**Test-Driven Development (TDD)**

A diagram of a life cycle

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**Integration Testing Approaches**

* Big bang approach
* Incremental approach

In **integration testing**, there are two common approaches to integrating and testing the components or modules of a system: the **Big Bang Approach** and the **Incremental Approach**. Here's an explanation of both:

**1. Big Bang Approach**

The **Big Bang Approach** to integration testing is when all modules or components of the system are integrated together at once, and then testing is performed on the entire system as a whole.

**Characteristics:**

* **All components are combined at the same time**: No intermediate testing is done until everything is developed and integrated.
* **Testing occurs only after full integration**: Once the integration is complete, testing begins to see if the components work together as expected.
* **Time-efficient for development but risky**: Since there is no step-by-step integration, this approach can seem quicker in the initial phases, but it poses significant risks.

**Advantages:**

* **Simple to execute**: There is no need to plan the order of integration.
* **Fast integration**: Developers focus on building the entire system first before testing.

**Disadvantages:**

* **Difficult to isolate issues**: If an error occurs, it can be challenging to determine which component is causing the issue.
* **Risk of critical failures**: If the components don’t work well together, testing and debugging can be complicated, leading to significant delays.
* **Testing is delayed**: Since no testing happens until everything is integrated, bugs may accumulate and become harder to trace and fix.

**Best for:**

* Projects where all components are relatively independent of each other or where the system is relatively simple.

**2. Incremental Approach**

The **Incremental Approach** to integration testing is when components or modules are integrated one at a time, and testing is done as each new module is integrated. This allows testing to occur incrementally, catching issues as they arise.

**Types of Incremental Approaches:**

1. **Top-Down Integration**: Modules are integrated starting from the top of the module hierarchy (typically the main module) and proceed downward, one at a time. Stubs are used to simulate lower modules that haven’t been integrated yet.
2. **Bottom-Up Integration**: Modules are integrated starting from the lower levels of the hierarchy and moving upwards. Drivers (dummy modules) are used to simulate higher-level modules that haven’t been integrated yet.
3. **Hybrid (or Sandwich) Integration**: Combines both top-down and bottom-up approaches, with testing happening in both directions simultaneously.

**Characteristics:**

* **Step-by-step integration**: Components are added and tested incrementally.
* **Early testing**: Issues are detected early in the integration process, reducing the risk of finding complex bugs later on.
* **Isolated testing**: Makes it easier to isolate and debug specific issues in individual components.

**Advantages:**

* **Easier to identify and fix bugs**: Errors can be isolated more easily as testing happens after each module is integrated.
* **Less risk of system-wide failure**: Since the system is tested incrementally, there’s less risk of encountering large, complex issues.
* **Continuous progress and feedback**: Developers get continuous feedback about the integration process.

**Disadvantages:**

* **Requires more time and effort**: The incremental process of adding and testing modules can take more time and requires careful planning.
* **Requires the use of stubs and drivers**: If certain components are not ready, testers may have to use stubs or drivers to simulate missing parts, which can complicate the process.

**Best for:**

* Large or complex systems where components are dependent on each other.
* Systems where early defect detection and isolation are critical.

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Both approaches have their own advantages and drawbacks, and the choice between them depends on the nature of the system being tested and the project requirements.

**Drivers and Stubs**

**Drivers** and **Stubs** are used in **incremental integration testing** to simulate missing components during the testing of individual modules or parts of a system. They allow for partial testing when some modules are not yet developed or integrated. These are especially useful in **Top-Down** or **Bottom-Up Integration Approaches**.

**1. Drivers:**

A **Driver** is a piece of code that simulates a calling module or higher-level component that is not yet developed. Drivers are used in **Bottom-Up Integration Testing**, where lower-level modules are integrated and tested first, and the higher-level modules that would normally call them are not yet available.

**Purpose:**

* **To call the module being tested**: The driver provides the necessary inputs and calls the lower-level module for testing.
* **Simulates control**: The driver mimics the behavior of the parent module (which would call the module being tested), providing the necessary environment for the test.

**Example:**

Suppose we are testing a function that calculates the total sales in a store, but the main program that calls this function is not yet developed. We create a driver to simulate the main program's behaviour by providing the necessary inputs and invoking the function to test its functionality.

**When to use:**

* **Bottom-Up Integration**: When lower-level modules are ready, but the higher-level modules that should call them are not.

**2. Stubs:**

A **Stub** is a piece of code that simulates a called module or lower-level component that is not yet developed. Stubs are used in **Top-Down Integration Testing**, where higher-level modules are tested first, and the lower-level modules that the higher-level module depends on are not yet available.

**Purpose:**

* **To simulate a lower-level module's response**: The stub provides dummy data or a fixed response when the module being tested calls it.
* **Provides a temporary placeholder**: The stub helps in testing higher-level modules by simulating the behavior of lower-level modules that are still in development.

**Example:**

Suppose you have developed a function that processes customer orders but haven't yet developed the function to retrieve customer details from a database. You can create a stub to simulate the response from the database, returning mock customer details so that you can test the order processing function.

**When to use:**

* **Top-Down Integration**: When higher-level modules are ready but lower-level modules that they depend on are not.

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**Summary:**

* **Drivers** are temporary components that simulate **higher-level modules** and are used to test **lower-level modules**.
* **Stubs** are temporary components that simulate **lower-level modules** and are used to test **higher-level modules**.

Both are essential in incremental testing strategies to allow testing even when all components are not yet available.

