Testing Web-based Systems

Prof. Durga Prasad Mohapatra
Professor
Dept.of CSE, NIT Rourkela

What is Web-based System?

- Web-based software systems consist of a set of web pages and components that interact to form a system which executes using web server(s), network, HTTP, and a browser, in which user input affects the state of system.
- These are typical programs that operate on the Internet, interacting with the user through a browser.

Some related terms

- **Web page:** The information that can be viewed in a single browser window.
- **Website:** A collection of web pages and associated software components that are related semantically by content and syntactically through links and other control mechanisms. They can be dynamic and interactive.

Some related terms   cont …

- **Web application:** A program that runs as a whole or in part on one or more web servers and that can be run through a website.
- Web applications need the presence of a web server in simple configuration or multiple servers in more complex settings.
- Such applications are called web-based applications.

Some related terms   cont …

- Similar applications, which may operate independent of any servers and rely on operating systems services to perform their functions, are termed web-enabled applications.
- Now a days, with the integration of technologies for development of such applications, there is a thin line separating web-based and web-enabled applications.
- So, they are collectively referred to as web applications.

Traditional software vs. web-based software

- Web systems are based on the client-server architecture wherein a client typically enables users to communicate with the server.
- Therefore, these systems share some characteristics of client-server architecture.
- However, there are a number of aspects of web systems that necessitate having the different techniques to test them.

Traditional software vs. web-based software cont…

‣ Clients of the traditional client-server systems are platform-specific.
  ◦ This means that a client application is developed and tested for each supported client operating system.
  ◦ But the web client is operating within the web browser's environment.
  ◦ Web browsers already consist of operating system-specific client software running on a client computer.
  ◦ But these browsers need to support HTML, as well as active contents to display web page information.

Traditional software vs web-based software cont …

  ◦ For this purpose, browser vendors must create rendering engines and interpreters to translate and format HTML contents.
  ◦ In making these software components, various browsers and their releases introduce incompatibility issues.

Traditional software vs web-based software cont…

‣ Web-based systems have a more dynamic environment as compared to traditional client-server systems.
  ◦ In client-server systems, the roles of the clients and servers and their interaction are predefined and static as compared to web applications, where client side programs and contents may be generated dynamically.

Traditional software vs web-based software cont…

  ◦ Moreover, the environment for web applications is not predefined and is changing dynamically i.e. hardware and software are changing, configuration are ever-changing, etc.
  ◦ Web applications often are affected by these factors that may cause incompatibility and interoperability issues.

Traditional software vs web-based software cont…

‣ In the traditional client-server systems, the normal flow of control is not affected by the user.
  ◦ But in web applications, users can break the normal control flow.
  ◦ For example, users can press the back or refresh button in the web browser.

Traditional Software vs web-based software cont…

‣ Due to the dynamic environment, web systems demand more frequent maintenance.
‣ The user profile for web systems is very diverse as compared to client-server systems.
  ◦ Therefore, the load on web access due to this diversity is not predictable.

Challenges in Testing for Web-based Systems

- Diversity and Complexity
- Dynamic environment
- Very short development time
- Continuous evolution
- Compatibility and interoperability

Types of Testing for Web-based Systems

- Interface Testing
- Usability Testing
- Content Testing
- Navigation Testing
- Configuration/Compatibility Testing
- Security Testing
- Performance Testing

Interface Testing

- Web model must be checked to ensure all interfaces.
- Interface between client and server
- Two interfaces on server side :
    Web server and application server interface
    Application server and database server interface
- Check for error messages, roll backs
- Errors must be cached, handled, and displayed

Interface Testing   cont..

- Check for :
  ◦ The user interruption in between transactions

  ◦ Connection to the web server is reset in between

  ◦ Compatibility of the server with software, hardware, network, and data base.

Usability Testing

- We can lose users because of a poor design.
- It is not a functional testing
- The web application is reviewed and tested from a users point of view
- Take help from use case diagrams

Usability Testing   cont …

- Check that form controls such as boxes and buttons are easy to use, appropriate to the task, and provide easy navigation for the user.
- Check Spelling errors
- Check the misleading links

Usability Testing   cont…

▸ For validation, perform a scenario based usability testing with the help of use cases
▸ Take help from end users :
  ◦ In form of a questionnaire
  ◦ As they use, answer, and give feedback

Content Testing

▸ The content seen on the web pages has a strong impression on user.
▸ Affects the next visit to web page.
  ◦ If these contents are not satisfactory to him, he may not visit the web page again.

