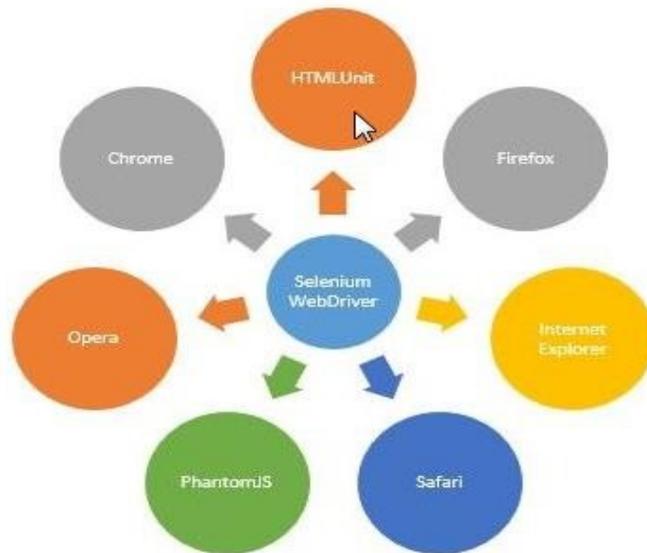


Fig. 4: Programming Languages of Selenium Web Driver

Having the facility of customising the test procedure using diversified programming languages, helps non-dependency of functions built within this tool. This advantage can help us in defining conditional operations, variable and constant parameters declaration, testing loops, etc.

This automation tool also provides remarkable features, enhanced cohesive and OOPs oriented API which are considered as an outcome to overcome the limitations of ancient testing tools.

SELENIUM-GRID

Selenium Grid is a tool which helps to execute the scripts simultaneously (parallel processing) across virtual or physical machines. This tool helps histrionically accelerates the process of software testing process transversely browsers and platforms, it gives very swift and precise feedback. Multiple instances of Web Driver or RC tests can be run in parallel using the same code base. This helps to overcome the need of code presence in the system where they are executed.

Selenium Grid can be incorporated in a Hub and a Node. The Hub can be considered as Server, and acts as a central point in which the test of software is triggered. It can have only one hub and can be executed in single system once. Nodes are considered as instances of Selenium testing tool which are attached to the Hub for execution of the tests. Each Hub in Selenium Grid can have one or more nodes depending on the requirement of software testing process. The architecture of Selenium Grid is as given in Fig 5 below :

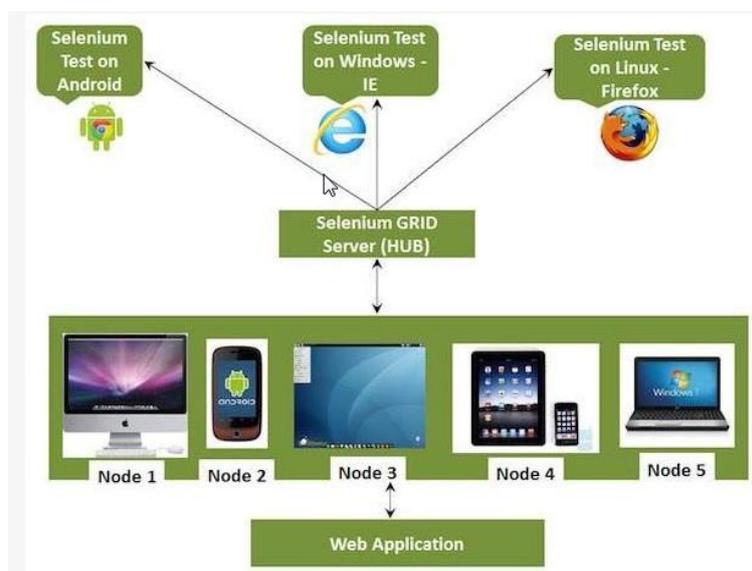


Fig. 5: Selenium Grid Architecture

The Selenium Framework is the combination all the above tools, which can be chosen depending on the requirement, complexity of the software application to be tested.

CHOOSING THE RIGHT SELENIUM TOOL

Choosing the right selenium tool depends of the expertise, knowledge and experience of the software tester, to select an optimum tool suitable for the requirement. Ideally people with who are not having any much experience with scripting and programming language will be use Selenium IDE. This tool can be used for getting familiarisation with Selenium testing process and commands. This tool helps the users to create simple and easy test procedures quickly. But this tool is not suitable for all the automated tests.

