Title of Paper: **Tools Used for Different Types of Testing**

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Abstract: Software Testing is the process of comparing the expected results with the actual results to ensure that the product is bug-free. It involves identifying the gaps and the missing functionalities by reviewing the requirements of the product. [1] There are two types of Software Testing: Manual and Automated Testing. Manual Testing involves manually writing the test cases by preparing a test document which consists of different test cases and the expected and the actual results. Automated Testing is the process of testing the software using an automated tool to find the defects in which the testers execute the test scripts and the test results are generated automatically by the automation test tools. There are two methods of testing: Static and Dynamic Testing. Static Testing also known as Verification Testing is the process of testing the software by reviewing the requirements and the files to verify whether we are building the right product. Dynamic Testing also known as Validation Testing is the process of testing the actual product by going through the implementation part. Software Testing Techniques are Black Box and White Box Testing. Black Box testing tests the functionality of the application without looking at the internal code structure. White Box Testing tests the functionality of the application by looking at the internal perspectives, programming skills and design the testcases. [2] Testing is carried out at various levels like: Unit Testing, Integration Testing, System Testing and Acceptance Testing. Unit Testing involves testing the module in a project. Integration Testing involves testing the entire process as a collection of modules. There are different types of testing tools available for different types of testing in the market:[3]

1. **Automated Testing Tools:** Applicable for various types of testing. E.g. – Selenium, HPE Unified Functional Testing (QTP).
2. **Database Testing Tools:** Specific to database testing. E.g. – Data Factory, Mockup Data.
3. **Regression Testing Tools:** Specific to regression testing. E.g.- TestingWhiz, TestComplete.
4. **Browser Testing Tools:** Specific to browser testing. E.g. – BrowserStack, Browsershots.
5. **API Testing Tools:** Specific to the web services/API testing. E.g.- SOAPUI, Postman.
6. **Functional Testing Tools:** Specific to the functional testing. E.g.- Ranorex, Selenium, Test IO.
7. **UI Test Automation Tools:** Specific to UI testing.

This paper will focus on the different types of testing tools used in the IT industry, their use, advantages and the disadvantages of these tools and comparison of the performance of these tools. There are several reasons why Software Testing becomes important and significant part in the process of Software development: Cost effectiveness, Customer satisfaction, Security and Product Quality. The defects in the product need to be detected in the early stage of the development phase to make sure that the bug is fixed in cost effective way. Customer satisfaction is the most important goal of Software Testing. Security is an another most important part of testing. All the users of the product expect to use a secure product. Product Quality helps in strengthening

the reputation of the company by delivering the quality product according to the requirements. Thus, the Software Testing plays an important role in the process of Product Development.

Testing Types:

1. **Manual Testing-** Manual testing is the process in which the tests are executed manually by a QA analysts. It is performed to discover bugs in the software during the development phase of the product. In this type of testing the tester manually checks all the essential features of the software. The testers execute test cases without the use of any automation tools. It is a classical and a traditional way of testing a software.[15]
2. **Automation Testing-** In this type of testing the testers write a script to automate the test execution. The testers use automation tools to develop the test scripts and validate the software. This is the more modern way of testing a software which takes less amount of time. It allows you to run the repetitive tasks and regression tests without the need of a tester. The automation requires some manual effort to write the script.[15]

Manual Testing vs Automation Testing:[15]

Parameter	Automation Testing	Manual Testing
Exploratory Testing	Does not allow random testing	Allows exploratory testing
Initial investment	High	Low
Reliability	Reliable	Not reliable
UI Change	For trivial change in UI need to modify the script	Small changes would not modify the execution process
Investment	Investment of Tools	Investment of human resources
Test Report	Users can login in the system and check the test automation report	Users usually record the results in Word or Excel
Performance Testing	Performance Testing is usually performed by the automation testing tool	Performance testing is not performed by the manual tester
Parallel Execution	Parallel execution is possible	Require more human resource for parallel execution which is expensive.

Batch Testing	Batch Testing is possible	Batch Testing not possible
Programming Knowledge	Programming knowledge is a must	Programming knowledge is not a must
Setup	Requires less execution setup	Requires more execution setup
Framework	It uses Data Drive, Keyword, Hybrid to accelerate the process	It does not use any frameworks but may use guidelines, checklists, stringent processes to draft certain testcases

Thus, since there are many disadvantages of the manual testing since it involves the manual effort it is preferable to use the approach of automation testing.

Tools Used for Types of Testing:

1. **Automated Testing Tools:**
    1. **Selenium (Also known as Selenium Testing)-** Selenium is an automated testing suite for web applications across different browsers and platforms. It is not a single tool but a suite of software's. It consists of 4 components:
        - **Selenium Integrated Development Environment (IDE) (Also known as Selenium Recorder)** – It is a tool used to record, edit, debug and replay the functional tests. It is implemented as an extension to the Chrome and an addon in Firefox. With this plugin you can record and export tests in languages like Ruby, Java, PHP, JavaScript.[4]
        - **Selenium Remote Control (RC) –** Selenium Core was the first tool in the suite of tools. It was deprecated due to some issues related to the cross-domain testing because of the same-origin policy. So, the Selenium RC was introduced to resolve that issue. Remote Control has an HTTP proxy server which helps in befooling the browser into believing that both Selenium Core and the Web app are in same domain this removing the issue of cross-domain issue. The RC is divided into two parts which help in overcoming the cross-domain issue: Selenium Remote Server and Selenium Remote Client. But RC takes a lot of time communicating using the HTTP requests which is the reason it was not much in use.[4]
        - **WebDriver –** Every browser has a different driver. It accepts commands via client API and sends them to the browsers. The webdriver is a browser specific driver that helps in accessing and launching different browsers which provides an interface to write and run the automation scripts.[4]

- **Selenium Grid-** In this we can run parallel test sessions across different browsers. It is a hub-node architecture in which the Hub controls the Selenium scripts running on the different nodes and the test scripts running on different nodes can be written in any programming language. Nowadays people find Webdriver better than RC and Grid works with both RC and Webdriver.[4]

The architecture of the Selenium is as follows:

Core components of the Selenium library are as follows:

1. **Selenium Client Library** – Selenium supports different languages like Java, Ruby, Python, PHP, JavaScript, etc.
2. **JSON Wire Protocol over HTTP-** It is used to transfer the data from the server and a client on web. JSON wire protocol is a REST API that transfers the information between HTTP server.
3. **Browser Drivers-** They communicate with the respective browser without revealing the internal logic. When a browser driver receives any command then that command will be executed on the respective browser and the response will go back in the form of the HTTP response.
4. **Browsers-** Supports multiple browsers like Firefox, Chrome, IE, Safari, etc.