Content Testing   cont …

▸ Check the web application contents(input fields) for :
  ◦ Completeness(existence)
      Check that certain information is available on a given web page, links between pages exist or even check the existence of the web pages themselves.
  ◦ Correctness(semantics)
      Web application content may need to be checked against semantic conditions to see if they meet the web document.
  ◦ Validation on each field for :
      ➢ specified lengths
      ➢ mandatory fields
      ➢ default values
      ➢ wrong inputs

Content Testing   cont …

▸ Therefore contents should be
  ◦ Correct
  ◦ Visible
  ◦ Flexible to use
  ◦ Organized
  ◦ Consistent

Content Testing   contd…

▸ This type of testing targets the testing of static and dynamic contents of web application
▸ Static contents can be checked as part of verification.
▸ For instance, forms are the integral part of any web site.
▸ Forms are used to get information from users and to keep interacting with them.

Content Testing   cont…

▸ First check all the validations on each field.
▸ Check for the default values of fields and also wrong forms if any, form delete, view or modify the forms must also be checked. inputs to the fields in the forms.
▸ Options to create forms if any, form delete, view or modify the forms must also be checked.

Content Testing   contd…

Static testing may consider the following points
- Various layouts.
- Check forms for their field validations, error message for wrong input, optional and mandatory fields with specified length, buttons on the form, etc.
- For tables, check that actually a table is present and has the expected number of rows & columns and the pre-defined properties.

Content Testing   cont…

- Grammatical mistakes in text description of web page.
- Typographical mistakes.
- Content organization.
- Content consistency.
- Data integrity and errors while you edit, delete, modify the forms.

Content Testing   cont…

- Content accuracy and completeness.
- Relationship between content objects
- Text contents
- Text fragments against formatting expectations.
- Graphics content with proper visibility.

Content Testing   cont…

- Media contents to be placed at appropriate places.
- All types of navigation links like internal links, external links, mail links, broken links to be placed at appropriate places.
- All links on a web page are active.

A check list for content verification may be prepared.

Content Testing   cont…

- There may be dynamic contents on a web page also.
- Largely dynamic testing will be suitable in testing these dynamic contents.
- These dynamic contents can be in many forms.
- One possibility is that constantly changing contents are there, e.g. weather information web pages or online news paper.
- Another case may be that web applications are generated dynamically from information contained in a data base or in a cookie.

Content Testing   cont…

- Many web applications work interactively in a manner, that in response to a user request for some information,
  - interact with some DBMS,
  - extract the relevant data,
  - create the dynamic content objects for this extracted data and
  - send these content objects to user for display.
- In the same manner, the information can be generated dynamically from cookies also.

Content Testing   cont…

- The problem in the design of these dynamic contents is
  - that there may be many errors due to its dynamic behviour.
- Therefore, testing of these dynamic contents becomes necessary to uncover the errors.
- Changing contents on a web page must be tested
  - whether the contents are appearing every time in the same format.
  - Moreover, there is consistency between the changed content and static content.

Content Testing   cont…

- Test all database interface-related functionalities for all dynamic content objects.
- Check
  - if all the database queries are executing correctly,
  - data is retrieved correctly, and
  - also updated correctly.
- Load testing or performance testing can also be done on database.

Content Testing   cont…

- Cookies are small files stored on the user machine.
- These are basically used to maintain the session, mainly the login sessions.
- The testing of the entire interface with these cookies must also be tested.

Content Testing   cont…

- Test the application by enabling or disabling the cookies in browser options.
- Test if the cookies are encrypted before writing to user machine.
- Check the effect on application security by deleting the cookies.

Summary

- Discussed the terminologies associated with testing of web-based applications.
- Explained the differences between traditional software vs. web-based software.
- Presented the challenges in testing of web-based Systems.
- Discussed the following types of testing for web-based systems:
  - Interface Testing
  - Usability Testing
  - Content Testing

References

1. Naresh Chauhan, Software Testing: Principles and Practices, (Chapter – 15), Second Edition, Oxford University Press, 2018.