For building an effective automated test process, we need to use more than two Selenium tools as framework (Web Driver or Grid or RC). However it's not recommend to do all test automations using Selenium IDE. To effectively use Selenium we need to build and run all the tests using either Selenium WebDriver or Selenium RC in combination with one or more braced programming languages.

All the Selenium tools have its own strengths and weaknesses. Hence, the tester who want to build a ideal test suite need to go with state of art testing tool

- Selenium Web Drive and use Selenium RC as backward compatibility.

TEST AUTOMATION FRAMEWORK

Any software of critical in nature has to endure rigorous function test, which can be performed by automated testing frameworks. These frameworks, helps to maintain quality software releases which are mission critical to any organisation's performance. We need to ensure that the automation framework should cover the complete business scenario and application requirements are provided error free and reliable. The software testing professional always face this dilemma of managing the costs and resources to achieve the said objective.

The speed, reliability and accuracy of the application software can be achieved, if an ideal automated testing framework is defined. This framework can significantly enhance the testing process and provide better return on investment to the organisation involved in software development and testing. This will also help in minimising the loss and risk by avoiding the resources and money used in the testing process. Test automation framework is as given in Fig – 6 below:

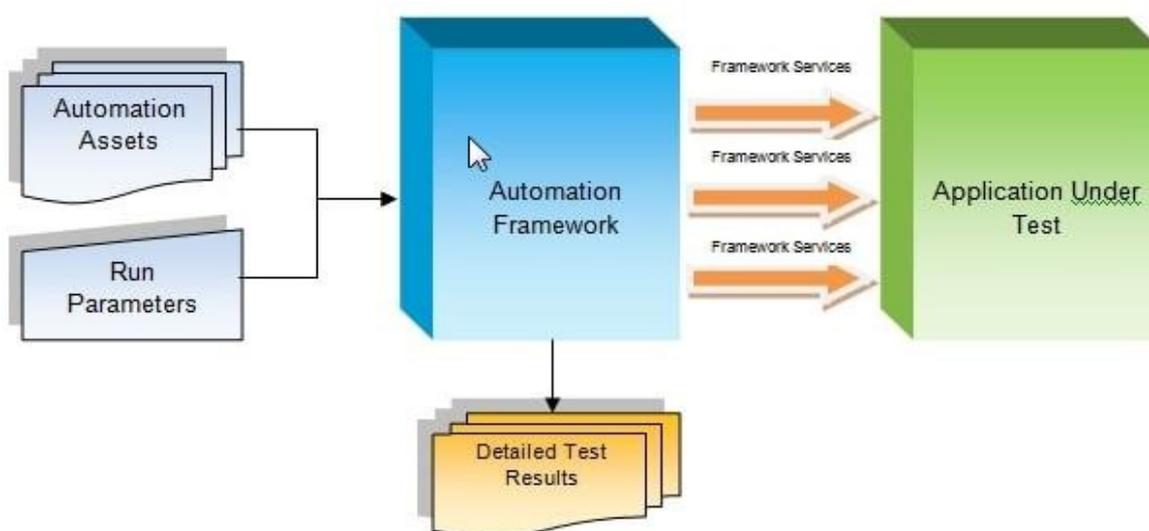


Fig. 6: Test Automation Framework

Using test automation framework, helps in script less representation of testing process, performing tests based on data driven, reporting concisely, consistency in scripting and standardisation, effective implementation and maximise reusability.

SELENIUM TESTING FRAMEWORK

Selenium Framework can be defined as structured code, which helps to maintain the same very easily. If the framework is not available, we tend to place "code" as well as "data" in the same place which is neither re-usable nor readable.

Frameworks, helps to increase re-usage of developed scripts, enhanced portability, code accessibility and readability, reduce maintenance cost of scripts, etc. Testing automation framework using Selenium tools is as given in Fig – 7.