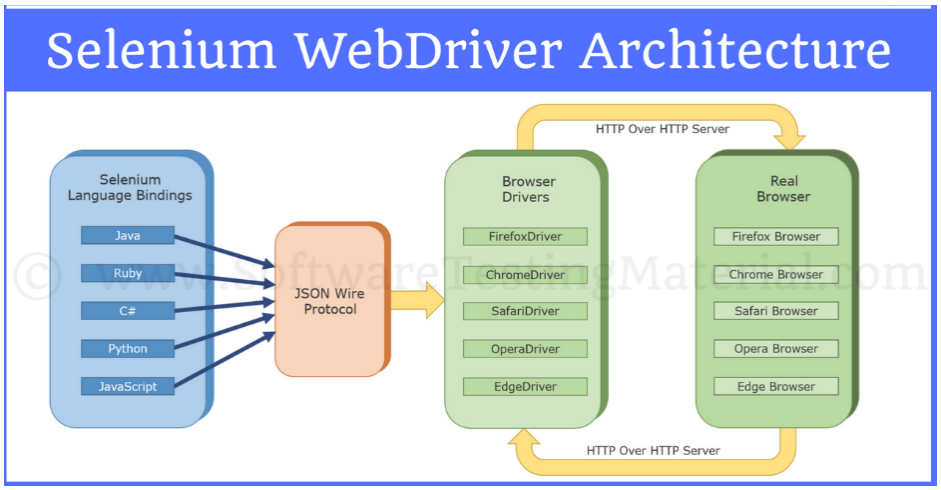


Fig.1: Architecture Of WebDriver[5]

How to choose the right Selenium tool:[19]

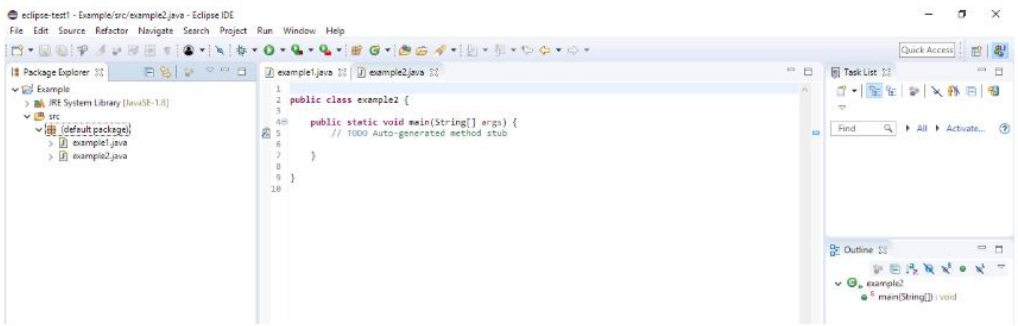
1. **Selenium IDE-** To learn about the concepts on automated testing and Selenium include:
    - Executing customized JavaScript using runScript.
    - Exporting test cases in various formats.
    - To create simple test cases and test suites that you can export later to RC or WebDriver.

- To test web application against Firefox and Chrome only.

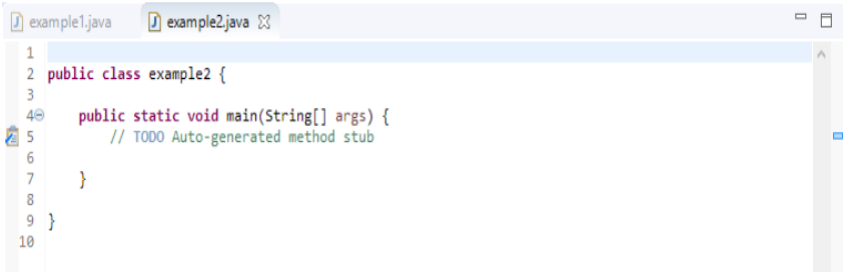
2. **Selenium RC-**
    - To design a test using a more expressive language than Selenese.
    - To run test against different browsers on different operating system.
    - To deploy test across multiple environments using Selenium Grid.
    - To test your application with complex AJAX based scenarios.
3. **WebDriver-**
    - To test applications that are rich in designing your test case.
    - To execute tests on the HTMLUnit browser.
    - To create customized test results.
4. **Selenium Grid-**
    - To run Selenium RC scripts in multiple browsers and operating systems simultaneously.
    - To run a huge test suite that needs to complete in soonest time.

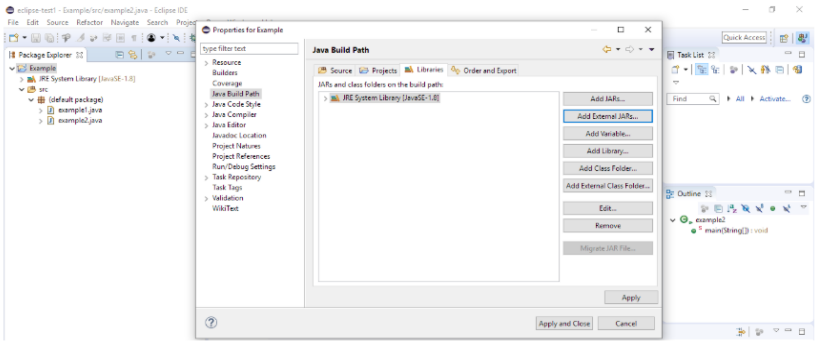
Steps to run the Selenium in our code:

1. Install Java and set the Java path through the environment variables and then install Eclipse IDE.
2. Create a new Eclipse project: Go to File->New->Project->Java Project. Give the project name and click on Finish. Now create a new class having the main method in the source(src) folder.



