System Testing

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1. What is System Testing

- Tests the behavior of a system as a whole, with respect to scenarios and requirements.
  - Assumes all components already work well
  - Integration testing finish(checking software quality by testing two or more dependent software modules as a group or a (sub)system.)
- Black-box testing techniques are used.
  - Reconciles software against top-level requirements
  - Tests stem from concrete use cases in the requirements
- Verifies that the new SW system integrates with the existing environment. This may include other systems, hardware, people and databases.

2. System Testing Types

- Test “types” classify the purpose of the test, rather than its scope or mechanism.
  - Functional testing
    - Ensure compliance with functional requirements
  - Non-functional testing
    - Ensure compliance with non-functional requirements
  - Regression testing

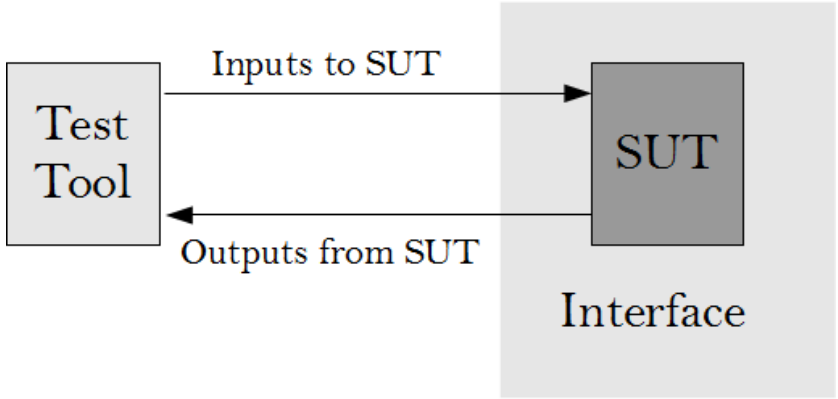
2.1 System Testing (Functional)

The default assumption in testing

- Functional testing verifies the software's behavior matches expectations.
- Also includes testing bad inputs, to check implicit assumptions
  - i.e., given nonsense input, the program should do "something reasonable"
- Cuts across all levels of testing, but heavy on unit testing
  - The interface used for testing is the System Interface : the user interface, the network interface, dedicated hardware interfaces, etc.

System Testing – Test Environment

A generic test environment model for System Testing is shown in the Figure.

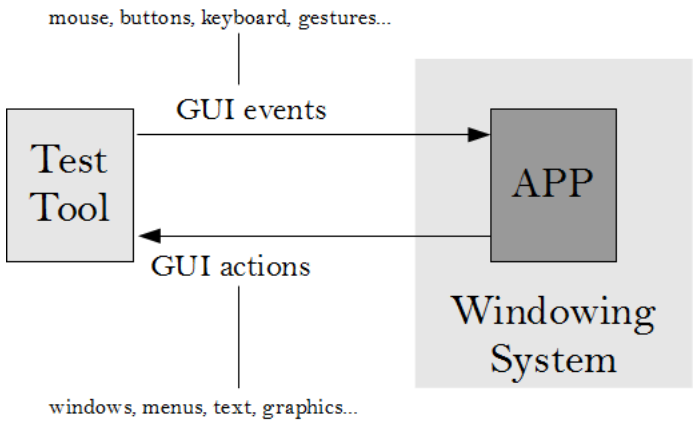


- The Test Tool provides input to the SUT, and receives output from the SUT, over the system interface

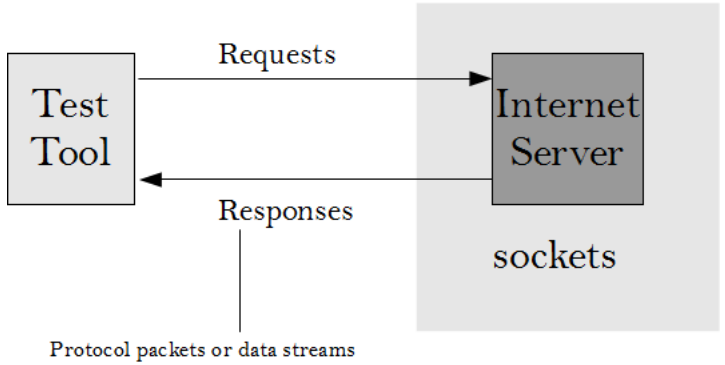
.