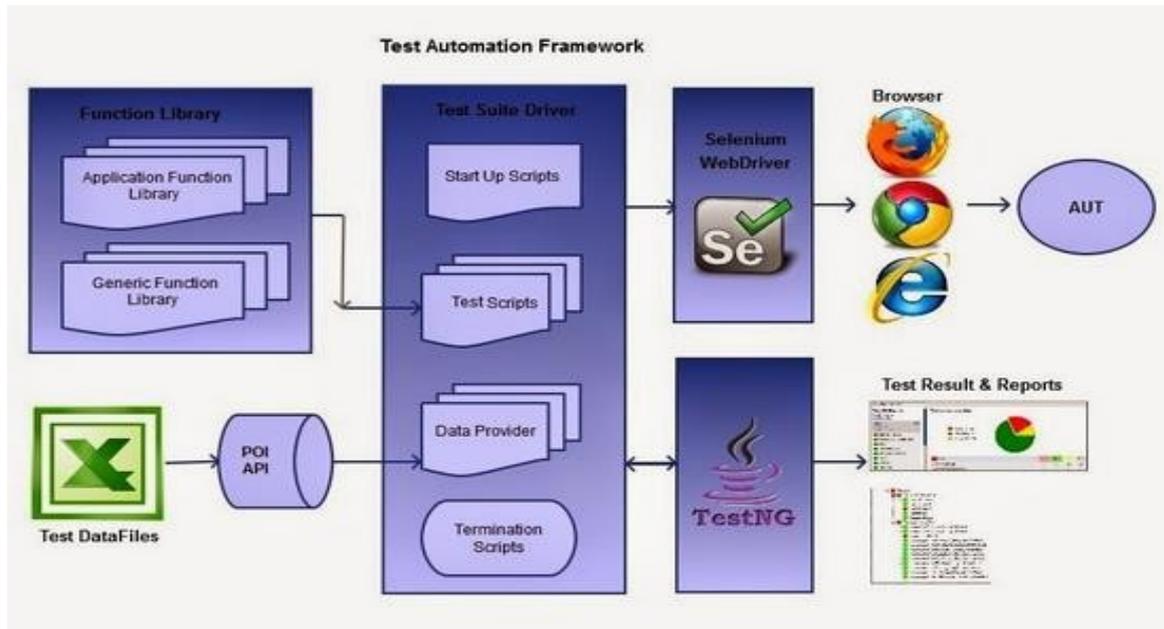


Fig. 7: Selenium Testing Framework

Considering the ideal tool for web application testing as Selenium Web Driver, and the framework of the same are – Data Driven, Keyword Driven and Hybrid. The architecture of this framework is as given in Fig – 8.

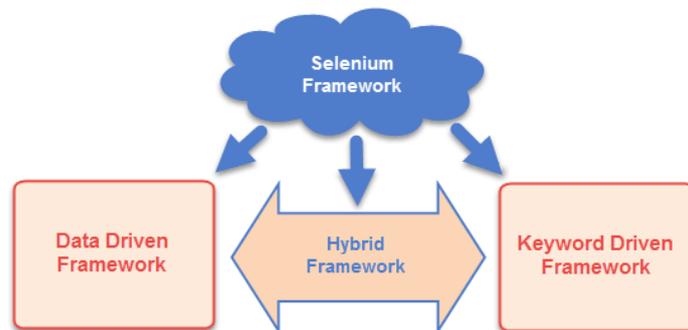


Fig. 8: Selenium Framework These frameworks are briefly explained below

Data Driven Test Framework

In the current market scenario, data driven framework is a prevalent automation testing tool. In this method, the test data set is created in an excel sheet and the same is imported into automation testing tool to process for testing of the software developed.

In this framework, all the requisite data is created from the external file sources like Excel, XML, database table etc. This external file source helps to run the test automatically for multiple times having varied inputs and validating values. The architecture of Data Driven Framework is as given in Fig – 9.

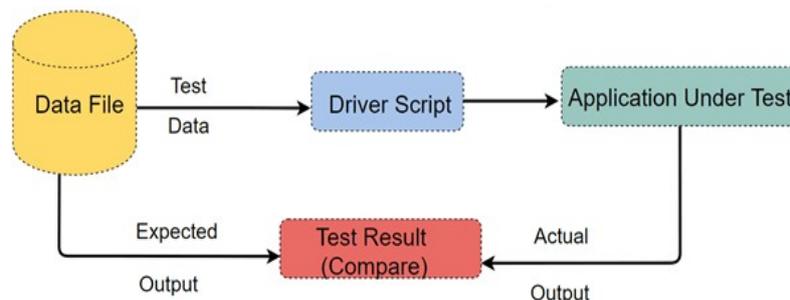


Fig. 9: Data Driven Framework Architecture

The problem of keeping the data at a separate location for functional test helps to resolve using this approach. Test results can be generated using the same test scripts being executed with various combination of input test data.