3. Download and configure the selenium jar files for the respective language. Right click on the project and select Properties and click Java Build Path and come to the Libraries tab. Click on Add External JARs and then select the jars and click on open.





4. Choose the browser to run.
5. Create a driver object based on your browser.
6. Set the system property of your browser and run your first program.

```
//invoke .exe file
System.setProperty("webdriverchrome.driver","C:\\Chromedriver.exe");
```

2. **Quick Test Professional-** QTP is a product of HP. QTP is an automated functional testing tool which allows the testers to perform the automated regression testing. Regression testing is important as some new changes in the software should not affect the existing functionality. It can be used by the technical and nontechnical tester.[6]

   The architecture of QTP is as follows:

   The components of the architecture are as follows:

   1. **AUT (Application Under Test)-** The application which is to be automated.
   2. **Object Repository-** It is a repository of objects from AUT.
   3. **General User Library-** It has a list of common functions. Any AUT can access the General User Library.
   4. **Business User Library-** It has application specific functions.
   5. **Test Data-** Data that is required for testing.
   6. **Environment Variables-** The global variables used by the Driver script.
   7. **Recovery Scenarios-** They are written to manage the unexpected error during execution.
   8. **Driver Scripts-** This is the main script where the logic is written for the automation.
   9. **Test Execution Report-** This report displays whether the script execution result is pass/fail.[7]

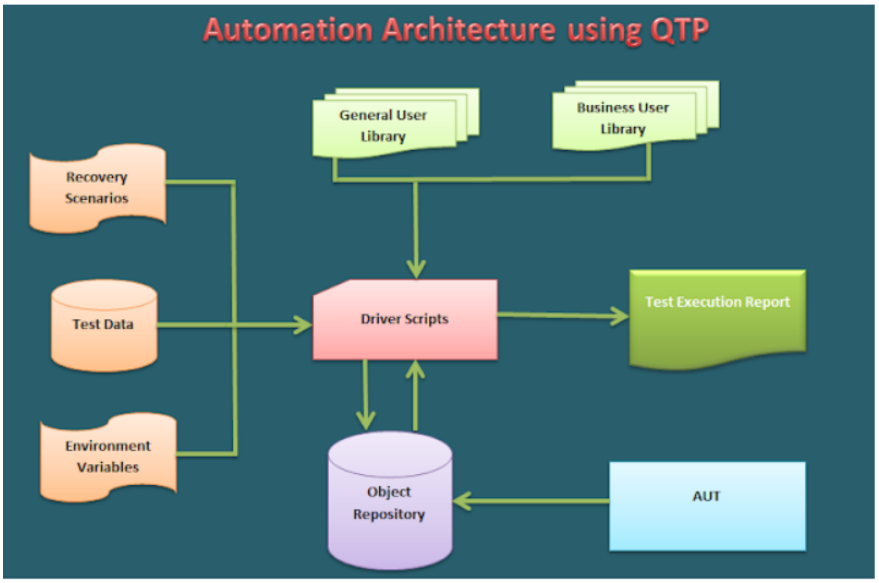
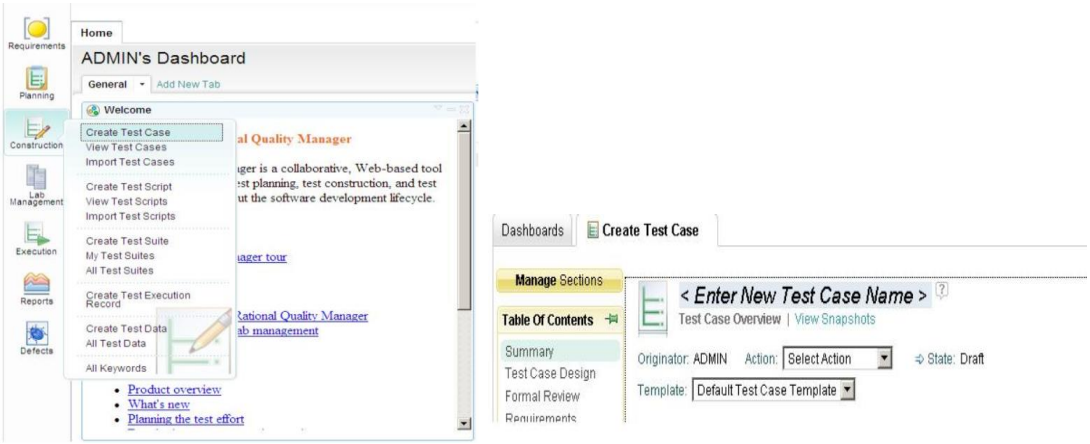


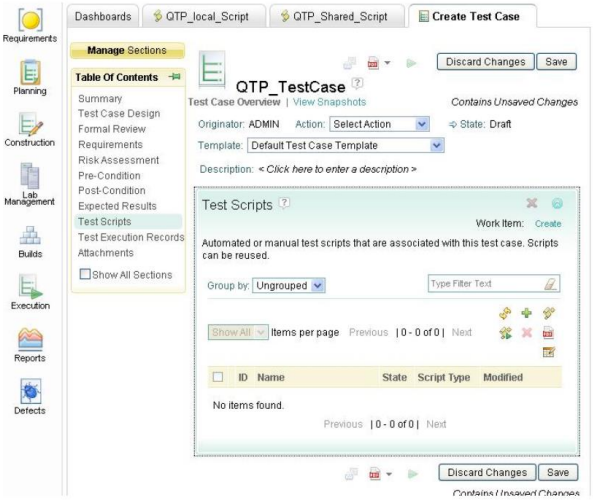
Fig.2: Automation architecture Of QTP[7]