  - In some cases the interface will be synchronous, where every input generates an output.
  - In other cases the interface will be asynchronous, where an input may create a sequence of outputs over time, or the software may spontaneously generate outputs based on timers or other internal events

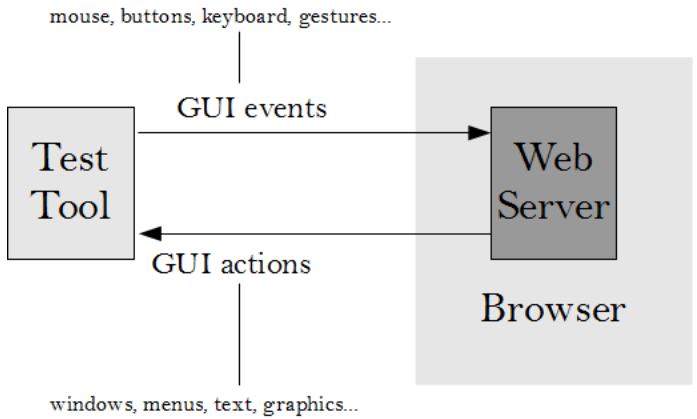
System Testing – Test Environment



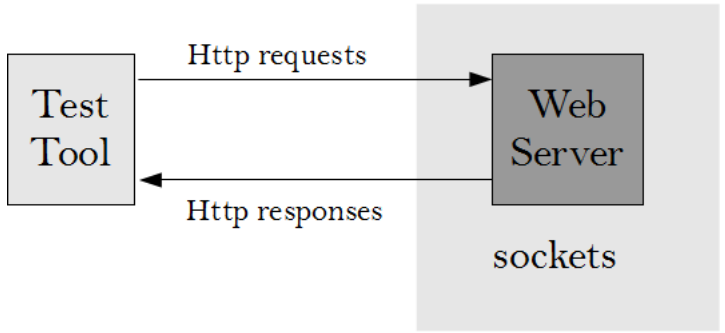
GUI Test Model



Network Test Model



Browser Web Test Model



Direct Web Test Model

Functional Testing Strategy

- The selection of Test Cases is based on Black-Box Testing.
- Application of Scenario Testing, Equivalence Partitions, Boundary Value Analysis, Error Guessing, Decision-Table Testing, Random Testing etc. is relatively straightforward.
  - Like Unit Testing, test cases and test data are selected using the technique being used.
  - The only difference is that instead of calling a method with the specified parameters, the data must be entered into the interface as appropriate, and then the results collected from the interface.

2.2 System Testing (Non - Functional)

- Roughly, testing things that are not “functionality”
- Generally, tests quality of the software, also called the “-ilities”
  - Usability
  - Reliability
  - Maintainability
  - Security
  - Performance
  - ……

Functional vs. Nonfunctional
Functional testing concerns *what* the software does.
Nonfunctional testing concerns *how* it does it.

- Nonfunctional testing is an umbrella term for many test types.
  - Note these aren’t all mutually exclusive!
  - Not all of these may be carried out on the product or be applicable to it.

System Testing (Non - Functional)

Conformance Testing

- Used to verify that the system conforms to a set of published standards. Many standards will have a published suite of conformance tests or have a selected authority to run these tests.
- This is particularly important for communications software, as software system must correctly interoperate with other implementations.

Documentation Testing

- Used to verify that the documentation (in printed form, online, help, or prompts) is sufficient for the software to be installed and operated efficiently.
- Typically, a full installation is performed, and then the different system functions are executed, exactly as documented. Responses are checked against the documented responses.

System Testing (Non - Functional)

Usability Testing

- Used to verify the ease-of-use of the system.
- This can be either automated (verifying font sizes, information placement on the screen, use of colors, or the speed of progress by users of different experience levels), or manual (based on feedback forms completed by users).

Interoperability Testing

- Used to verify that the software can exchange and share information with other required software products.
- Typically, tests are run on all pairs of products to see that all the information that needs to be shared is transferred correctly. This is particularly important for communications software.

System Testing (Non - Functional)

Performance Testing

- Used to verify that the performance targets for the software have been met.
- These tests verify that metrics such as the configuration limits (static), response latency or maximum number of simultaneous users (dynamic) are measured and compared to the specified requirements.

