

# Software Testing Tools & Techniques for Web Applications

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**Abstract**— The testing of software is important to determine its quality. Testing typically consumes 40-50% of development efforts. It is an important part of the software development life cycle. Testing is a process of analyzing software to find the differences between existing and required conditions i.e. defects and to evaluate features of that software. Testing is evaluation of a system or its component(s) to find whether it satisfies the specified requirements of system or not. Testing is executing a system identify gaps, errors according to the actual requirements. There are lots of testing techniques and tools are available to complete the task. In this paper, various testing techniques and tools are described.

**Index Terms**— Software testing, Testing Methodology, Levels of Testing, Testing Tools

## I. INTRODUCTION

Software testing is important activity in Software Development Life Cycle. Software testing is assessing the functionality and correctness of software by execution. Software Testing is an important means to determine quality of software. [2]. The IEEE definition of testing is "the process of evaluating a system by manual or automated means to check that it satisfies requirements or to find out differences between expected and actual results." [6]. Software testing is a technique whose aim is to evaluate attributes or capability of software and determine that it meets its quality. Software testing also checks for other quality factors like reliability, security, capability, portability, maintainability etc [7]. In the real world, the various type definitions about software testing, but one can shortly define that as: A process of executing a software program with the goal of finding errors [5].

Software testing is not a "silver bullet" who guarantees the production of high quality software. While a "correct" correctness which tells that software will always operate in a given manner, software testing which is not fully correct can only suggest the presence of errors and cannot prove their absence. Moreover it is impossible to completely test an application because (1) the domain of program inputs is too large, (2) there are too many possible input paths, and (3) design and specification issues are difficult test. [11] Software testing is an important phase of Software Development Life Cycle. There are three different testing phases in SDLC are:

- i. Test Analysis:* tester tries to understand about the project.
- ii. Test Design:* tester design the test cases based on user requirement.

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- iii. Test Execution:* tester executes the test cases and raise defects, if any [10].

### Verification & Validation

These two terms are very confusing and interchangeable. The differences between verification and validation are.

- A. *Verification:* Ensures that the software meet all the functionality. Verification takes place first and checks for documentation, code. Verification is like: "Are you building it right?" It is done by developers.
- B. *Validation:* Ensures that the functionality meet the intended behavior. Validation process start after verification and it involves checking the overall product. Validation is like: "Are you building the right thing?" It is done by testers.

## II. TYPES OF TESTING

- A. *Manual Testing:* Manual testing includes testing software without using any automated tool. Tester takes the role of a user and tests to identify any error or bug. Testers use test plans, test cases to ensure the completeness of testing. Manual testing also use exploratory testing because testers explore the software to identify errors in it.
- B. *Automation Testing:* Automation testing is that in which tester uses software to test the product. Automation Testing is used to re-run the test cases or scenarios that were performed manually [8]

## III. TESTING METHODOLOGY

There are 3 methods of testing a software or application:

Black Box Testing	White Box Testing	Grey Box Testing
Black box testing is based on the requirements specifications. In Black box testing, there is no need to examine the code.	White box testing is based on the structure of code. It mainly focuses on internal logic.	Gray-box testing combine benefits of both black-box and white-box testing. It takes straightforward approach of black-box testing, but limited knowledge of the inner workings of the application.
It is done on the bases of customers view point only	This is done when the tester has full knowledge on the program structure.	This is done on the basis of high-level database diagrams and data flow

In this tester knows the set of inputs and predictable outputs.	In this, it is possible to test every branch and decision in the program	diagrams. In this tester can verify both the output of the user interface and also the process. It can be applied to most testing phases; however it is mostly used in integration
It is also known as closed-box testing or functional testing.	It is also known as clear-box testing or code base testing	It is also known as clear testing, as the tester has limited knowledge.
This is performed by end-users and also by testers and developers.	This is performed by testers and developers.	This is performed by end-users and testers and developers.

Conceptual Difference among Three Types of Testing

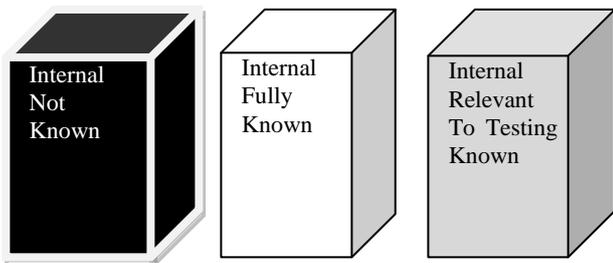


Fig (1): Software testing methodologies

IV. TESTING LEVELS

Software is broken into multiple smaller units for the ease of the development process and easily checks the progress and reduces the chances of failures during process. Development of software done by different levels starting from creation of units, unit's integration and then complete system development [4]

