Testing Concepts

Lesson 3: Testing throughout the Software Life Cycle

Capgemini

Lesson Objectives

To understand the following topics:

- Testing throughout the Software Life Cycle
- Introduction of SDLC and V-Model
- SDLC and V-Model
- Iterative Life Cycles
- Rapid Application Development
- Rational Unified Process (RUP) Phases
- RUP Phases and Disciplines
- Agile Development – Extreme Programming (XP)
- Testing Phases
- Introduction of Component Testing
- Component /Unit Testing

Lesson Objectives

To understand the following topics:

- Introduction of Integration testing
- Why Integration Testing is Required?
- Types of Integration testing
- Top Down Integration Testing
- Top Down Integration Testing
- Bottom Up Integration Testing
- Top Down vs. Bottom Up Testing
- Introduction to System Testing
- Types of System Testing

Testing throughout the Software Life Cycle

Testing is not a stand-alone activity

It has its place within a SDLC model

In any SDLC model, a part of testing is focused on Verification and a part is focused on Validation

- Verification: Is the deliverable built according to the specification?
- Validation: Is the deliverable fit for purpose?

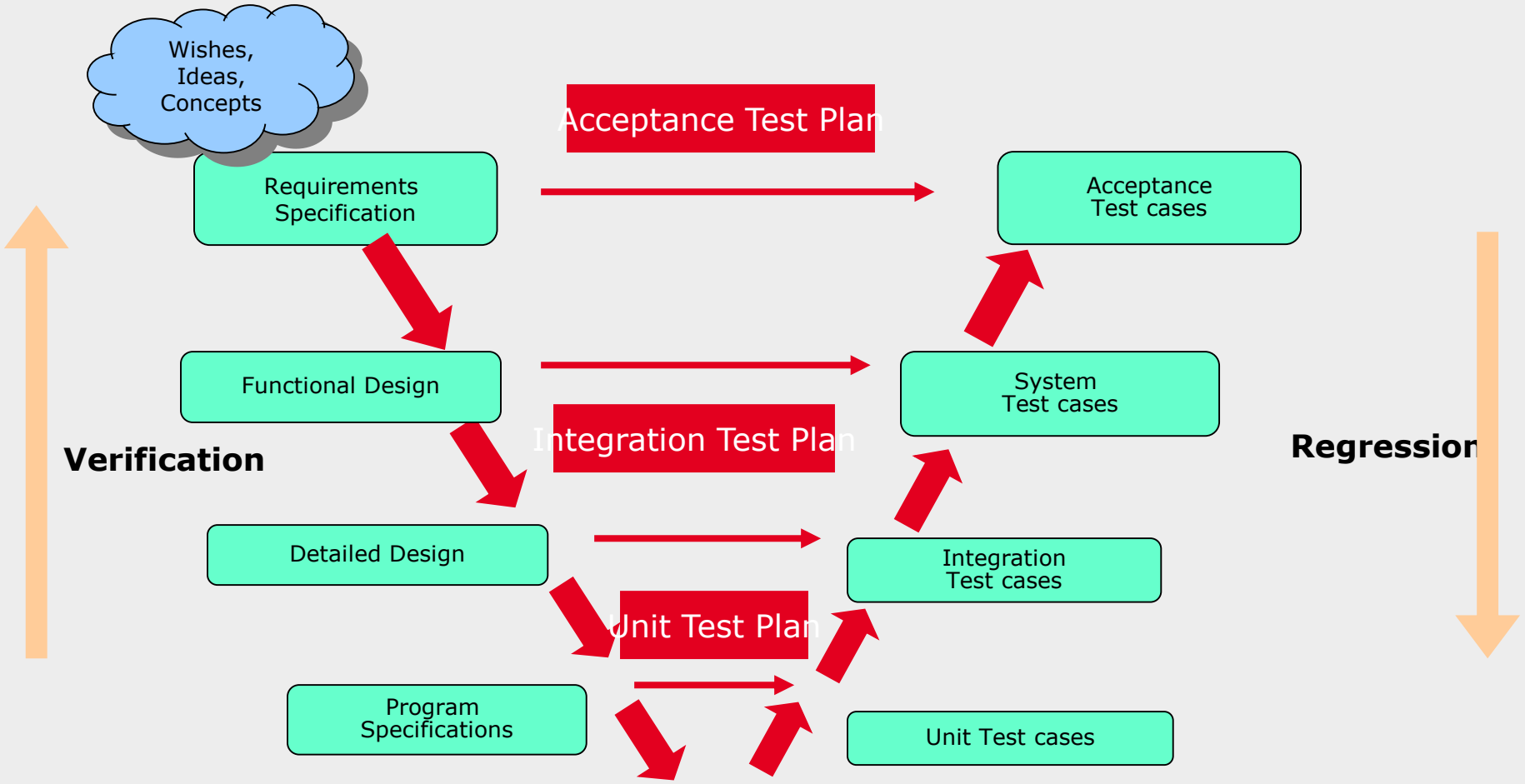
Various SDLC models are :