Portability Testing

- Used to verify that the software is portable to another operating environment.
- A selection of tests from the original platform are run in each new environment.
- The new platforms may be software platforms (such as 32-bit and 64-bit versions of the same operating system, or implementations by different vendors), or hardware platforms (such as mobile phones, tablets, laptops, workstations, and servers), or different environments (databases, networks, etc.).

System Testing (Non - Functional)

Software reliability

- Used to verify the probability of failure-free operation of an application in a specified operating environment and time period.
- Failure Intensity: The number of failures occurring in a given time period.
- MTTF: The average value of the next failure interval 

Security Testing

- Used to verify that the system security features are not vulnerable to attack.
- The tests will deliberately attempt to break security measures.
- Examples would include impersonating another user, accessing protected files, accessing network ports, breaking encrypted storage or communications, or inserting unauthorized software.

2.3 Regression Testing

- Making sure that code changes haven't broken existing functionality, performance, security, etc.

The Need for Regression Testing

It's common to introduce new bugs while changing existing code, whether fixing an earlier bug or adding a new feature.

- In practice, this means re-running tests after a code change
- With good test automation and good unit/integration/system/etc. tests, this is literally running tests again after a change.

3. Usability Overview

In mature engineering fields, customers choose products they can use without help

- Can I drive the car without extra training?
- Can I use this web application without being taught?
- Can I adjust my privacy settings?
- Can I use my stopwatch without help?

Software Usability Design

- How to break down the essential characteristics of usable software from an analytical viewpoint

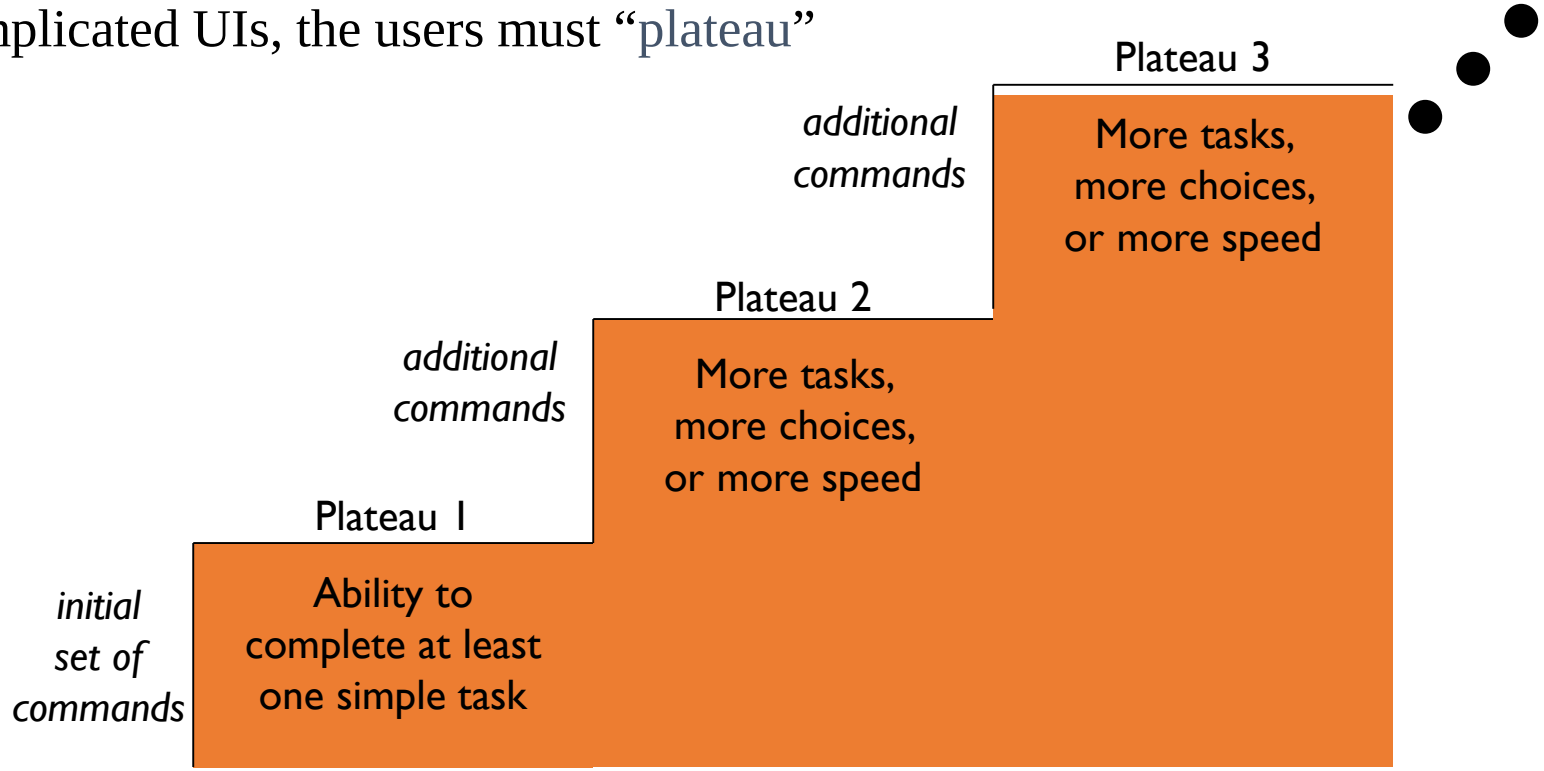
- Engineering principles for designing and building software interfaces that are
  - Fast to learn
  - Speedy to use
  - Avoid user errors
- How to recognize and articulate the difference between “this program sucks” and “I can improve this program by changing X,Y, and Z”
- Life-long habits for engineering usable products
  - **UI Guidelines**