Thank You

Testing Web-based Systems   *cont …*

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Navigation Testing

▸ Navigation testing is performed on various possible paths in web applications
  ◦ to ensure the functioning of correct sequence of navigations
▸ Design the test cases such that the following navigations are correctly executing :
  ◦ Internal links & External links
  ◦ Redirected links (the redirected links should be with proper messages displayed to the user)
  ◦ Navigation for searching inside the web application

Navigation Testing   *cont…*

▸ The errors must be checked for the followings:
  ◦ The broken links (the links should not be broken due to any reason).
  ◦ The proper redirected links with proper messages displayed
  ◦ Ensuring whether all possible navigation paths active and relevant or not.
  ◦ The navigations for the back and forward buttons, and their proper working

Configuration/Compatibility Testing

▸ Diversity in configuration for web applications makes the testing of these systems very difficult.
▸ There may be various types of :
  ◦ Browsers supporting different operating systems
  ◦ Variation in servers
  ◦ Networks, etc.

Configuration/Compatibility Testing   *cont …*

▸ Therefore, configuration testing becomes important so that there is compatibility between various available resources and application software.
▸ The tester must consider these configurations and compatibility issues
  ❑ so that they can design the test cases incorporating all the configurations.

Configuration/Compatibility Testing <small>cont …</small>

Some important points for configuration testing:
- There are a number of different browsers and browser options.
  - ◦ The web application has to be designed to be compatible for majority of the browsers.

Configuration/Compatibility Testing <small>cont …</small>

- The graphics and other objects on a website have to be tested on multiple browsers.
  - ◦ If more than one browser will be supported,
    then the graphics have to be visually checked for differences in the physical appearance.
  - ◦ Some of the things to check are
    - ✓ centering of objects,
    - ✓ table layouts,
    - ✓ colours,
    - ✓ monitor resolution,
    - ✓ forms and
    - ✓ buttons

Configuration/Compatibility Testing <small>cont …</small>

- The code that executes from the browser also has to be tested.
  - ◦ There are different versions of HTML.
  - ◦ They are similar in some ways
    but they have different tags which may produce different features.

Configuration/Compatibility Testing <small>cont …</small>

- ◦ Some of the other codes, besides HTML, to be tested are
  - ✓ Java
  - ✓ JavaScript
  - ✓ ActiveX
  - ✓ VBScripts
  - ✓ Cgi-Bin Scripts
  - ✓ Database access
- ◦ Cgi-Bin Scripts have to be checked for end-to-end operations and is most essential for e-commerce sites.
- ◦ The same goes for database access.

Configuration/Compatibility Testing <small>cont …</small>

- All new technologies used in the web development like graphics designs, interface calls like different API's, may not be available in all the operating systems.
  - ◦ Test your web application on different operating systems:
    - ✓ Windows,
    - ✓ Unix,
    - ✓ MAC,
    - ✓ Linux,
    - ✓ Solaris with different OS flavors.

Security Testing

- The most challenging issue is to protect the web applications from
  - ◦ Hackers
  - ◦ Crackers
  - ◦ Spoofers
  - ◦ Virus launchers, etc.

Security Testing   cont …

- Through security testing we try to ensure:
  - ◦ Confidentiality
  - ◦ Integrity
  - ◦ Availability
  - ◦ Non Repudiation
- The web application must be able to nullify the external attacks

Security Test Plan

▸ Security testing is carried out for:
  - ◦ Security of the infrastructure hosting the web application
  - ◦ Vulnerabilities of the web application
▸ Firewall and port scans can be the solutions for security infrastructure
▸ For vulnerabilities, user authentication, restricted and encrypted use of cookies, data communication must be planned. Users should not be able to browse through the directories in the server.

Security Test Plan   cont …

▸ Check the interfaces of the components, because most of the security bugs lie on the interfaces only.
▸ Prioritize the interfaces according to their level of vulnerability.
▸ High-priority interfaces are tested thoroughly by injecting mutated data to be accessed by that interface in order to check the security.

Security Test Plan   cont …

- While performing security checking, do not modify
  - ◦ the configuration of the system or server,
  - ◦ services running on the server, and
  - ◦ existing user or customer data hosted by the application.

Various Threat types and their Corresponding Test Cases

▸ Unauthorized users/fake identity/password cracking
  - ◦ check for the confidentiality of the contents/data.
▸ Buffer overflows
  - ◦ Due to this malicious code can be executed
  - ◦ Check the buffer overflow module and the different ways of submitting a range of lengths to the application

Threats and their Test Cases   cont..

