# UNIT – IV SOFTWARE TESTING AND MAINTENANCE

SYLLABUS: Software testing fundamentals-Internal and external views of Testing- white box testing - basis path testing-control structure testing- black box testingRegression Testing – Unit Testing – Integration Testing – Validation Testing – System Testing And Debugging – Software Implementation Techniques: Coding practices-

Refactoring - Maintenance and Reengineering-BPR modelReengineering process model- Reverse and Forward

Engineering.

- **Software testing fundamentals:**
- Definition of testing:

  Software testing is a critical element of software quality assurance and represents the ultimate review of specification, design and coding.

- Purpose of testing:

  To ensure whether the software functions appear to be working according to specifications and performance requirements.

- **Testing Objectives:**

- According to Glen Myers the testing objectives are,
  - It is a process of executing a program and finding an error.
  - A good test case is one that has high probability of finding an undiscovered error.

- **Testing Principles:**
  - All tests should be traceable to customer requirements.
  - Tests should be planned long before testing begins.
  - The **pareto principle** can be applied to software testing-80% of all errors uncovered during testing.
  - Testing should begin in “in the small” and progress toward testing “in the large”.
  - Exhaustive testing is not possible.
  - Testing should be conducted by an independent third party.

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- **Why testing is important?**

- Generally, testing is a process that requires more efforts than any other software engineering activity.
- Testing, is a set of activities that can be planned in advance and conducted systematically.
- If it is conducted haphazardly, then only time will be wasted and more even worse errors may get introduced.

## INTERNAL AND EXTERNAL VIEWS OF TESTING

- There are two views of the testing.
  - ❖Internal view → white box testing.

❖External view→ black box testing.

## ❖Black box testing:

- It is used to demonstrate that the software functions are operational.
- As the name suggests in black box testing it is tested whether the input is accepted properly and output is correctly produced.
- The major focus of black box testing is on,
  - functions,
  - operations,
  - external interfaces ,
  - external data and information

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# ❖White box testing:

- In this testing the internals of software are tested to make sure that they operate according to specifications and designs.
- The major focus of white box testing is on
  - internal structures,
  - logic paths,
  - control flows,
  - data flows,
  - internal data structures,
  - conditions, oops etc.,

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# White Box Testing

- It is also called as structural testing.
- In this testing derivation of test cases is according to program structure.
- objective of white box testing is to exercise all program statements.
- Types:
  - Condition testing
  - Loop testing
  - Basis path testing

## ➢ Condition testing:

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- To test the logical conditions in the program module the condition testing is used.
- The condition is incorrect in the following situations.
  - Boolean operator is incorrect, missing, or extra.
  - Boolean variable is incorrect.
  - Boolean parenthesis may be incorrect, missing, or extra.
  - Error in relational operator.
  - Error in arithmetic operator.
  - Condition testing → focuses on each testing condition in the program.
  - Branch testing → every true or false branches are tested.

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- Domain testing → relational expression can be tested using three or four tests.

## ➢ Loop testing:

- It is a white box testing technique which is used to test the loop constructs.
- There are 3 types of loops.
  - Simple loops
  - Nested loops
  - Concatenated loops
  - Unstructured loops

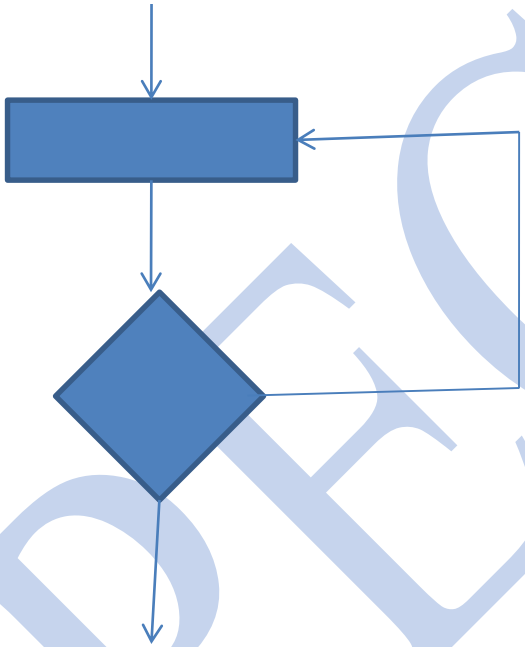
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- **Simple loops:**
- The test can be performed for n number of classes. if,

i) n=0 that means skip the loop completely.

ii) n=1 that means one pass through the loop is tested. iii) n=2 that means two pass through the loop is tested. iv) n=m that means testing is done when there are m passes where m<n. v) Perform the testing when number of passes are n-1,n,n+1.