- V-Model
- Iterative life cycles
  - Rapid Application Development (RAD)
  - Rational Unified Process (RUP)
  - Dynamic System Development Methodology [DSDM]
  - Agile - Extreme Programming (XP)

Introduction of SDLC and V-Model

- There are some distinct test phases that take place in each of the software life cycle activity
- It is easier to visualize through the famous Waterfall development model and V- model of testing
- The V proceeds from left to right, depicting the basic sequence of development and testing activities
- The V model is valuable because it highlights the existence of several levels or phases of testing and depicts the way each relates to a different development phase.

SDLC and V-Model



Iterative Life Cycles

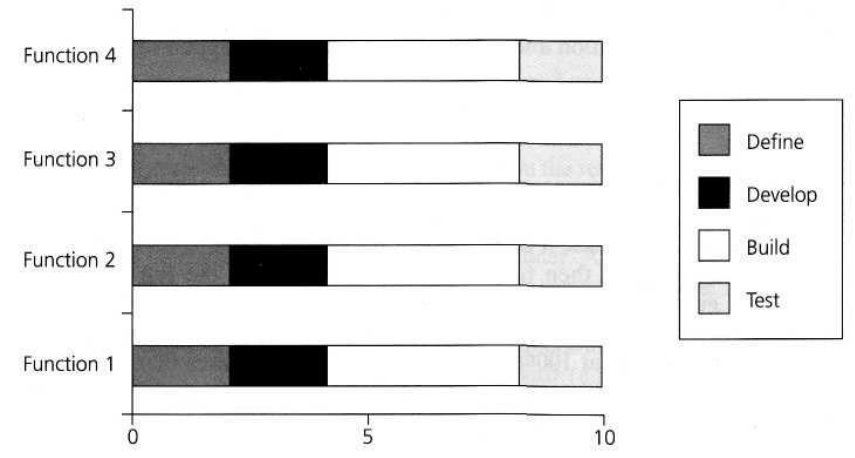
- Iterative life cycle can give early market presence with critical functionality .
- The delivery is divided into increments. Each increment adds new functionality.
- Testing of the new functionality, regression testing, and integration testing are prominent test types performed in iterative life cycle models.
- Simpler to manage because the workload is divided into smaller pieces
- Iterative models are also known as incremental development models

Examples are

- Rapid Application Development (RAD)
- Rational Unified Process (RUP)
- Agile development

Rapid Application Development

- Components are developed in parallel
- The developments are time-boxed, delivered, and then assembled into a working prototype
- Very quickly gives the customer something to see and use
- Rapid development and rapid response to changing requirements is possible
- Allows early validation of technology risks



Rational Unified Process (RUP) Phases

RUP is created by the Rational Software Corporation consisting of four phases and nine disciplines

Inception

- The objective is to define scope the system. The business case which includes business context, success factors and financial forecast is established.

Elaboration

- The objective is to mitigate the key risk items. The problem domain analysis is made and the architecture of the project gets its basic form.