Steps to use the QTP automation tool [8]-

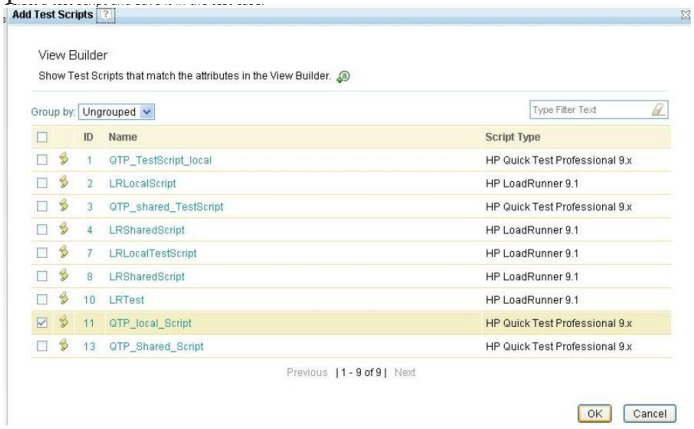
1. Download the QTP tool from the internet.
2. From the left sidebar, point to the construction icon and click “Create Test Case”. Enter the testcase name.



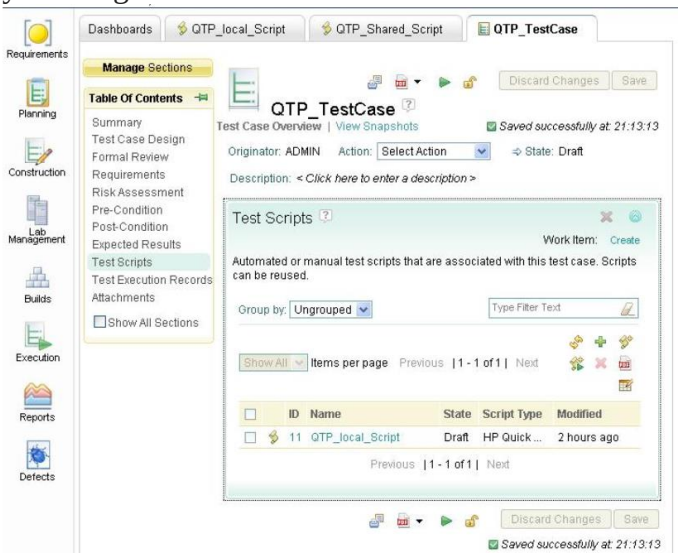
3. Select the tab of test scripts on the left side and add a test script



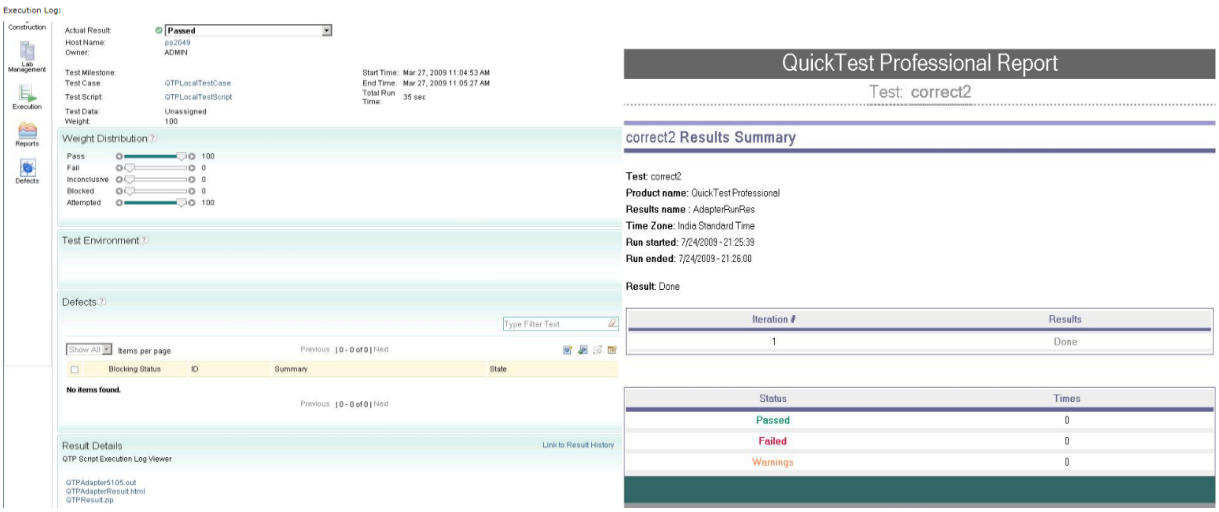
4. Select a test script and save it in the test case.



5. Execute the test case by clicking on “Run” icon.



6. Select a machine where we want to run the testcase and click on “Ok”.
7. The test results are shown as follows:



Advantages of QTP Automation:[6]

1. It supports record and playback.
2. It uses an active screen to record scripts and helps tester in referring the screen object properties.
3. It has an excellent object identification process or mechanism.
4. It supports different add-ins like Oracle, Java, SAP, NET, Web Forms, etc.
5. It allows you to enhance the existing tests even without the AUT through an active screen.
6. It is easy to maintain.
7. It supports popular automation frameworks- keyword driven testing approach, data-driven testing approach, etc.
8. Test reporting is possible.