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- **Nested loops:**
- Testing begins from the innermost loop first.
- The simple loop test for innermost loop is done.
- Conduct the loop testing for the next loop by keeping the outer loops at minimum values and other nested loops at some specified value.

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- This testing process is continued until all the loops have been tested.

- **Concatenated loops:**

- These loops can be tested in the same manner as simple loop tests.

- **Un structured loops:**

- The testing cannot be effectively conducted for unstructured loops. Hence, these types of loops needs to be redesigned.

Note:Diagrams see in book.

## ➢ Basis path testing:

- Path testing is a structural testing strategy.

- This method is intended to exercise every independent execution path of program at least once.
- Following steps are carried out while performing basis path testing.
  - Step1:Design the flow graph for the program or a component.
  - Step2: Calculate the cyclomatic complexity.
  - Step3:Select the basis set of path.
  - Step4: Generate test cases for these paths.

# BLACK BOX TESTING

- It is also called as behavioural testing.
- This testing methods focus on functional requirements of the software. Test cases are derived that fully exercise all functional requirements.

- It is not an alternative to white box testing and it uncovers different class of errors than white box testing.
- **Why to performing black box testing?**
- To uncover the following types of errors.
- Incorrect or missing functions
- Interface errors
- Errors in data structures
- Performance errors
- Termination errors
- Equivalance class partitioning
- Boundary value analysis

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# Comparison Between Black Box And White Box Testing

| S.No | Back box testing | White box testing |
|---|---|---|
| 1. | It is a way of software testing in which the internal structure or the program or the code is hidden and nothing is known about it. | It is a way of testing the software in which the tester has knowledge about the internal structure or the code or the program of the software. |
| 2. | Implementation of code is not needed for black box testing. | Code implementation is necessary for white box testing. |
| 3. | It is mostly done by software testers. | It is mostly done by software developers. |

| | | |
|---|---|---|
| 4. | No knowledge of implementation is needed. | Knowledge of implementation is required. |
| 5. | It can be referred to as outer or external software testing. | It is the inner or the internal software testing. |
| 6. | It is a functional test of the software. | It is a structural test of the software. |
| 7. | This testing can be initiated based on the requirement specifications document. | This type of testing of software is started after a detail design document. |

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| | | |
|---|---|---|
| 8. | No knowledge of programming is required. | It is mandatory to have knowledge of programming. |
| 9. | It is the behavior testing of the software. | It is the logic testing of the software. |
| 10. | It is applicable to the higher levels of testing of software. | It is generally applicable to the lower levels of software testing. |

- Advantages of Black Box Testing:
- Efficient when used on large systems.
- Since the tester and developer are independent of each other, testing is balanced .
- Tester can be non-technical.

- There is no need for the tester to have detailed functional knowledge of system.
- Tests will be done from an end user's point of view, because the end user should accept the system. (This testing technique is sometimes also called Acceptance testing.)

- Disadvantages of Black Box Testing:
- Test cases are challenging to design without having clear functional specifications.
- It is difficult to identify tricky inputs if the test cases are not developed based on specifications.
- It is difficult to identify all possible inputs in limited testing time. As a result, writing test cases may be slow and difficult.
- There are chances of having unidentified paths during the testing process.
- There is a high probability of repeating tests already performed by the programmer.
- Advantages of White box testing:

- It helps in evaluating all the loops and paths.
- It can provide stability and usability of the test cases.
- Thoroughness achieved in white box testing is far more than black box testing.
- Various hidden defects get unearth while conducting clear box testing.
- Dis Advantages of White box testing:
- Sometimes a change in the code may be required and thus all the scenarios may need to be tested again.
- White box testing is an exhaustive method.
- It takes time to tester to develop the test cases.
- Test cases are a waste if changes in the implementation code are done frequently.

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- If the application is large then complete testing through white box techniques is not feasible.