A. Functional Testing: This is a type of black-box testing that is based on the specifications which has to test. Functional testing of software is done when the whole system is ready to check the system's performance with respect to its specified requirements [8]

o Unit Testing: It is done at the lowest level. It tests the basic unit of software, which can be a module or component. Unit is the smallest module i.e. smallest set of lines of code which can be tested. Unit testing is first level of testing which contribute in testing a whole system [1].

o Integration Testing: After unit testing, modules are integrated to form the complete software package. Integration testing is systematic technique for verifying the software [4].Involves building a system from its components and testing it for problems that arise from component interactions.

o Top-down integration: Develop the skeleton of the system and populate it with components.  
o Bottom-up integration: Integrate units then add functional components. [3]

o System Testing: After all the modules are combined and tested, system testing is started. Its aim is to check the software which is developed that it meets its requirements laid out in the SRS document [4]. System testing of software is conducted on a complete, combined system to check the system's compliance with its specified requirements.[7]

o Regression Testing: It is to be done to software that was previously working correctly and stops working as intended due to changes [9]. Whenever a change in a software application is made, it is quite possible that application have been affected by this change. Regression testing is done to check that a fixed error hasn't affected functionality [8].

o Acceptance Testing: Formal testing with respect to user needs to determine the acceptability of the system [10].It involves running a suite of tests on the completed system [9].

o Alpha Testing: Alpha testing is a type of acceptance testing carried out at developer's site by users [14]. Alpha testing is the system testing performed by the development team [4].

o Beta Testing: Beta testing is the system testing performed by the customer himself after the product delivery to determine whether to accept the delivered product or to reject it [4]. Beta testing carried out by real users in real environment [10].

B. Non-functional Testing: Non-functional testing involves testing those requirements which are not functional in nature but which are important like performance, user interface, security etc [8].

o Performance Testing: It is the testing which refers to the assessment of the performance of a human examinee.[9] It is mostly used to identify any bottlenecks or performance issues rather than finding bugs in a software.

There are different causes to lower the performance of software:

- ❖ Network delay
- ❖ Client-side processing
- ❖ Database transaction processing
- ❖ Load balancing between servers

Performance testing is important and compulsory testing type due to following aspects:

- ❖ Speed
- ❖ Capacity
- ❖ Stability
- ❖ Scalability

Performance testing can either be qualitative or quantitative. It can be further divided into two types which are: Load testing and Stress testing [8].

- *Load Testing*: It is the testing which conducted to evaluate the compliance of a system with specified performance requirements [15]. Testing an application under heavy loads i.e. testing of a web site under a range of loads to check that system response time degraded or fails [3].
- *Stress Testing*: Testing is done under heavy loads, repetition of some actions or inputs, input can be of large numerical values or complex queries to a database etc [3]. This testing is done to check a system or component at or beyond the limits of its specified requirements to check that it fails under which load [15].
- *Security Testing*: Security testing involves testing software in order to identify any flaws and gaps from security and vulnerability point of view. The main aspects that security testing should ensure:

- ❖ Confidentiality
- ❖ Integrity
- ❖ Authentication
- ❖ Availability
- ❖ Authorization
- ❖ Non-repudiation [8]

## V. TESTING TOOLS

The Software Engineering Tools and Methods Knowledge Area include both the software development environments and the development methods knowledge areas identified in the simple Man version. Software development environments are the computer based tools that are intended to assist the software development process. Tools allow repeated, well-defined actions to be automated, which reducing the load on the software engineer. The engineer is then free to concentrate on the creative aspects of the process. Tools are often designed to support some methods, to reduce the administrative load with applying the method manually. They are used to make development systematically and they vary in scope from supporting particular tasks to encompassing the complete life cycle. [13]

## VI. WEB APPLICATION TESTING TECHNIQUE AND TOOLS

Web applications are the software which are growing fast now days. Web applications are used by various activities these days. Web applications are developed at huge rate and even helped in fast adoption but quality of the software is decreased. That is why that it has become essential to test the web applications. For the web based application to be used widely and successfully by users, testing methods which are used must be flexible. It should be able to handle the dynamic nature of web application.

The testing of web based applications includes testing of its functionality and configuration. It includes checking for the errors in web application as compared to the faults in software. The numbers of issues are observed between testing

of traditional software and web application. Some of them are as follows:

- Web applications typically undergo maintenance at a faster rate than other software systems.
- Web applications are used by huge number of people, due to which there is high demand for the good performance of server and the ability to deal with number of transaction at a time. [12]

The types of testing which are performed to test web applications are described below.