Difference between Selenium and QTP:[13]

Features	Selenium	QTP
Programming Knowledge	Required	Required
Record and Playback	Selenium ID to be used	Can only be used in Internet Explorer
Cost	Free	License fee and fees for upgradation
Testing Applicability	Web based Apps	Client server and desktop applications
Cloud Ready	Can run simultaneous tests on different machines using different browsers	Cannot make use of distributed test execution via cloud based architecture
Execution Efficiency	Multiple test on a single machine	One test per machine
RAM & CPU	Less compared to QTP	More compared to Selenium
Browser Compatibility	Works with 4 browsers which QTP supports plus 5 more browsers	Works with 4 browsers
Language Compatibility	Java, Python, Perl, JavaScript, PHP	Microsoft Visual Basic
OS compatibility	Windows, Linux, OSX, Solaris, Android	Windows
Object Repository	Non editable	Called as Window Declarations. They can be edited from the editor
Test Case	Automation Scripts are written	Block of coding statements required
Functional Testing, Load Testing, Service monitoring from one test script	Not Available	Complex code required
Data Driven Testing	Requires extensive coding	Complex VB scripting required

Result Reporting	Basic reporting is done	They are stored in binary files with extension .res. They can be converted into different formats.
Defect management reporting	Not available	In built defect reporting
Test Management Integration	Not available. Need to track separately	TD/QC will be easily integrated
Scheduled Execution	Yes with complex code	Not available
Support Dialog Boxes	Supports partially	Supports all kinds of dialog boxes

According to my opinion, if the web based projects require the flexibility across OS, efficiency, RAM, and script languages at lowest cost and better performance then Selenium is the winner over the QTP. Inspite of so many pros and cons of Selenium provides the better payback and versatility over the medium.

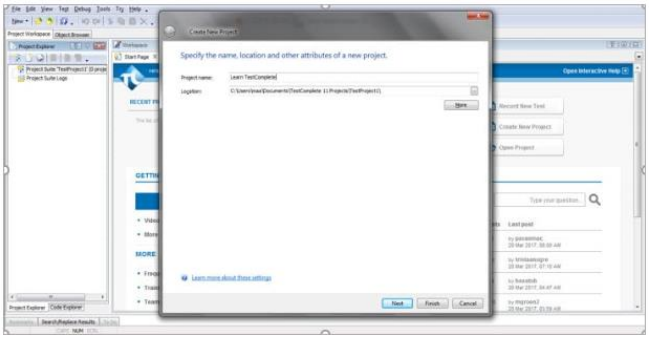
2. **Regression Testing Tools:**

Regression testing is a type of testing in which the software is tested to confirm that the changes in the program does not affect the existing features of a software.

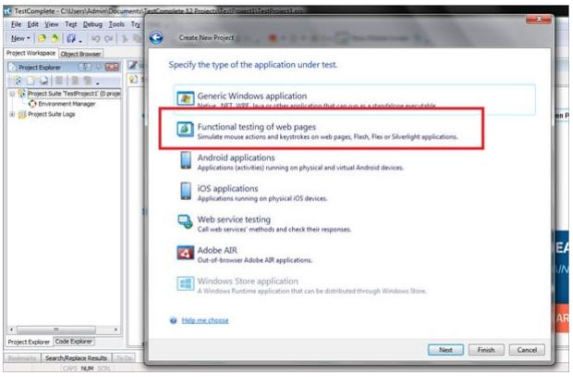
1. **Test Complete-** Test Complete is a regression testing tool that supports various languages like Java, HTML, Python, Visual Basic, Flash, etc. This tool offers a wide range of test automation capabilities like:
   1. Keyword Testing: Use of built-in keyword driven test can develop keyword driven frameworks.
   2. Scripted Testing: Testers can write the test scripts from scratch and modify the existing ones.
   3. Test Record and Playback: Provides the mechanism of record and playback for test creation.
   4. Integration to Bug Tracking Software: It integrates with various bug tracking software like Jira, Bugzilla, etc.
   5. Data Driven Testing: Easy data extraction from the CSV files, database tables and Excel sheets.
   6. Test Visualizer: Captures screenshots during test execution which helps to differentiate the expected output with the actual output.

   Steps to implement the TestComplete testcases:[9]

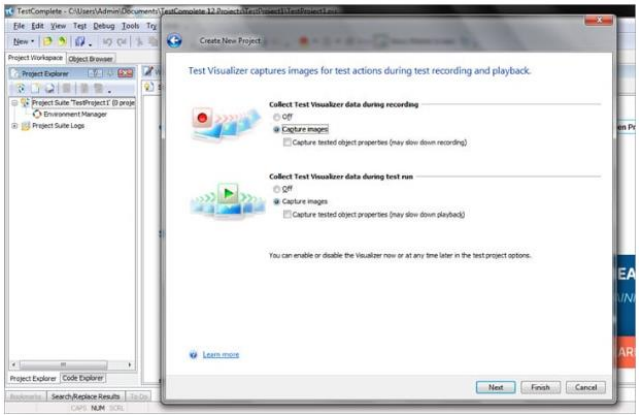
   1. Download the TestComplete software from the internet.
   2. Go to File-> New ->New Project->Give the project name and click on “Next”.



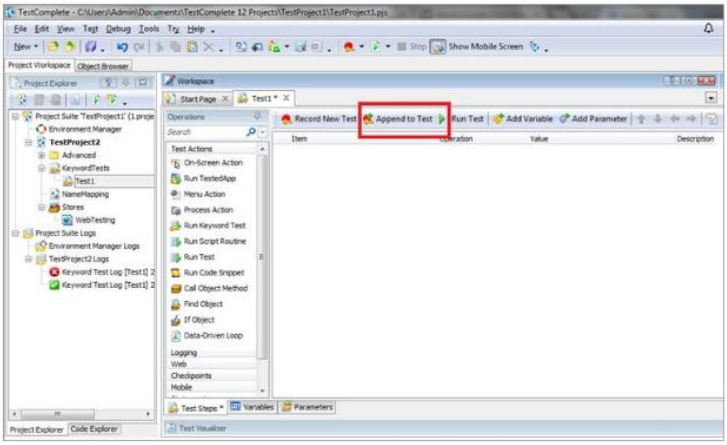
3. For testing a web-based application select “Functional Testing of web pages” and click “Next”.