# Unit Testing

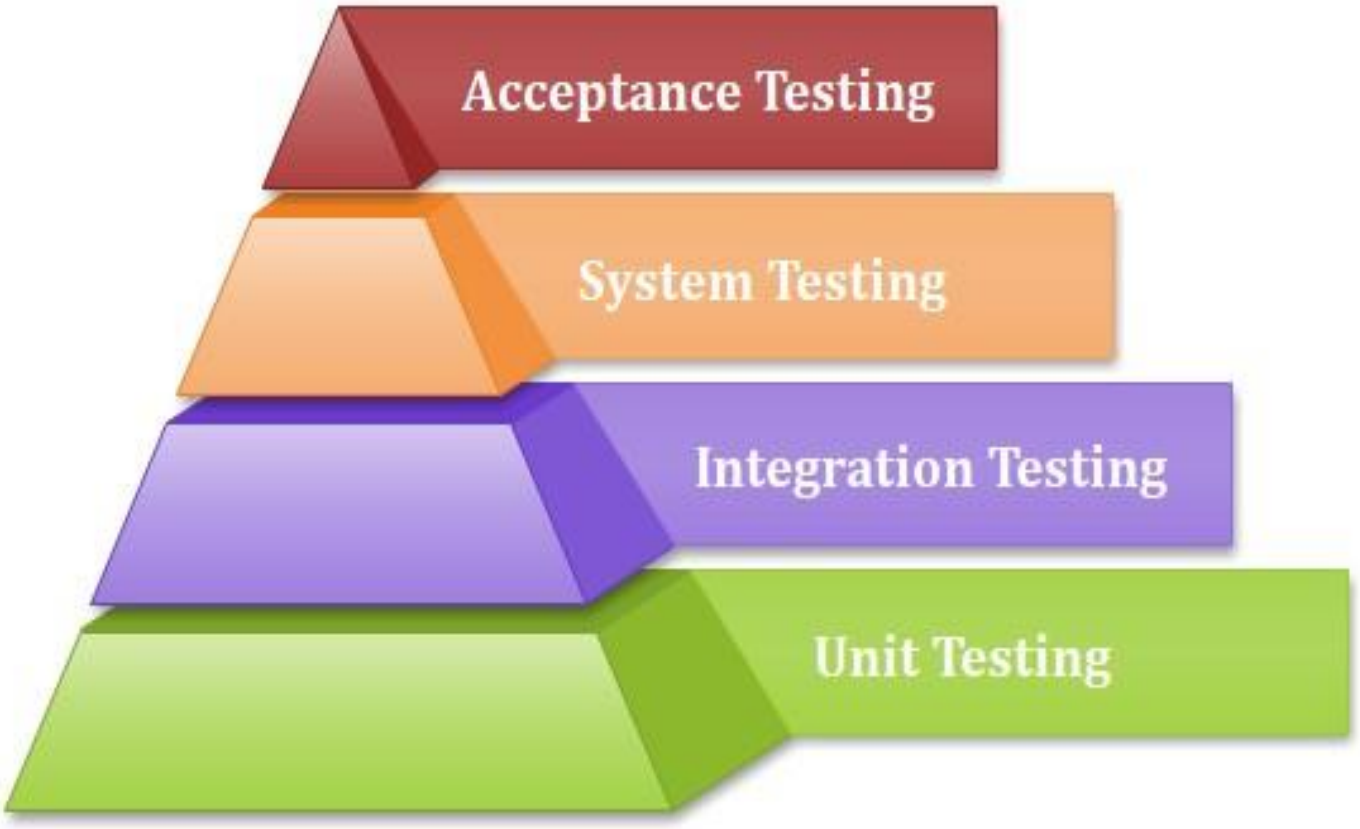
- Unit testing involves the testing of each unit or an individual component of the software application.
- It is the first level of functional testing.
- The aim behind unit testing is to validate unit components with its performance.
- A unit is a single testable part of a software system and tested during the development phase of the application software.
- **Purpose:**

- The purpose of unit testing is to test the correctness of isolated code. A unit component is an individual function or code of the application. White box testing approach used for unit testing and usually done by the developers.
- Whenever the application is ready and given to the Test engineer, he/she will start checking every component of the module or module of the application independently or one by one, and this process is known as **Unit testing** or **components testing.**

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- **Why Unit Testing?**
- In a testing level hierarchy, unit testing is the first level of testing done before integration and other remaining levels of the testing.
- It uses modules for the testing process which reduces the dependency of waiting for Unit testing frameworks, stubs, drivers and mock objects are used for assistance in unit testing.