- A. *Functionality Testing*: It test for links which are present in web pages, connectivity with database, forms that are used in the web pages for getting or submitting information from user and testing for Cookies.[17]  
*Tools which are used for functional testing of web application are: QTP, Selenium, and IBM Rational [8]*
- B. *Usability Testing*: Usability testing has become a important part of any web application now. Usability testing is carried out by testers to the target the audience of the web application.[16]  
*Tools which are used to test usability testing of any web application are: Clippy, Feedback Army, Chalkmark, and Clicktale [8].*
- C. *Interface Testing*: In interface testing, there are three areas which has to be tested –
  - i. *Application*: Test whether the requests sent to the Database correctly and output is displayed correctly at the client side. If there is any error in the application, it should only be shown to the administrator
  - ii. *Web Server*: It test whether all the request of application is handled without any delay.
  - iii. *Database Server*: It checks that queries sent to the database give same results which were expected.  
*Tools which are used for interface testing of web application are: Ranorex, AlertFox [8]*
- D. *Database Testing*: In database testing, tester checks integrity of data and find errors when we add, delete, modify the forms or any functionality related to database.[17]  
*Tools used for database testing of a web application are: QTP [8]*
- E. *Compatibility Testing*: In compatibility testing, tester checks all function of application with different browser, security profile settings, operating systems, and hardware devices to check the correctness of Web application. [16]  
*Tools used for compatibility testing of web application are: NetMechanic*
- F. *Performance Testing*: Performance testing includes: Web Load Testing, Web Stress Testing.

In web load testing tester test if many users are accessing the same page. Can system will work in heavy load that time? Web application should handle many user

requests same time, accept large amount of data from different users, and connection with database different users simultaneously, heavy load on some particular pages etc.

In Stress testing: Stress means stretching the system beyond the limits which it can have. Stress is given to break the site and check whether how system reacts to that stress and even how system recovers from this type of crashes. Stress is mostly given on fields of input, login and sign up pages. [17]

Tools used for performance testing of web application are: Loadrunner, JMeter

G. Security Testing: In security testing, tester checks URLs of different operations in application without logging. Test the authentication by putting false user name and password. Tester checks for X.509 security certificates on Web pages of application which are secure. Checks the application for various function with invalid type input fields and text fields.[16]

Tools used for security testing of web application are: Babel Enterprise, BFBTester and CROSS

### VII. JMETER

JMeter is an Open Source software for testing. It is Java application for load and performance testing. JMeter is designed for these testing types like load, functional, performance, regression, etc., and it requires JDK 5 or higher [18].

The protocols which are supported by JMeter are as follows

- Web – HTTP, HTTPS sites 'web 1.0' web 2.0 (ajax, flex and flex-ws-amf) ·
- Web Services – SOAP / XML-RPC ·
- Database via JDBC drivers ·
- Directory – LDAP ·
- Messaging oriented service via JMS ·
- Service – POP3, IMAP, SMTP · FTP Service.[19]

Following are some of the features of JMeter –

- It has a simple and intuitive GUI.
- It is a platform-independent tool. On Linux/Unix, JMeter can be invoked by clicking on JMeter shell script. On Windows, it can be invoked by starting the jmeter.bat file.
- It has full Swing and lightweight component support.
- JMeter store its test plans in XML format. This means you can generate a test plan using a text editor.
- Its full multi-threading framework allows concurrent sampling by many threads and simultaneous sampling of different functions by separate thread groups.
- It can also be used to perform automated and functional testing of the applications.[19]

JMeter simulates a group of users sending requests to a target server, and returns statistics that show the performance/functionality of the target server/application via tables, graphs, etc.

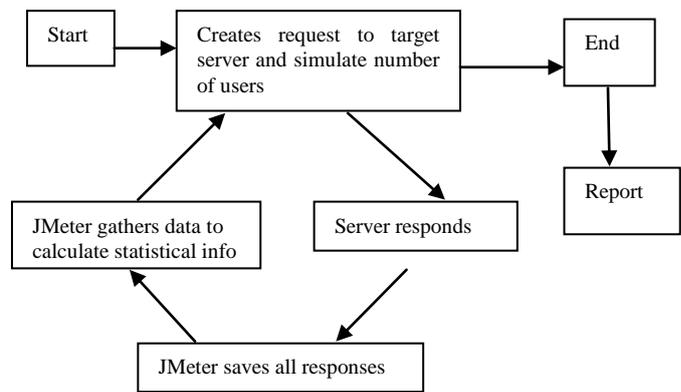


Fig (2): Working Of JMeter

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