Shneiderman's measurable criteria

1) Time to learn
2) Speed of UI use
3) Rate of user errors
4) Retention of skills
5) Subjective satisfaction

(1). Time to learn

- The time it takes to learn some basic level of skills
- With complicated UIs, the users must "plateau"



- Well designed interfaces make
  - the first plateau easy to get to
  - subsequent plateaus clearly available

(2). Speed of UI use

- Number of UI “interactions” it takes to accomplish tasks
- This is about navigating through the interface, **not** how fast the software or network runs
- *Interaction points* are places where the users interact with the software:
  - Buttons
  - Text boxes
  - Commands
- Speed of UI performance is roughly the number of interactions needed to accomplish a task

(3). Rate of user errors

- How often users make mistakes
- Users will always make mistakes
- UIs can encourage or discourage mistakes
  - Consistency, instructions, navigation, …

- Consider :
  - C/C++ : The lack of typing, particularly on pointers, and the complexity of the syntax actively encourages programmers to make mistakes .

    Thus we become debuggers, not programmers
  - Unix : The large, complicated command language encourages many mistakes as a result of simple typos and confusion
  - Entering grades in a dropdown instead of radio buttons

(4). Retention of skills

- How well users remember how to use the UI
- Some interfaces are easy to remember, some are hard
- If they flow logically (that is, match the user's mental model or expectations), they are very easy to remember
- If an interface is very easy to learn, then the retention is not important – users can just learn again
- Retention is typically more important with UIs that are hard to learn

(5). Subjective satisfaction

- The lack of annoying features
- Subjective satisfaction is defined to be how much the users "like" the UI
- This depends on the user (thus the word "subjective")
- Think of it in reverse: Users are unhappy when there is something annoying in the interface
  - Blinking
  - Ugly colors
  - Spelling errors in massages
- Most important in competitive software systems
  - Like … everything on the Web !

Accessibility Testing (testing for the disabled)

- The following impairments make using computers especially difficult:
  - Visual
    - E.g., color blindness, tunnel vision, cataracts.
  - Hearing
    - E.g., partial or complete deafness.
  - Motion
    - E.g., injury can make using a keyboard or mouse difficult or impossible.
  - Cognitive and language
    - E.g., dyslexia or memory problems and using complex UIs

- Legal requirement
  - laws applied to developing software with a UI that can be used by the disabled

Microsoft Windows accessibility features

- **Sticky-keys**: Allow Shift, Ctrl, Alt keys to stay in effect until the next key is pressed.
- **Filter-keys**: Prevents brief repeated keystrokes from being recognized.
- **Toggle-keys**: Plays tomes when Caps Lock, Scroll Lock, or Num Lock keyboard modes are enabled.
- **Sound-sentry**: Creates a visual warning whenever the system generates a sound.
- **Show-sounds**: Instructs program to display captions for any sounds or speech they make.
- **High contrast**: Sets up the screen with colors and fonts designed to be read by the visually impaired.
- **Mouse-keys**: Allows the use of keyboard keys instead of he mouse to navigate.
- **Serial-keys**: Sets up a communication port to read in key strokes from an external (non-keyboard) device.