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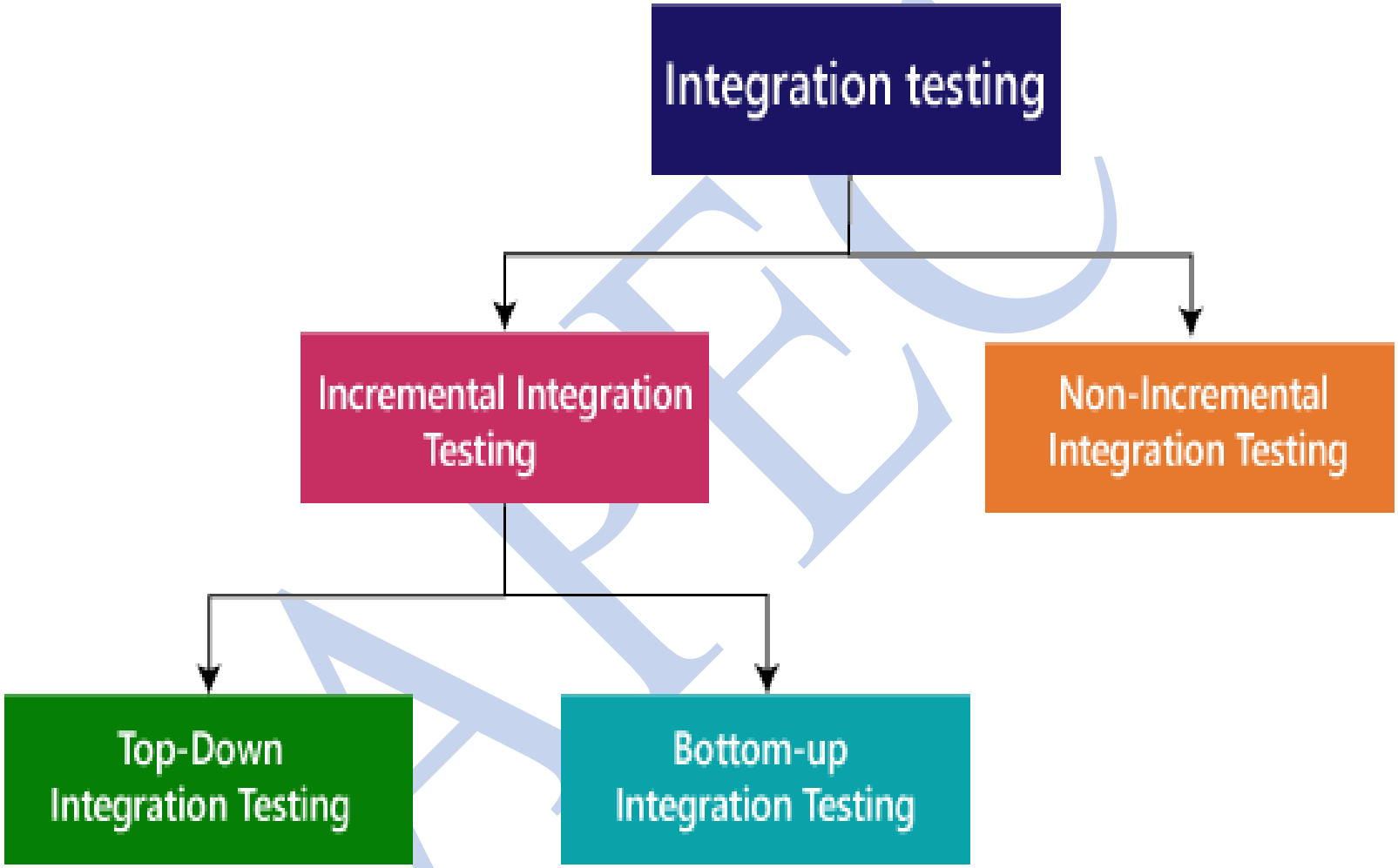

**Unit testing continuation see in book**

# INTEGRATION TESTING

- Integration testing is the second level of the software testing process comes after unit testing.
- In this testing, units or individual components of the software are tested in a group.
- The focus of the integration testing level is to expose defects at the time of interaction between integrated components or units.
- Types of Integration Testing:
- Integration testing can be classified into two parts:
  - **Incremental integration testing**

- **Non-incremental integration testing**

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Integration testing
Incremental Integration Testing
Non-Incremental Integration Testing
Top-Down Integration Testing
Bottom-up Integration Testing

