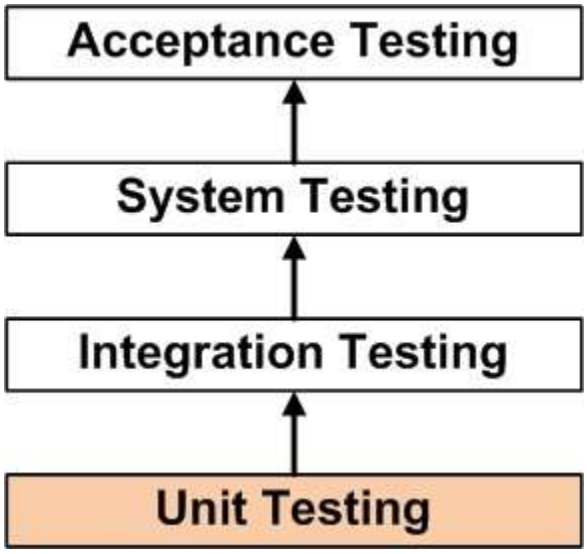
Unit Testing is a level of software testing where individual units/ components of a software are tested. The purpose is to validate that each unit of the software performs as designed.



A unit is the smallest testable part of software. It usually has one or a few inputs and usually a single output. In procedural programming a unit may be an individual program, function, procedure, etc. In object-oriented programming, the smallest unit is a method, which may belong to a base/ super class, abstract class or derived/ child class. (Some treat a module of an application as a unit. This is to be discouraged as there will probably be many individual units within that module.)

Unit testing frameworks, drivers, stubs, and mock/ fake objects are used to assist in unit testing.

METHOD

Unit Testing is performed by using the White Box Testing method.

When is it performed?

Unit Testing is the first level of testing and is performed prior to Integration Testing.

BENEFITS

- Unit testing increases confidence in changing/ maintaining code. If good unit tests are written and if they are run every time any code is changed, we will be able to promptly catch any defects introduced due to the change. Also, if codes

are already made less interdependent to make unit testing possible, the unintended impact of changes to any code is less.

- Codes are more reusable. In order to make unit testing possible, codes need to be modular. This means that codes are easier to reuse.
- Development is faster. How? If you do not have unit testing in place, you write your code and perform that fuzzy 'developer test' (You set some breakpoints, fire up the GUI, provide a few inputs that hopefully hit your code and hope that you are all set.) If you have unit testing in place, you write the test, write the code and run the test. Writing tests takes time but the time is compensated by the less amount of time it takes to run the tests; You need not fire up the GUI and provide all those inputs. And, of course, unit tests are more reliable than 'developer tests'. Development is faster in the long run too. How? The effort required to find and fix defects found during unit testing is very less in comparison to the effort required to fix defects found during system testing or acceptance testing.

WHITE BOX TESTING Fundamentals

DEFINITION

White Box Testing (also known as Clear Box Testing, Open Box Testing, Glass Box Testing, Transparent Box Testing, Code-Based Testing or Structural Testing) is a software testing method in which the internal structure/ design/ implementation of the item being tested is known to the tester. The tester chooses inputs to exercise paths through the code and determines the appropriate outputs. Programming know-how and the implementation knowledge is essential.

This method is named so because the software program, in the eyes of the tester, is like a white/ transparent box; inside which one clearly sees.

Definition by ISTQB

- **white-box testing:** Testing based on an analysis of the internal structure of the component or
  system.

- **white-box test design technique:** Procedure to derive and/or select test cases based on an
  analysis of the internal structure of a component or system.

EXAMPLE

A tester, usually a developer as well, studies the implementation code of a certain field on a webpage, determines all legal (valid and invalid) AND illegal inputs and verifies the outputs against the expected outcomes, which is also determined by studying the implementation code.

White Box Testing is like the work of a mechanic who examines the engine to see why the car is not moving.

LEVELS APPLICABLE TO

White Box Testing method is applicable to the following levels of software testing:

- Unit Testing: For testing paths within a unit.
- Integration Testing: For testing paths between units.
- System Testing: For testing paths between subsystems.

However, it is mainly applied to Unit Testing.

WHITE BOX TESTING DISADVANTAGES

- Since tests can be very complex, highly skilled resources are required, with thorough knowledge of programming and implementation.
- Test script maintenance can be a burden if the implementation changes too frequently.
- Since this method of testing it closely tied with the application being testing, tools to cater to every kind of implementation/platform may not be readily available.

Integration Testing Fundamentals

DEFINITION

Integration Testing is a level of software testing where individual units are combined and tested as a group.

The purpose of this level of testing is to expose faults in the interaction between integrated units. Test drivers and test stubs are used to assist in Integration Testing.

integration testing: Testing performed to expose defects in the interfaces and in the interactions between integrated components or systems. See also *component integration*

ANALOGY

During the process of manufacturing a ballpoint pen, the cap, the body, the tail and clip, the ink cartridge and the ballpoint are produced separately and unit tested separately. When two or more units are ready, they are assembled and Integration Testing is performed. For example, whether the cap fits into the body or not.

METHOD

Any of Black Box Testing, White Box Testing, and Gray Box Testing methods can be used. Normally, the method depends on your definition of 'unit'

Black Box Testing

SYSTEM TESTING Fundamentals

DEFINITION

System Testing is a level of the software testing where a complete and integrated software is tested.

The purpose of this test is to evaluate the system's compliance with the specified requirements.