Key Word Driven Framework

Keyword based testing framework can be created both manually and automated. This framework is usually incorporated for automated testing process. The main advantages of using this framework are – for reducing the cost of maintenance, duplicate specifications can be avoided, function scripting can be reused many times, greater testing and support available and many testing process can be done with minimum effort.

We can create many sample functional test using Keyword driven framework during the initial stages of development itself. With this framework, we can test the application software at each and every minute stages of development. Recording of the keyword testing process is the easiest way to implement. Once recorded these test scripts can be modified and customized to meet the defined requirement of testing process. In this framework, each keyword will be linked with minimum of one command, functional of the software or test scripts used for testing, for implementing the actions that is relating to particular keyword. It is the extension of data driven framework as the performance little better than the earlier one.

These defined keywords are considered as self- guiding parameter, which guides us to identify the action to be performed on the application software to be tested. The architecture of keyword driven framework is given in Fig – 10.

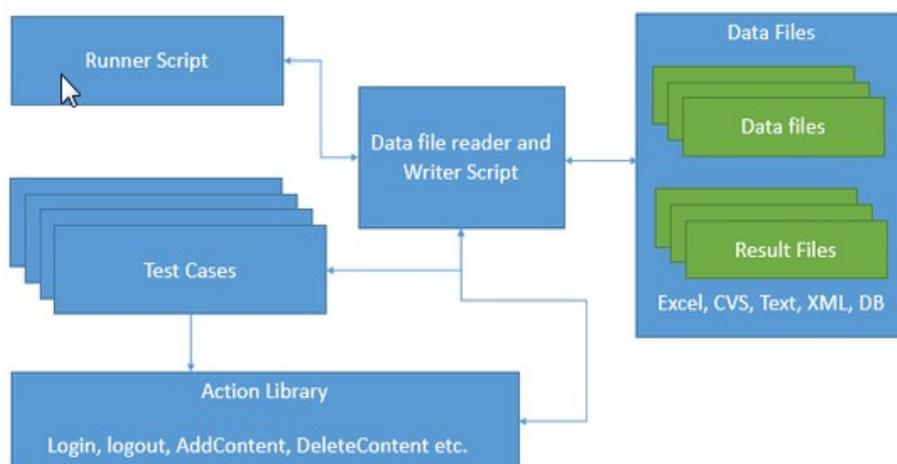


Fig. 10: Keyword Driven Framework Architecture
Hybrid Framework

Hybrid Testing Framework is a combination Data and Keyword driven framework, which has the advantages of both. This framework is considered as beginner level tool and easy to understand by testing professionals not having much expertise. The architecture of Hybrid Testing Framework is given in Fig11.

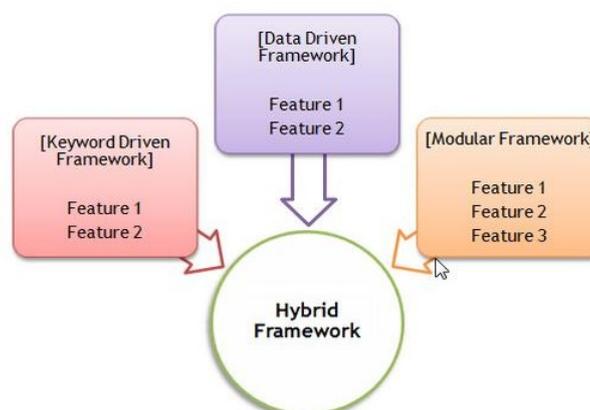


Fig. 11: Hybrid Testing Framework Architecture

CONCLUSION

This paper helps to understand basic concept of Selenium as an open source testing tool for the web based application. In the current scenario many testing professionals are started using this tools as a prime defect prediction methodology. As compared to other testing tools like [5] SAHI Pro, Windmill, LoadRunner, QTP, etc. As compared to SAHI Pro and Selenium testing framework, the performance of the later is better in case of execution speed and time complexity. Hence this framework, is proposed as a state of art tool available for automated software testing, especially for the web based application. However, the advantages are very high for this framework, it also has the bottleneck of highly complex in nature, many components are involved in creating a test framework, cumbersome process of creating test scripts [6]. Predicting the defects using testing tools is a novel research area for any computer science research student, and prominent in the field of software dominated world. It is concluded that Selenium Testing Framework, a combination of one or more testing tool will be an ideal defect prediction framework, optimum for certain specific web based application and better choice for many more software of mission critical.