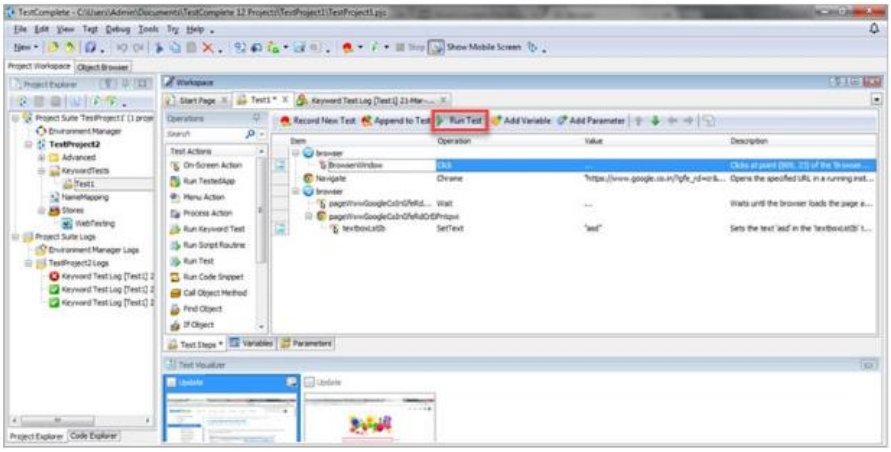
4. Once we have selected the platform a project creating wizard will take us to the Test Visualizer Page where we can enable/disable Test Visualizer functionality. Click on “Next”. Select the programming language and click “Ok”.



5. To record a web application click on “Append to Test”.



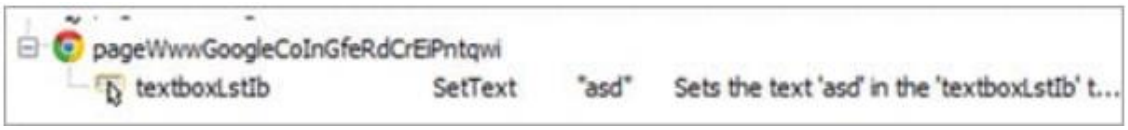
6. A recording panel will appear and indicates that the recording of the test has started. Launch the browser with the URL “www.google.com”. Click on “Stop” button to stop the recording. To playback the recorded test cases click on “Run Test”.



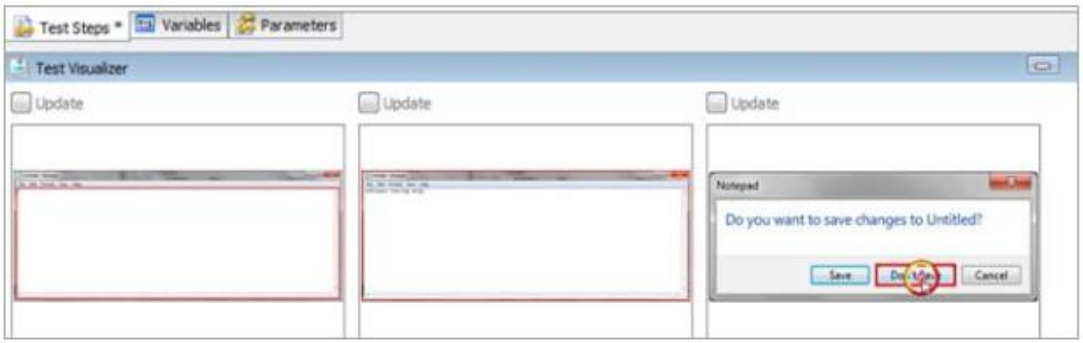
7. The run browser launches the browser.

This command waits for the page to load.

This command is used to set text in the Google search.



The following text is displayed after search.



2. **TestingWhiz-** Testingwhiz is an automation testing tool used for regression testing to test the web and cloud applications. It is an affordable solution based on a robust fast automation engine and is built on advanced technology which includes keyword driven and data driven techniques. [10]

Architecture of Testingwhiz:

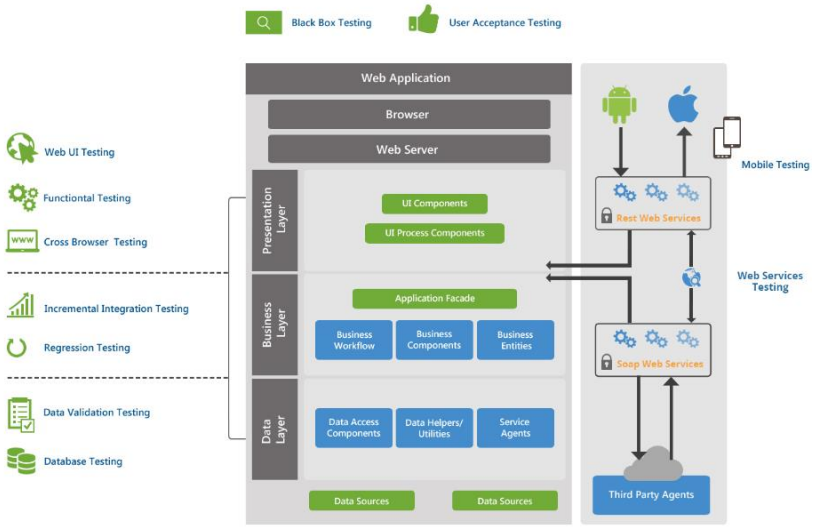
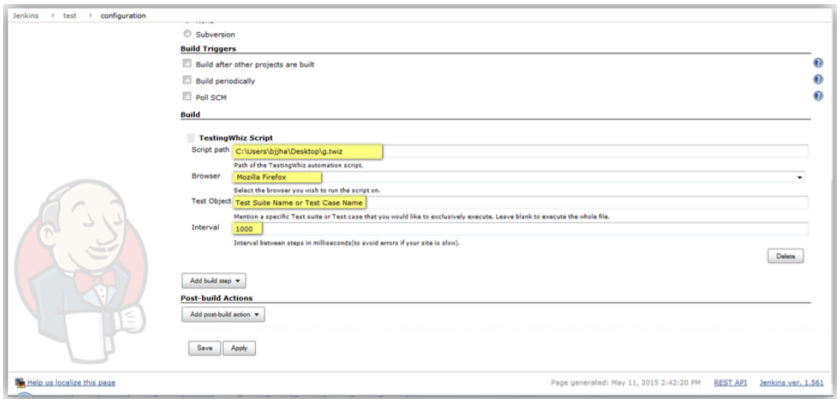