**Integration testing approach**

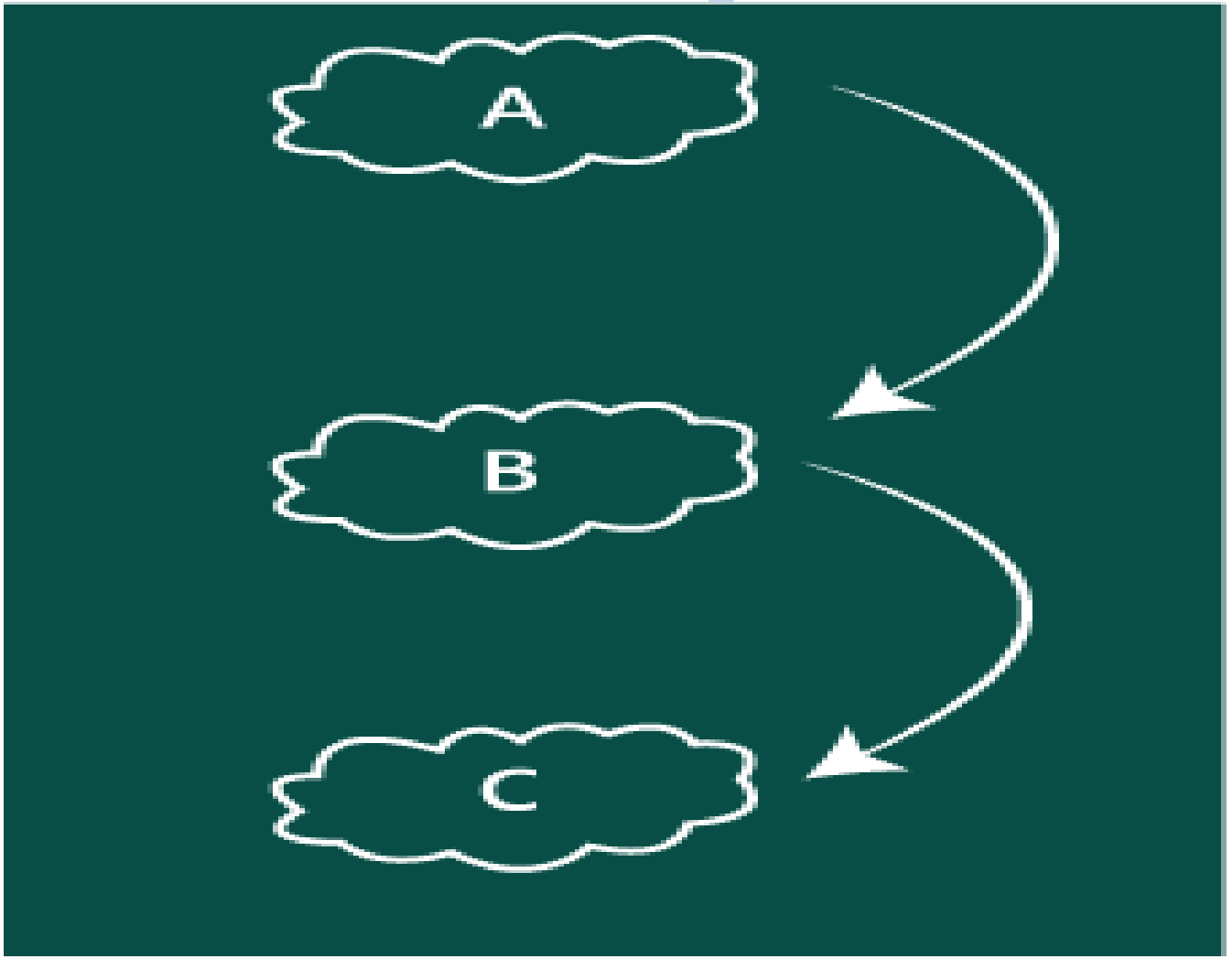
- Incremental Integration:
- In the Incremental Approach, modules are added in ascending order one by one or according to need.
- The selected modules must be logically related.
- Generally, two or more than two modules are added and tested to determine the correctness of functions.
- The process continues until the successful testing of all the modules.
- **For example:** Suppose we have a Flipkart application, we will perform incremental integration testing, and the flow of the application would like this:
- Flipkart→ Login→ Home → Search→ Add cart → Payment →

Logout

- Incremental integration testing is carried out by further methods:
- **Top-Down approach**
- **Bottom-Up approach**
- **Top-Down Approach:**
- The top-down testing strategy deals with the process in which higher level modules are tested with lower level modules until the successful completion of testing of all the modules.
- Major design flaws can be detected and fixed early because critical modules tested first.
- In this type of method, we will add the modules incrementally or one by one and check the data flow in the same order.