A diagram of a driver's program

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A diagram of a software development process

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A diagram of a software development process

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**Top-down** and **Bottom-up** are two popular approaches used in **incremental integration testing**, where components are integrated and tested step by step. Here’s a detailed comparison and explanation of both approaches:

**1. Top-Down Integration Testing**

In the **Top-Down Integration Testing** approach, the system is developed and tested starting from the **topmost module (main module)** in the hierarchy, progressively integrating and testing lower-level modules step by step.

**Key Characteristics:**

* **Starts with the top-level module**: The process begins with the highest-level module in the system hierarchy, usually the "main" function or controller.
* **Uses stubs for missing lower-level modules**: Since lower-level modules may not yet be developed, **stubs** are used as placeholders to simulate their behavior.
* **Progressively replaces stubs with actual modules**: As lower modules are developed, they replace the stubs, and integration testing continues down the hierarchy.
* **Test-driven by control flow**: Testing follows the control flow of the program, starting at the top and moving downward.

**Advantages:**

* **Early discovery of design issues**: Since testing starts at the top, architectural and control flow issues can be detected early.
* **Demonstrates system-level functionality early**: Early integration of high-level modules allows testers to see the system’s behavior early in the process.
* **No need for drivers**: The higher-level modules are already in place to invoke lower-level modules as they are integrated.

**Disadvantages:**

* **Requires many stubs**: If lower-level modules aren’t ready, many stubs must be created to simulate them.
* **Lower-level testing is delayed**: Lower modules may not be tested thoroughly until later in the process, as they are integrated only after the higher modules.
* **Time-consuming to create and maintain stubs**: Developing accurate stubs can be complex and adds overhead.

**Best Suited For:**

* Systems where the high-level functionality is critical and should be tested first, such as user interfaces or control systems.

**2. Bottom-Up Integration Testing**

In the **Bottom-Up Integration Testing** approach, testing begins with the **lowest-level modules** (i.e., the foundational components), and progressively higher-level modules are integrated and tested.

**Key Characteristics:**

* **Starts with the lowest-level modules**: Testing begins at the base of the module hierarchy (utility or foundational modules).
* **Uses drivers for missing higher-level modules**: Since the higher-level modules may not be ready, **drivers** are used to simulate the behavior of the calling (higher) modules.
* **Progressively integrates higher modules**: Once the lower modules are integrated and tested, higher modules are gradually added and tested.
* **Test-driven by data flow**: The approach generally follows the data flow, starting from the data-processing modules and moving upward.

**Advantages:**

* **Thorough testing of lower-level modules**: Since lower modules are tested first, they are thoroughly verified before being integrated into higher-level modules.
* **No need for stubs**: There’s no need to simulate lower-level modules, as they are developed and tested first.
* **Easier debugging**: Testing lower modules first makes it easier to isolate and fix issues, as foundational components are tested before integration with higher modules.

**Disadvantages:**

* **Drivers required**: Test drivers need to be created to simulate higher-level modules, which adds overhead.
* **Late discovery of system-level issues**: Since higher-level modules and the overall control flow of the system are tested later, system-level issues may be discovered late in the process.
* **Top-level functionality is delayed**: The full system functionality, especially at the user interface or control levels, is tested late in the process.

**Best Suited For:**

* Systems where foundational or utility modules are critical, and their correctness is paramount, such as database or backend-heavy systems.

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**Summary:**

* **Top-Down Integration**: Starts with high-level modules and integrates downward. It’s ideal for systems where the control flow or user interface is critical, but it requires **stubs** to simulate lower modules.
* **Bottom-Up Integration**: Starts with low-level modules and integrates upward. It’s ideal for systems where foundational components are critical, but it requires **drivers** to simulate higher modules.

Choosing between **Top-Down** and **Bottom-Up** depends on the system’s architecture and what parts of the system are most critical to test first.

**Postman**

* npm install (Terminal) to install all the dependencies
* Create **.env** file
* npm run seed (Terminal) to seed some dummy data
* npm run start (Terminal) to run the project

1. Postman Desktop (if we use localhost, we need this. Otherwise, can use web Postman).
   1. <https://www.postman.com/downloads/>
2. Create a new environment

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1. Create a new collection

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1. Create a new request

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* <https://reqres.in/>
  1. Login endpoint. Since I was using seed, the default username = admin and password = okay.

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* 1. Create endpoint. Need AccessToken field (Get from Login endpoint).

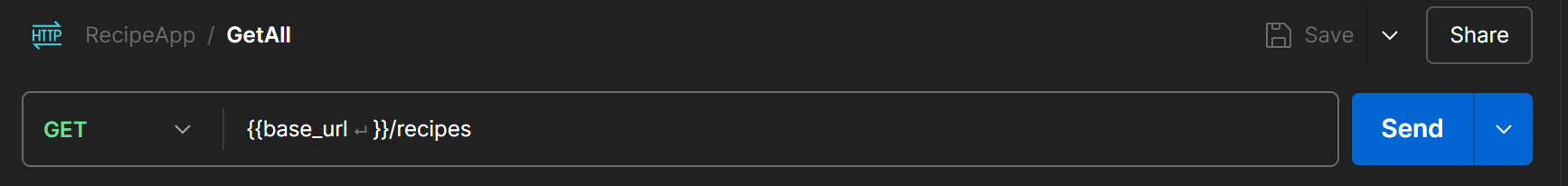
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* 1. GetAll



* 1. GetOne. Need the \_id field from GetAll request.

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* 1. PATCH (Partial update) vs PUT (Entire update). Need AccessToken field (Get from Login endpoint).

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* 1. DELETE. Need AccessToken field (Get from Login endpoint).

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**Introduction to Jest**

* **Jest:** a testing library created by Facebook to help test JavaScript code.

**Setup Jest for testing RESTful API**

* HTTP Requests
  + GET
  + POST
  + PATCH
  + PUT
  + DELETE