Fig.2: Testingwhiz architecture[11]

Testingwhiz is built over Java and Eclipse RCP as a platform. The layered architecture allows the QAs to test all layers of the software from presentation layer to middle layer to data layer. It integrates with continuous integration tools like Jenkins, Bamboo to support CI/CD philosophy. Testwhiz does Automate, Execute and Manage Test Cases Effortlessly & Efficiently. It also allows users to verify the critical functioning of their web applications and deliver efficient and effective web interfaces. Tool caters well to support Restful and Soapful web services and hence it allows extended architecture layer testing for applications residing on cloud infrastructure or any third party applications. [11]

Steps to execute the test script via Jenkins plugin: [12]

1. Download the Testingwhiz Jenkins plugin from Testingwhiz download page. Place the plugin file in the .Jenkins home directory. Start the Jenkins server and access in the browser.
2. Build a Free style project.
3. Click on the “Add Build Step” and select Testwhiz script.
4. Enter the server address where the Testingwhiz server is running (http://ipaddress:5050/). Specify the Base URL in the format(http://host:port/). Specify the absolute path where the test scripts are stored to execute. Specify the browser where you want to run the test scripts.
5. Enter a specific Test suite or Test case to exclusively execute the Test Object column or leave it blank to execute the entire script.
6. Specify the time interval between two steps that is to be performed while execution. Specify the minimum time taken by any test case to execute.
7. Tools and then Start Server.
8. The test script is ready to be executed via Jenkins server.



Difference between Test Complete and Testingwhiz:

Features	Test Complete	TestingWhiz
Platforms Supported	Windows, Mac, SaaS, iOS, Android	Windows, Mac, iOS, Android
Cost	Free	Pay for license
Requirements	Meets requirements more accurately than Testing whiz	Meets requirements less accurately than Test Complete
Ease of Use	Difficult to use	Easy to use
Ease of Setup	Easy to setup	Difficult to setup
Ease of Admin	Difficult	Easy
Quality of Support	Less support compared to the Testing whiz	More support as compared to the Test Complete
Execution Speed	Very High compared to TestingWhiz	Low as compared to Test Complete

Thus according to me, considering the execution speed, cost, Setup, platforms supported the Test Complete wins over the TestingWhiz.

3. Functional Testing Tools:

The functional testing is the process of testing a software product with respect to the requirements of the software product.

1. **Ranorex-** It is a powerful too, to automate tests for web applications, standalone and mobile applications. It supports all the technologies like .Net, Java, Flex, HTML can be used for different browsers like IE, Chrome, Firefox and mobile applications like Android, iOS. The main component of this tool Ranorex Studio, which includes the Ranorex Recorder, object repository, Ranorex Spy, code editor, and debugger in a single environment.[16]

   Architecture Of Ranorex:[17]

   TeamCity Build Agent- It consists of the server and a many build agents which run build and makeup a build grid. The server only distributes the tasks of building the software with new code

changes on the company's build grid and provides the web UI. The job of building and executing the test cases is done by the build agents.

Version Control System- Team City integrates with a number of most frequently used Version Control Systems from which it obtains the source files to create the builds.

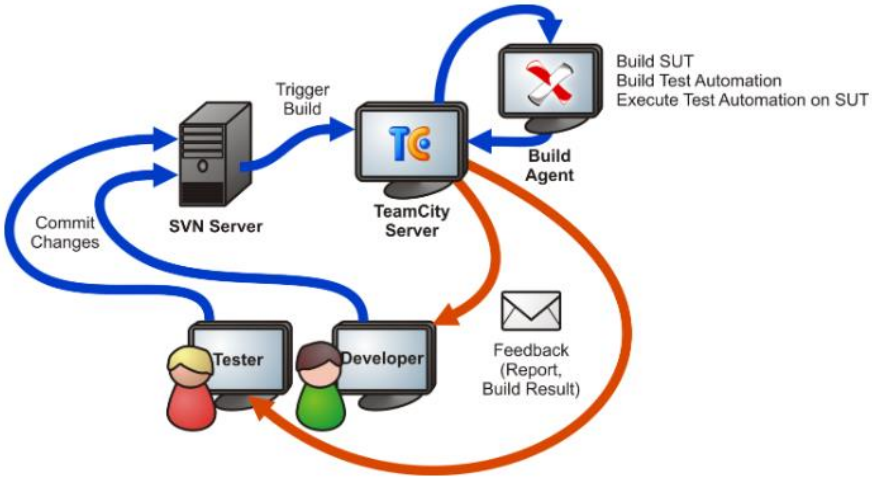
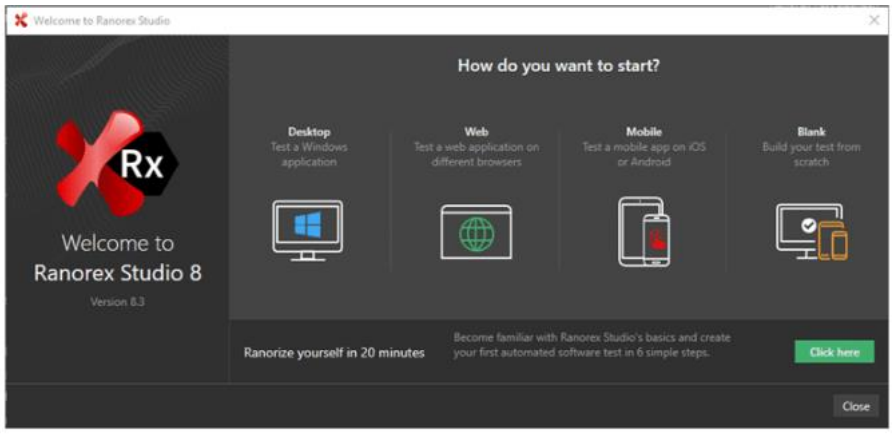