REFERENCES

- [1] Udayakumar, R., Khanaa, V., & Saravanan, T. (2013). Analysis of polarization mode dispersion in fibers and its mitigation using an optical compensation technique. *Indian Journal of Science and Technology*, 6(6), 4767-4771.
- [2] Udayakumar, R., Kumaravel, A., & Rangarajan, K. (2013). Introducing an efficient programming paradigm for object-oriented distributed systems. *Indian Journal of Science and Technology*, 6(5S), 4596-4603.
- [3] Mageswaran, S.U., & Sekhar, N.G. (2013). Reactive power contribution of multiple STATCOM using particle swarm optimization. *International Journal of Engineering & Technology*, 5(1), 122-126.
- [4] Giri, R.K., & Saikia, M. (2013). Multipath routing for admission control and load balancing in wireless mesh networks. *International Review on Computers and Software*, 8(3), 779-785.
- [5] Padmapriya, G., Manikandan, A., Krishnasamy, V., Jaganathan, S.K., & Antony, S.A. (2016). Spinel NixZn1-xFe2O4 (0.0 ≤ x ≤ 1.0) nano-photocatalysts: synthesis, characterization and photocatalytic degradation of methylene blue dye. *Journal of Molecular Structure*, 1119, 39-47.
- [6] Vijayaragavan, S.P., Karthik, B., Kiran Kumar, T.V.U., & Sundar Raj, M. (2013). Analysis of chaotic DC-DC converter using wavelet transform. *Middle-East Journal of Scientific Research*, 16(12), 1813-1819.
- [7] Aravind, D., & Deepa, K. (2015). Power Improvement of Photovoltaic System Using IEDM in Smart Grid Application. *Excel International Journal of Technology, Engineering and Management*, 2(2), 22-26.
- [8] Naveen, N., & Rajesh Kumar, B. (2015). Automatic LPG Drum Level Pointer and SMS Booking System with Refuge. *Excel International Journal of Technology, Engineering and Management*, 2(2), 27-29.
- [9] Dr.Veenadhari, S. (2016). Crop Advisor: A Software Tool for Forecasting Paddy Yield. *Bonfring International Journal of Data Mining*, 6(3), 34-38.
- [10] Kondori, M.A.P., & Peashdad, M.H. (2015). Analysis of challenges and solutions in cloud computing security. *International Academic Journal of Innovative Research*, 2(8), 1-11.
- [11] Kargar, M.J., & Motaghian, S. (2015). Creating Semi – Automatic Ontology on Persian Wikipedia Texts. *International Academic Journal of Innovative Research*, 2(8), 38-44.
- [12] Sandhiya, K., & Yamuna, L. (2014). High Performance Dual-Band Printed Doublet Design Loaded with Split Resonator Structures. *International Journal of Communication and Computer Technologies*, 2(1), 64-67.
- [13] Lenin, G.J.N., Noora, J.A., Packiyalakshmi, D., Priyatharshini, S., & Thanapriya, T. (2014). Highly Directive Rectangular Patch Antenna Arrays. *International Journal of Communication and Computer Technologies*, 2(1), 68-73.
- [14] Oh, T.J., & Anthony, (2017). New and Fast Emerging Advance Structure of Text Mining from Unstructured Data. *Bonfring International Journal of Industrial Engineering and Management Science*, 7(2), 13-16.