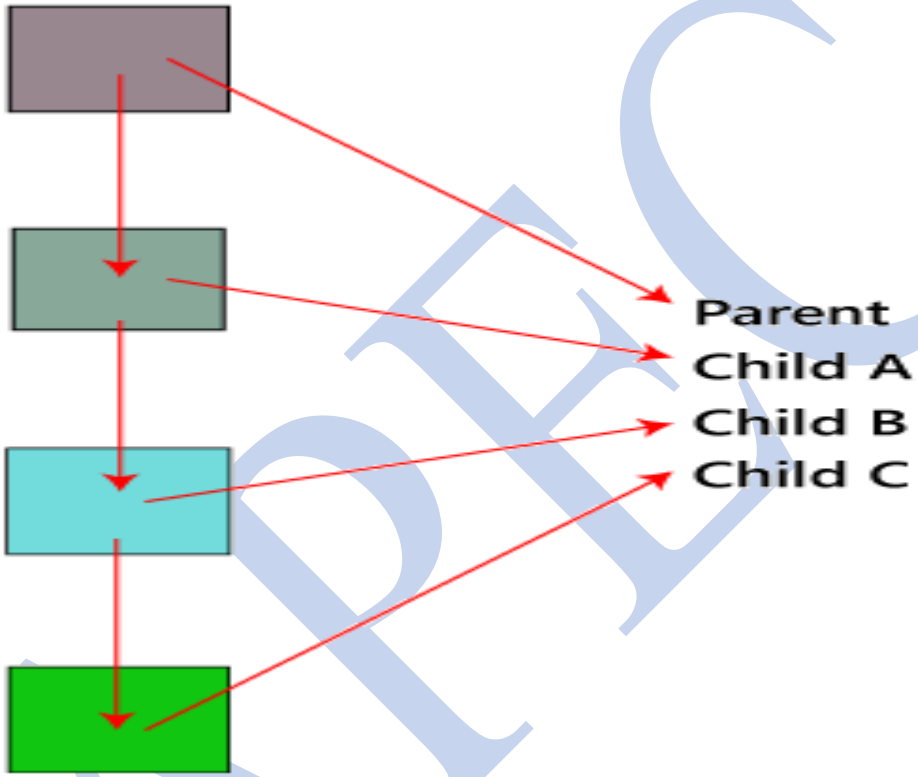
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# Top-Down Approach



- In the top-down approach, we will be ensuring that the module we are adding is the **child of the previous one like Child C is a child of Child B** and so on as we can see in the below image:

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- **Advantages:**
- Identification of defect is difficult.

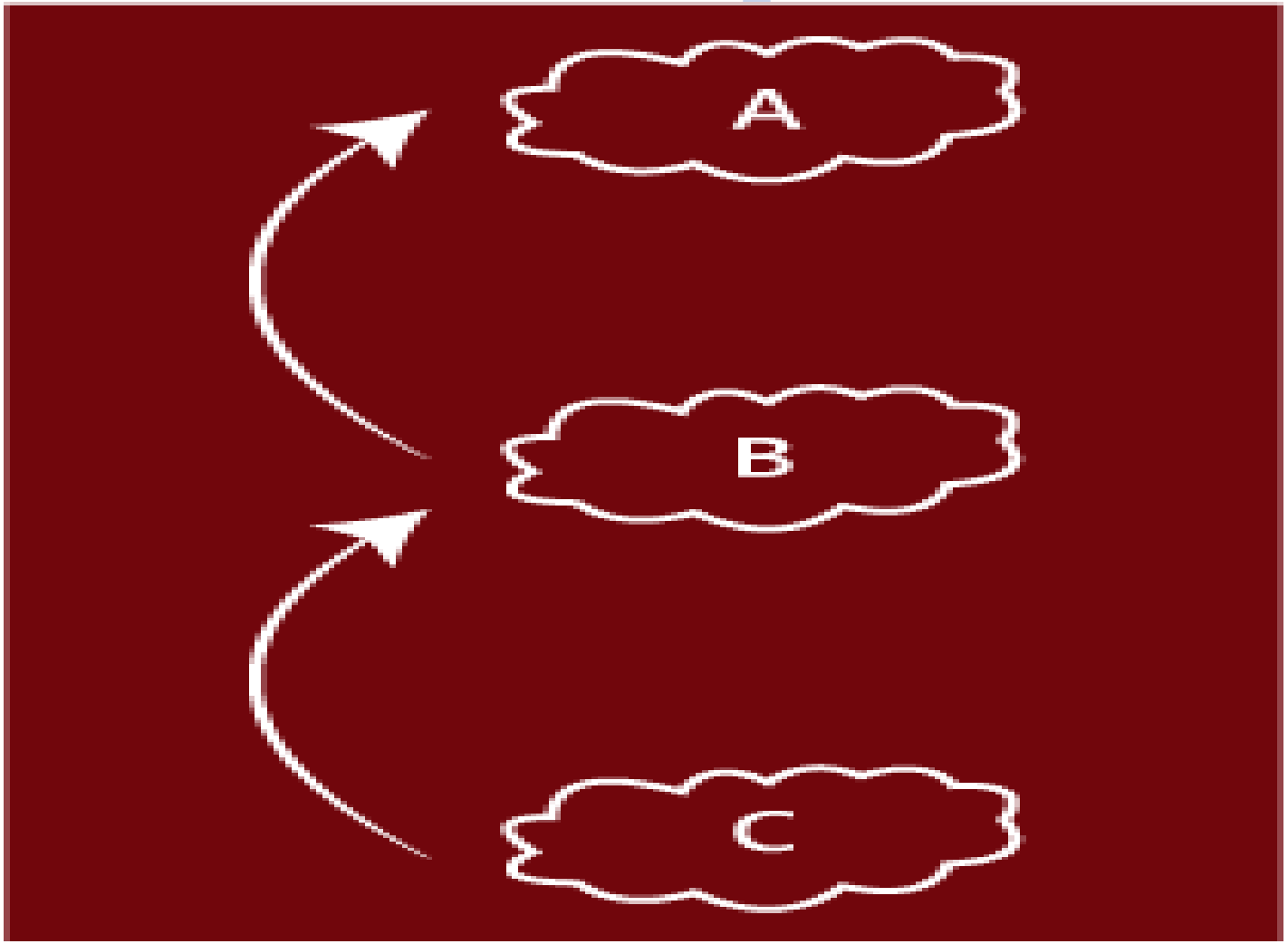
- An early prototype is possible.
- **Disadvantages:**
- Due to the high number of stubs, it gets quite complicated.
- Lower level modules are tested inadequately.
- Critical Modules are tested first so that fewer chances of defects.
- Bottom-Up Method