Microsoft's accessibility website

Microsoft accessibility features

There is no limit to what people can achieve when technology reflects the diversity of all who use it. Across Microsoft, we are dedicated to providing accessibility tools and features that help people achieve more at home, school, and work.

Windows

Windows 11 was inclusively designed to support productivity, creativity, and ease of use for people with disabilities. With a robust set of built-in and third-party accessibility features, Windows adapts to you.

Accessibility in Windows 11 >

Microsoft 365

Microsoft 365 provides accessible apps and cloud services to help people and organizations create, communicate, and collaborate from any device. Find out how Microsoft 365 helps make everyone more inclusive and independent.

Accessibility in Microsoft 365 >

Xbox

Nothing should come between you and the games you love. Xbox strives to eliminate barriers, and to empower gamers to play the way they play.

Accessibility in Xbox >

Usability Testing

- There are many tests out there and this will introduce you to several popular ones in a Nutshell!

    1) Questionnaires
    2) Interviews
    3) Observation
    4) Thinking aloud
    5) Heuristic Evaluation

- One or more may be chosen for your particular application

Questionnaires

- These Contain various questions that you come up with in regards to your interface
- They are easy to repeat and can find user preferences
- However, pilot work may be needed to prevent misunderstandings and it may be hard to receive all of the questionnaires back.
- Suggested number for significant results: at least 30

Interviews

- These are flexible and can be more or less in-depth depending on the person.
- However, they are time-consuming and can be hard to compare from interview-to-interview.
- Suggested number for significant results: 5

Observation

- Observation is very good in revealing how the user actually goes about performing tasks including what functions and features that they use.
- However, appointments may be hard to set up and the experimenter does not have much control as they are silently observing the user.
- Suggested number for significant results: 3 or more

Thinking Aloud

- The thinking aloud method involves observing users and asking them to 'think aloud'
- This test is good at pinpointing user misconceptions and is a cheap test.
- However, it may feel unnatural to the users that are using the product to speak out loud at the same time!
- Suggested number for significant results: 3-5

Heuristic Evaluation

- This is a collection of usability guidelines to help a user to evaluate Usability!
- A Heuristic Evaluation tries to come up with an opinion as to what the good and bad things in an interface are.

  - Checklist for 5 criteria
  - Or 10 categories in the Heuristic Evaluation

Heuristic Evaluation categories

(1) Simple and Natural Dialogue

- Does the interface have a Simple and Natural Dialogue?
  - Are features easy to understand?
  - Are features easy to find?
  - Could the amount of navigation in the interface be minimized?
  - Are graphics intuitive?
  - Is the use of color appropriate?

(2) Speak the User's language

- Are terms understandable to the user?
  - Does the user know that the trash can is used to delete items?
  - Are units in the users native language?

Heuristic Evaluation categories

(3) Minimize the User's Memory Load

- Does the user have to remember too much?
  - For instance: instead of:
    - Enter Date: Use Enter Date (MM-DD-YYYY):

(4) Consistency

- Do commands and actions always have the same meaning?

(5) Feedback

- Do users receive feedback when they do something in a reasonable time response?
  - Status bars indicating that a program is installing
  - Feedback that a command has been executed
  - Notice that your email has been sent

Heuristic Evaluation categories

(6) Clearly Marked Exits

- Do users feel safe exiting a program without fear of losing work?

(7) Short-cuts

- Are short-cuts available for frequently performed operations?

(8) Good Error Messages

- Errors should be easy to understand and should help the user.

Heuristic Evaluation categories

(9) Prevent Errors

- Are there problems that could have been prevented?
- Appropriate to have special modes?
- Could something be designed to be more intuitive?

(10) Help and Documentation

- Most users do not read manuals
  - Do they need to read one or is the interface intuitive enough?
  - Does the documentation allow users to quickly find what they were searching for?