- [15] Janmohammadi, P., & Babazade, M. (2015). Resource Management in the Cloud Computing Using a Method Based on Ant Colony Optimization. *International Academic Journal of Science and Engineering*, 2(6), 40-54.
- [16] Farajzadeh, M., & Bakhsh, N.N. (2015). A mechanism to improve the throughput of cloud computing environments using congestion control. *International Academic Journal of Science and Engineering*, 2(7), 10-24.
- [17] Lokesh, K., Kavitha, G., Manikandan, E., Mani, G.K., Kaviyarasu, K., Rayappan, J.B.B., ... & Maaza, M. (2016). Effective ammonia detection using n-ZnO/p-NiO heterostructured nanofibers. *IEEE Sensors Journal*, 16(8), 2477-2483.
- [18] Abraham, A.G., Manikandan, A., Manikandan, E., Vadivel, S., Jaganathan, S.K., Baykal, A., & Renganathan, P.S. (2018). Enhanced magneto-optical and photo-catalytic properties of transition metal cobalt (Co²⁺ ions) doped spinel MgFe₂O₄ ferrite nanocomposites. *Journal of Magnetism and Magnetic Materials*, 452, 380-388.
- [19] Kennedy, J., Fang, F., Futter, J., Leveneur, J., Murmu, P.P., Panin, G.N., & Manikandan, E. (2017). Synthesis and enhanced field emission of zinc oxide incorporated carbon nanotubes. *Diamond and Related Materials*, 71, 79-84.
- [20] Teresita, V.M., Manikandan, A., Josephine, B.A., Sujatha, S., & Antony, S.A. (2016). Electromagnetic properties and humidity-sensing studies of magnetically recoverable LaMg_xFe_{1-x}O_{3-δ} perovskites nano-photocatalysts by sol-gel route. *Journal of Superconductivity and Novel Magnetism*, 29(6), 1691-1701.
- [21] Caroline, M.L., & Vasudevan, S. (2009). Growth and characterization of pure and doped bis thiourea zinc acetate: Semiorganic nonlinear optical single crystals. *Current applied physics*, 9(5), 1054-1061.
- [22] Jayalakshmi, V., & Gunasekar, N.O. (2013). Implementation of discrete PWM control scheme on Dynamic Voltage Restorer for the mitigation of voltage sag/swell. *International Conference on Energy Efficient Technologies for Sustainability*, 1036-1040.
- [23] Udayakumar, R., Khanaa, V., & Kaliyamurthie, K.P. (2013). Optical ring architecture performance evaluation using ordinary receiver. *Indian Journal of Science and Technology*, 6(6), 4742-4747.
- [24] Udayakumar, R., Khanaa, V., & Kaliyamurthie, K.P. (2013). Performance analysis of resilient fth architecture with protection mechanism. *Indian Journal of Science and Technology*, 6(6), 4737-4741.
- [25] Saravanan, T., Srinivasan, V., & Sandiya, V.P. (2013). A two stage DC-DC converter with isolation for renewable energy applications. *Indian Journal of Science and Technology*, 6(6), 4824-4830.
- [26] Sundarraj, M. (2013). Study of compact ventilator. *Middle-East Journal of Scientific Research*, 16(12), 1741-1743.
- [27] Thema, F.T., Manikandan, E., Gurib-Fakim, A., & Maaza, M. (2016). Single phase Bunsenite NiO nanoparticles green synthesis by Agathosma betulina natural extract. *Journal of alloys and compounds*, 657, 655-661.
- [28] Sathyaseelan, B., Manikandan, E., Sivakumar, K., Kennedy, J., & Maaza, M. (2015). Enhanced visible photoluminescent and structural properties of ZnO/KIT-6 nanoporous materials for white light emitting diode (w-LED) application. *Journal of Alloys and Compounds*, 651, 479-482.
- [29] Gopalakrishnan, K., Prem Jeya Kumar, M., Sundeep Aanand, J., & Udayakumar, R. (2013). Analysis of static and dynamic load on hydrostatic bearing with variable viscosity and pressure. *Indian Journal of Science and Technology*, 6(6), 4783-4788.
- [30] Prabhu, M.R., Reji, V., & Sivabalan, A. (2012). Improved radiation and bandwidth of triangular and star patch antenna. *Research Journal of Applied Sciences, Engineering and Technology*, 4(12), 1740-1747.
- [31] Arumugam, S. and Ramareddy, S. (2012). Simulation comparison of class D/ Class E inverter fed induction heating. *Journal of Electrical Engineering*, 12(2), 71-76.
- [32] Udayakumar, R., Khanaa, V., & Kaliyamurthie, K.P. (2013). High data rate for coherent optical wired communication using DSP. *Indian Journal of Science and Technology*, 6(6), 4772-4776.
- [33] Nagarajan, C., & Madheswaran, M. (2012). Experimental Study and Steady State Stability Analysis of CLL-T Series Parallel Resonant Converter with Fuzzy Controller using State Space Analysis. *Iranian Journal of Electrical and Electronic Engineering*, 8(3): 259-267.