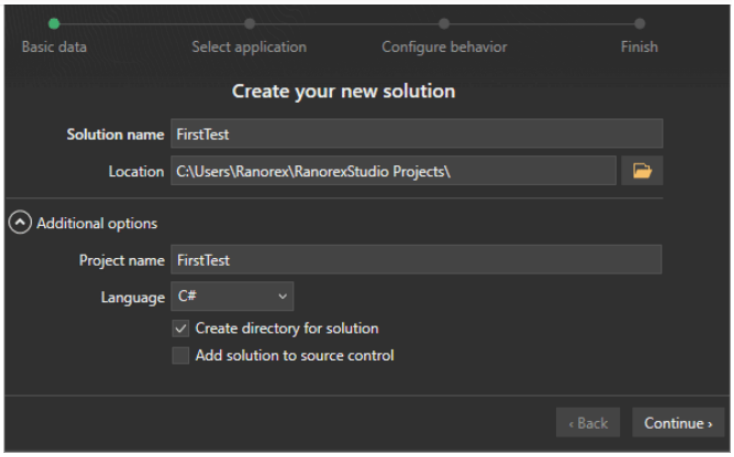
Fig.3: Architecture of Ranorex

Steps to execute a test case on Ranorex-[16]

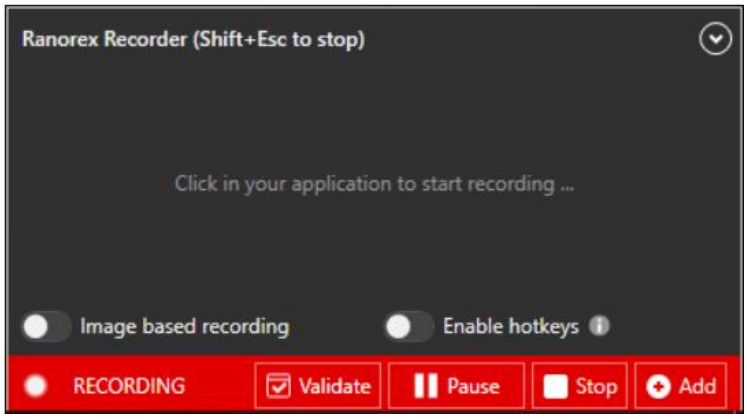
1. Download the Ranorex tool from the internet.
2. Click on "New test solution".
3. Choose the type of application(Desktop, Web, Mobile, Blank).



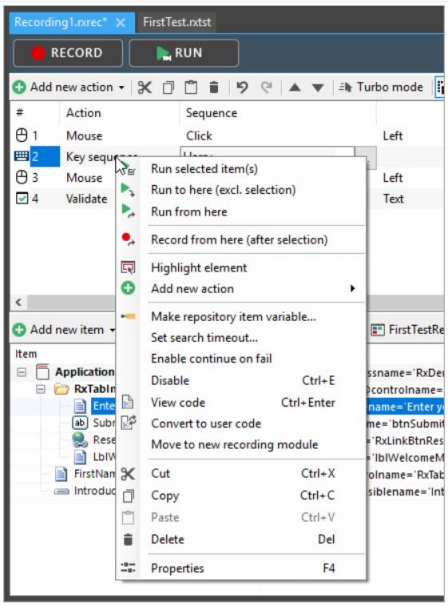
4. Enter the name of the test solution and choose appropriate path to save the solution files and click "Continue". Choose the application under test from the list of running applications. Choose the option from the "Focus on single application", "Focus on multiple applications", "No focus applied".



5. Double click on “Recording1” module file. Click on “Record” to start recording.
6. Perform the test actions by clicking on the UI elements. Once all actions are completed click on the “Stop” button in the recorder. Now the recording module is populated by the actions performed.



7. A range of options to modify each step are available to modify each step. It can be done by right clicking on that particular step.



8. To play the test click on “Run” button in Test suite.

Difference between Ranorex and Selenium:[18],[13]

Parameters	Ranorex	Selenium
Configuration	Easy	Difficult
Cost	It is licensed	It is opensource
Cross-platform	Windows	Windows, Linux, Unix, Mac
Support service	Yes	No
Test Capability	Desktop, Web and mobile applications	Web Applications
Modularization	It has easy modularization	It doesn’t have such features it don’t have click and go features and thus needs OOPS knowledge to function
Recording	Has recording option and has action table	Has recording option but action table is missing
GUI Repository	Yes	No
IDE Extension	No	Yes
Spy tool extension	Yes	No
Parallel Test execution	Yes	No
Ease of maintenance	Yes	No
Scripting Language	No specific scripting language. It is usually written in .Net using VB.Net, Python	
Programming Knowledge	Not Required	Required

Thus, according to me, Ranorex is a better functional testing tool over Selenium since it has more positives over Selenium in terms of applications support, support, configuration, etc.

Conclusion: Thus, this paper covered what is testing, why is testing required, how testing is performed, different types of testing, tools used for different types of testing and their comparison. In the automation testing, Selenium is the winner over QTP for some more positives over QTP. In the regression testing,

TestComplete is the winner over Testingwhiz because of it's unique features. In the functional testing, Ranorex is the winner for it's better features.

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