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- The bottom to up testing strategy deals with the process in which lower level modules are tested with higher level modules until the successful completion of testing of all the modules.
- Top level critical modules are tested at last, so it may cause a defect. Or we can say that we will be adding the modules from **bottom to the top** and check the data flow in the same order.

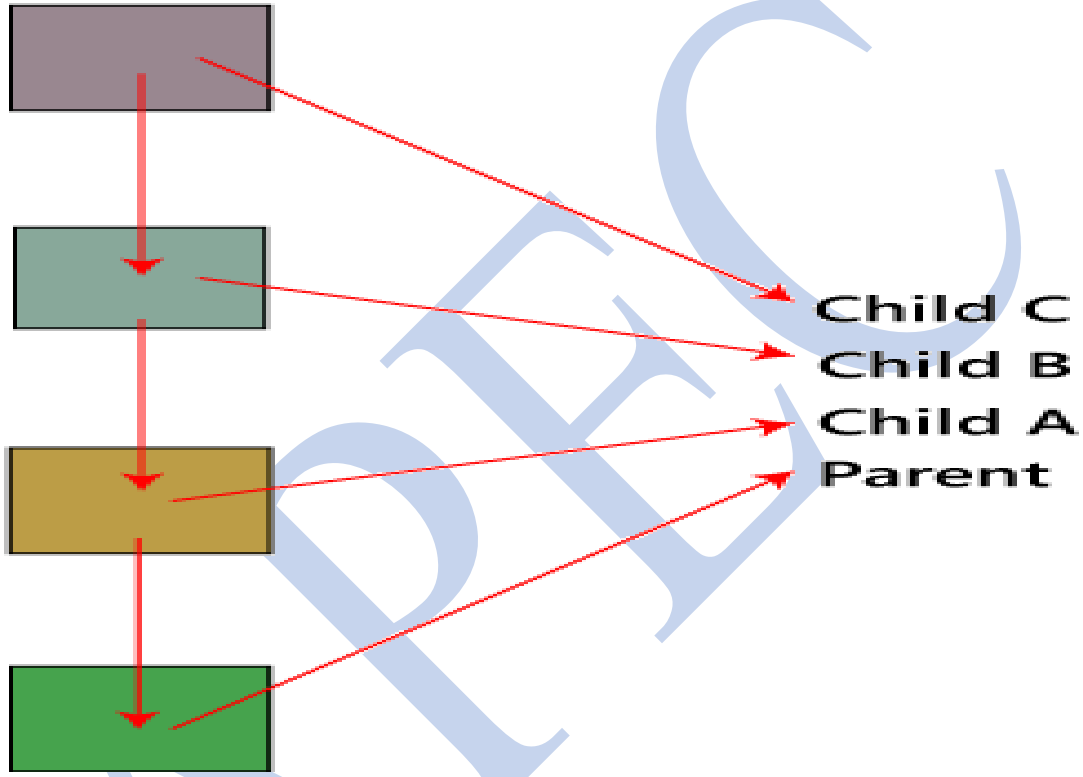
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# Bottom-up Appoarch



In the bottom-up method, we will ensure that the modules we are adding **are the parent of the previous one** as we can see in the below image:

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- **Advantages**
- Identification of defect is easy.

- Do not need to wait for the development of all the modules as it saves time.
- **Disadvantages**
- Critical modules are tested last due to which the defects can occur.
- There is no possibility of an early prototype.
- Non-incremental integration:
- It is given by the “big bang” approach.