- [34] Gopalakrishnan, K., PremJeya Kumar, M., SundeepAanand, J., & Udayakumar, R. (2013). Thermal properties of doped azopolyester and its application. *Indian Journal of Science and Technology*, 6(6), 4722-4725.
- [35] Kumaravel A., Meetei O.N. (2013). An application of non-uniform cellular automata for efficient cryptography. *Indian Journal of Science and Technology*, 6(5): 4560-4566.
- [36] Kumaravel, A., & Pradeepa, R. (2013). Layered approach for predicting protein subcellular localization in yeast microarray data. *Indian Journal of Science and Technology*, 6(5S), 4567-4571.
- [37] Kaviyarasu, K., Manikandan, E., Kennedy, J., & Maaza, M. (2016). Synthesis and analytical applications of photoluminescent carbon nanosheet by exfoliation of graphite oxide without purification. *Journal of Materials Science: Materials in Electronics*, 27(12), 13080-13085.
- [38] Mathubala, G., Manikandan, A., Antony, S.A., & Ramar, P. (2016). Photocatalytic degradation of methylene blue dye and magneto-optical studies of magnetically recyclable spinel $\text{Ni}_x\text{Mn}_{1-x}\text{Fe}_2\text{O}_4$ ($x= 0.0-1.0$) nanoparticles. *Journal of Molecular Structure*, 1113, 79-87.
- [39] Manikandan, E., Kennedy, J., Kavitha, G., Kaviyarasu, K., Maaza, M., Panigrahi, B.K., & Mudali, U.K. (2015). Hybrid nanostructured thin-films by PLD for enhanced field emission performance for radiation micro-nano dosimetry applications. *Journal of Alloys and Compounds*, 647, 141-145.
- [40] Kumaravel, A., & Meetei, O.N. (2013). An application of non-uniform cellular automata for efficient cryptography. *IEEE Conference on Information & Communication Technologies*: 1200-1205.
- [41] Langeswaran, K., Gowthamkumar, S., Vijayaprakash, S., Revathy, R., & Balasubramanian, M.P. (2013). Influence of limonin on Wnt signalling molecule in HepG2 cell lines. *Journal of natural science, biology, and medicine*, 4(1), 126-133.
- [42] Srinivasan, V., & Saravanan, T. (2013). Analysis of harmonic at educational division using CA 8332. *Middle-East Journal of Scientific Research*, 16(12), 1768-73.
- [43] Josephine, B.A., Manikandan, A., Teresita, V.M., & Antony, S A. (2016). Fundamental study of $\text{LaMg}_x\text{Cr}_{1-x}\text{O}_{3-\delta}$ perovskites nano-photocatalysts: sol-gel synthesis, characterization and humidity sensing. *Korean Journal of Chemical Engineering*, 33(5), 1590-1598.
- [44] Saravanan, T., Saritha, G., & Udayakumar, R. (2013). Robust H-Infinity Two Degree of Freedom Control for Electro Magnetic Suspension System. *Middle-East Journal of Scientific Research*, 18(12), 1827-1831.
- [45] Rajasulochana, P., Dhamotharan, R., Murugakoothan, P., Murugesan, S., & Krishnamoorthy, P. (2010). Biosynthesis and characterization of gold nanoparticles using the alga *Kappaphycus alvarezii*. *International Journal of Nanoscience*, 9(05), 511-516.
- [46] Slimani, Y., Güngüneş, H., Nawaz, M., Manikandan, A., El Sayed, H. S., Almessiere, M. A., & Baykal, A. (2018). Magneto-optical and microstructural properties of spinel cubic copper ferrites with Li-Al co-substitution. *Ceramics International*, 44(12), 14242-14250.
- [47] Kaviyarasu, K., Manikandan, E., Kennedy, J., Jayachandran, M., & Maaza, M. (2016). Rice husks as a sustainable source of high quality nanostructured silica for high performance Li-ion battery requital by sol-gel method—a review. *Adv. Mater. Lett*, 7(9), 684-696.
- [48] Ilayaraja, K., & Ambica, A. (2015). Spatial distribution of groundwater quality between injambakkamthiruvanmyiur areas, south east coast of India. *Nature Environment and Pollution Technology*, 14(4), 771-776, 2015.
- [49] Sharmila, S., Rebecca, L. J., Das, M.P., & Saduzzaman, M. (2012). Isolation and partial purification of protease from plant leaves. *Journal of Chemical and Pharmaceutical Research*, 4(8), 3808-3812.
- [50] Rajakumari, S.B., & Nalini, C. (2014). An efficient cost model for data storage with horizontal layout in the cloud. *Indian Journal of Science and Technology*, 7(3), 45-46.