Definition by ISTQB

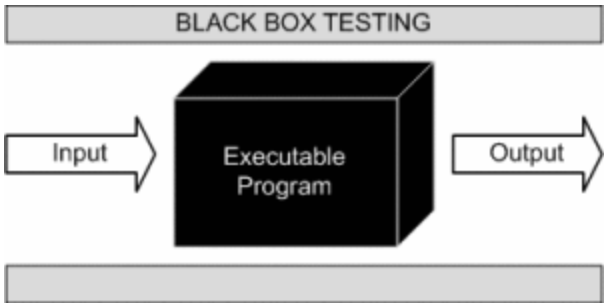
- **system testing:** The process of testing an integrated system to verify that it meets specified
  requirements.

- **ANALOGY**
- During the process of manufacturing a ballpoint pen, the cap, the body, the tail, the ink cartridge and the ballpoint are produced separately and unit tested separately. When two or more units are ready, they are assembled and Integration Testing is performed. When the complete pen is integrated, System Testing is performed.

BLACK BOX TESTING Fundamentals

DEFINITION

Black Box Testing, also known as Behavioral Testing, is a software testing methodin which the internal structure/ design/ implementation of the item being tested is not known to the tester. These tests can be functional or non-functional, though usually functional.



This method is named so because the software program, in the eyes of the tester, is like a black box; inside which one cannot see. This method attempts to find errors in the following categories:

- Incorrect or missing functions
- Interface errors
- Errors in data structures or external database access
- Behavior or performance errors
- Initialization and termination errors
- **EXAMPLE**
- A tester, without knowledge of the internal structures of a website, tests the web pages by using a browser; providing inputs (clicks, keystrokes) and verifying the outputs against the expected outcome.

LEVELS APPLICABLE TO

Black Box Testing method is applicable to the following levels of software testing:

- Integration Testing
- System Testing
- Acceptance Testing

BLACK BOX TESTING ADVANTAGES

- Tests are done from a user's point of view and will help in exposing discrepancies in the specifications.
- Tester need not know programming languages or how the software has been implemented.
- Tests can be conducted by a body independent from the developers, allowing for an objective perspective and the avoidance of developer-bias.
- Test cases can be designed as soon as the specifications are complete.

BLACK BOX TESTING DISADVANTAGES

- Only a small number of possible inputs can be tested and many program paths will be left untested.
- Without clear specifications, which is the situation in many projects, test cases will be difficult to design.
- Tests can be redundant if the software designer/ developer has already run a test case.

ACCEPTANCE TESTING Fundamentals

DEFINITION

Acceptance Testing is a level of the software testing where a system is tested for acceptability.

The purpose of this test is to evaluate the system's compliance with the business requirements and assess whether it is acceptable for delivery.

- **acceptance testing:** Formal testing with respect to user needs, requirements, and business processes conducted to determine whether or not a system satisfies the acceptance criteria and to enable the user, customers or other authorized entity to determine whether or not to accept the system.

ANALOGY

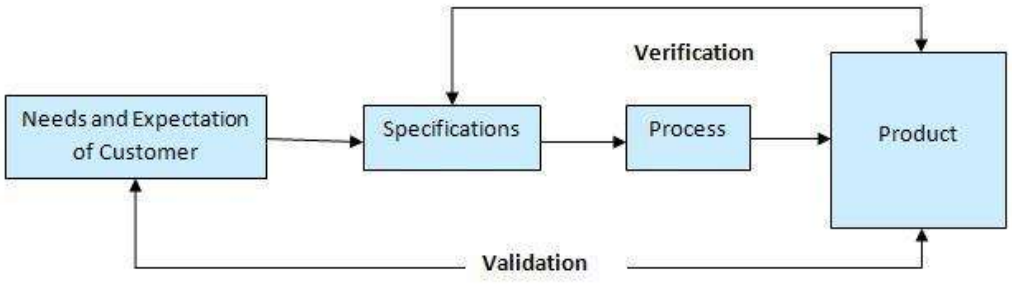
During the process of manufacturing a ballpoint pen, the cap, the body, the tail and clip, the ink cartridge and the ballpoint are produced separately and unit tested separately. When two or more units are ready, they are assembled and Integration Testing is performed. When the complete pen is integrated, System Testing is performed. Once System Testing is complete, Acceptance Testing is performed so as to confirm that the ballpoint pen is ready to be made available to the end-users.

METHOD

Usually, Black Box Testing method is used in Acceptance Testing

What is Validation in software testing?

- Determining if the system complies with the requirements and performs functions for which it is intended and meets the organization's goals and user needs.
- Validation is done at the end of the development process and takes place after verifications are completed.
- It answers the question like: **Am I building the right product?**
- Am I accessing the right data (in terms of the data required to satisfy the requirement).
- It is a High level activity.
- Performed after a work product is produced against established criteria ensuring that the product integrates correctly into the environment.
- Determination of correctness of the final software product by a development project with respect to the user needs and requirements.



A product can pass while verification, as it is done on the paper and no running or functional application is required. But, when same points which were verified on the paper is actually developed then the running application or product can fail while validation. This may happen because when a product or application is build as per the specification but these specifications are not up to the mark hence they fail to address the user requirements.

Advantages of Validation:

1. During verification if some defects are missed then during validation process it can be caught as failures.
2. If during verification some specification is misunderstood and development had happened then during validation process while executing that functionality the difference between the actual result and expected result can be understood.
3. Validation is done during testing like feature testing, integration testing, system testing, load testing, compatibility testing, stress testing, etc.
4. Validation helps in building the right product as per the customer’s requirement and helps in satisfying their needs.