▸ URL manipulation
  - ◦ Web application uses HTTP GET method to pass information between the client and server. The information is passed through parameters in the query string. An attacker may change some information in the query string passed from GET request so that he may get some information or corrupt the data. When somebody attempts to modify the data, it is known as fiddling of data.
  - ◦ Prevent fiddling in the HTTP GET query string for   the change or corruption of the data.
  - ◦ Design test cases to check that an user is trying to modify the private information.

Threats and their Test Cases   cont..

▸ SQL injection
  ◦ Hackers can put some SQL statements through the web interface (inputs) to get vital information
  ◦ Design test cases such that the special characters from the user inputs should be handled/escaped properly.

Threats and their Test Cases   cont …

▸ Denial of service (DoS)
When a service does not respond, it is known as denial of service
  ◦ There are several ways that can make an application fail:
    · Heavy load
    · Distorted data that may crash an application
    · Overloading of memory, etc.
  ◦ Testers should design the test cases considering all the above factors.

Threats and their Test Cases   cont …

▸ Cross-Site Scripting (XSS)
  · When a user inserts HTML/client side script in the user interface of a web application and this insertion is visible to other users, it is called cross-site scripting (XSS).
  · Using XSS, the attacker can use scripts like Java Scripts to steal user cookies and information stored in the cookies.
  · To avoid this, tester should check web application for XSS.

Performance Testing

▸ Performance testing helps the developer to identify the bottlenecks in the web application and can be rectified.
▸ The bottlenecks can be
  ▸ code,
  ▸ database,
  ▸ network,
  ▸ peripheral devices, etc.

Performance Parameters

▸ Resource Utilization
  ◦ The percentage of time a resource(CPU, memory, I/O, Peripheral, Network) is busy.
▸ Throughput
  ◦ The number of event responses that have been completed over a given interval of time.
▸ Response time
  ◦ The time lapsed between a request and its reply.

Performance Parameters   cont …

▸ Round-Trip Time
  ◦ How long does the entire user-requested transaction take, including connection and processing time?
▸ Scalability
  ◦ The ability of an application to handle additional workload, without adversary affecting performance, by adding resources such as processor, memory, and storage capacity.
▸ Database load
  ◦ The number of times database is accessed by web application over a given interval of time.

Types of Performance Testing for web applications

▸ Load Testing

▸ Stress Testing

Load Testing

- This testing is performed to check that whether the system can sustain at times of peak load.
- The site should handle many simultaneous user requests, large input data from users, simultaneous connections to database, heavy load on specific pages, etc. When we test the system with these types of loads, this testing is called load testing.
- It focuses on determining or validating performance characteristics of the system when subjected to workloads & load volumes expected during production operations. It refers to how much maximum load can be put on the web application & it will still serve flawlessly (e.g. 10 concurrent users).

Types of load testing

▸ Capacity testing
  ◦ Determines the maximum load the web service can handle before failing.
  ◦ Reveals the web services' ultimate limit.

▸ Scalability testing
  ◦ Determines how effectively the web service will expand to accommodate an increasing load.

Stress Testing

- Stress refers to stretching the system beyond its specification limits.
- Web stress testing is performed to break the site by giving stress and to know how the system reacts to the stress and how the system recovers from crashes.
- It focuses on determining or validating performance characteristics of the system when subjected to conditions beyond those expected during production operations.
- Tests the performance of the system under stressful conditions such as
  ◦ memory overflow,
  ◦ insufficient disk space,
  ◦ server failure etc.

Stress Testing   cont …

- These tests are designed to determine under what conditions an application will fail, and how gracefully it may recover from failure.
- Examples of graceful failure:
  ◦ The system saves the state at the time of failure and does not crash suddenly
  ◦ On restarting it, the system recovers from the last good state
  ◦ The system shows meaningful error messages to the user, etc.

Summary

- Discussed the following types of testing for web-based systems:
  ▸ Navigation Testing
  ▸ Configuration/Compatibility Testing
  ▸ Security Testing
  ▸ Performance Testing

References

1. Naresh Chauhan, Software Testing: Principles and Practices, (Chapter – 15), Second Edition, Oxford University Press, 2018.

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