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- All components are combined in advance.
- The entire program is tested as a whole.
- A set of errors is tested as a whole.
- Correction is difficult because, once these errors are corrected new ones appear.
- This process continues infinitely.
- Advantages:
- This approach is simple.

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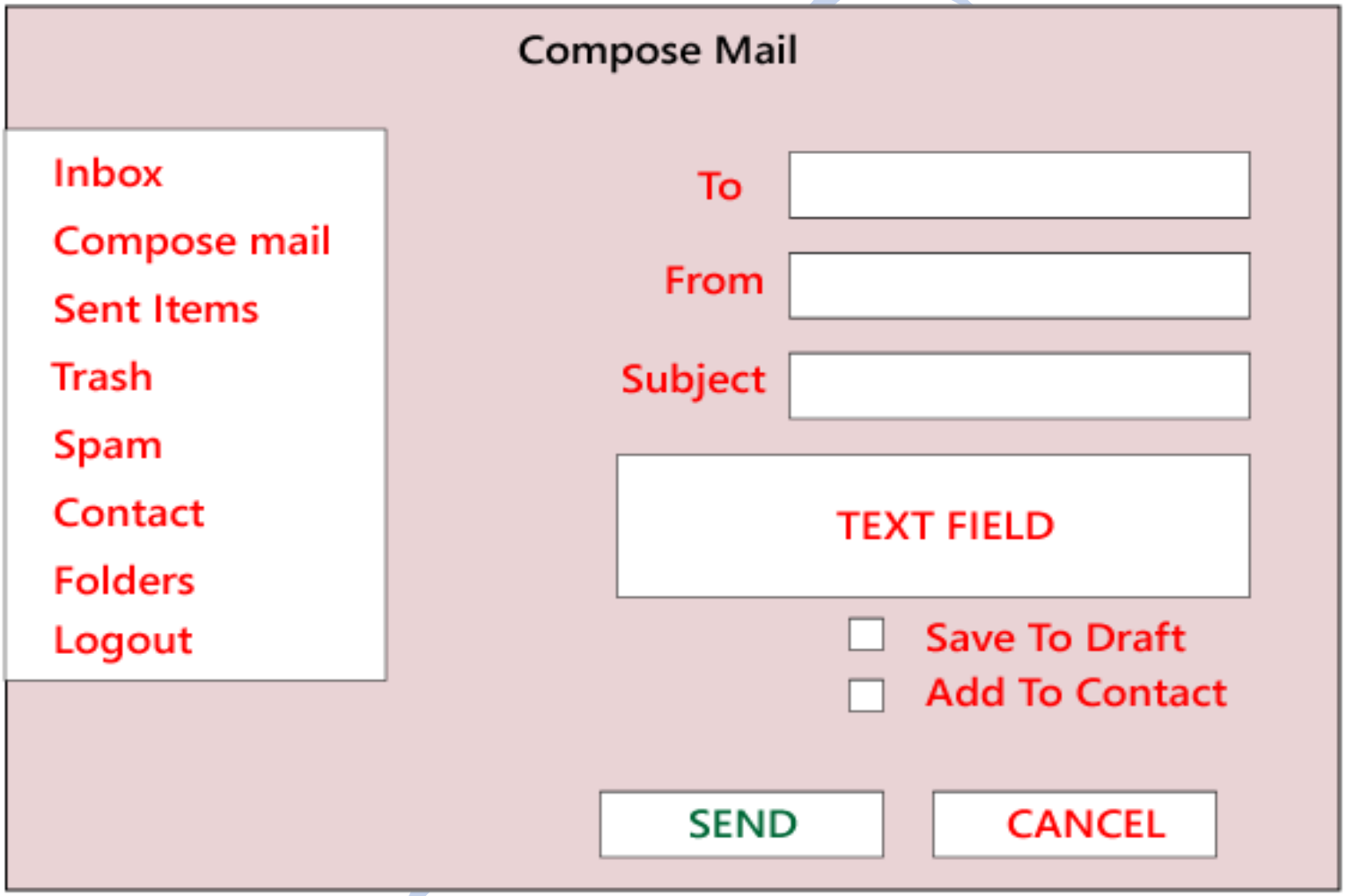
# Example of integration testing

- Let us assume that we have a **Gmail** application where we perform the integration testing.
- First, we will do **functional testing** on **the login page**, which includes the various components such as **username, password, submit, and cancel** button. Then only we can perform integration testing.

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- The different integration scenarios are as follows:

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Compose Mail
Inbox
Compose mail
Sent Items
Trash
Spam
Contact
Folders
Logout
To
From
Subject
TEXT FIELD
Save To Draft
Add To Contact
SEND
CANCEL