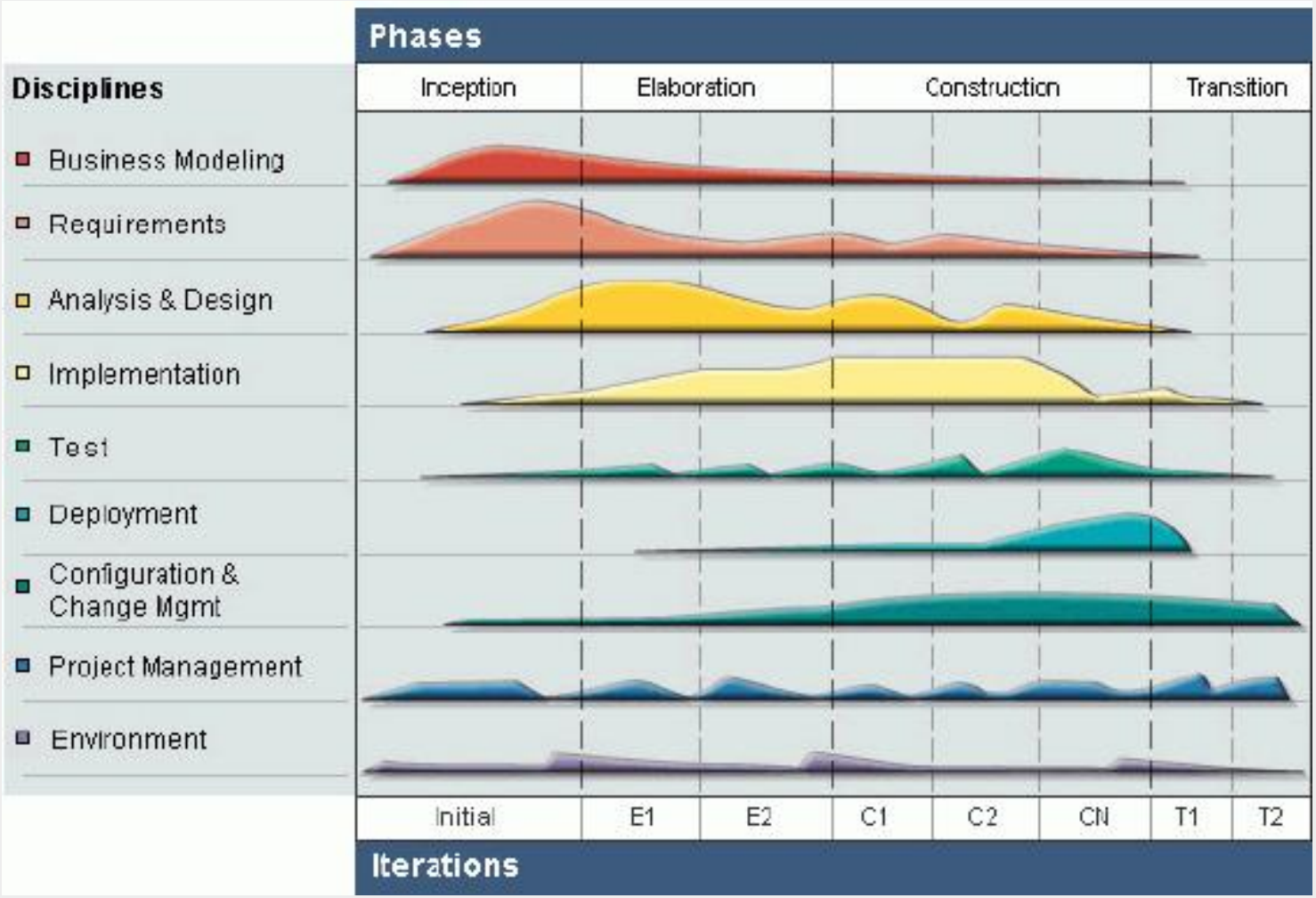
Construction

- The objective is to build the software system. The main focus is on the development of components of the system.

Transition

- The objective is to 'transit' the system from development into production. Activities include train the end users and beta testing the system.

RUP Phases and Disciplines



Agile Development – Extreme Programming (XP)

XP is one of the most well-known agile development life cycle models.

Some characteristics of XP are:

- It promotes the generation of business stories to define the functionality
- It demands an on-site customer for continual feedback and to define and carry out functional acceptance testing
- It promotes pair programming and shared code ownership amongst the developers
- It states that component test scripts shall be written before the code is written and those tests are automated
- It states that integration and testing of the code shall happen several times a day
- It focuses on implementing the simplest solution to meet today's problems

Testing Phases

Unit (Component) testing

- Unit testing is code-based and performed primarily by developers to demonstrate that their smallest pieces of executable code function suitably.

Integration testing

- Integration testing demonstrates that two or more units or other integrations work together properly, and tends to focus on the interfaces specified in low-level design.

System testing

- System testing demonstrates that the system works end-to-end in a production-like environment to provide the business functions specified in the high-level design.

Acceptance testing

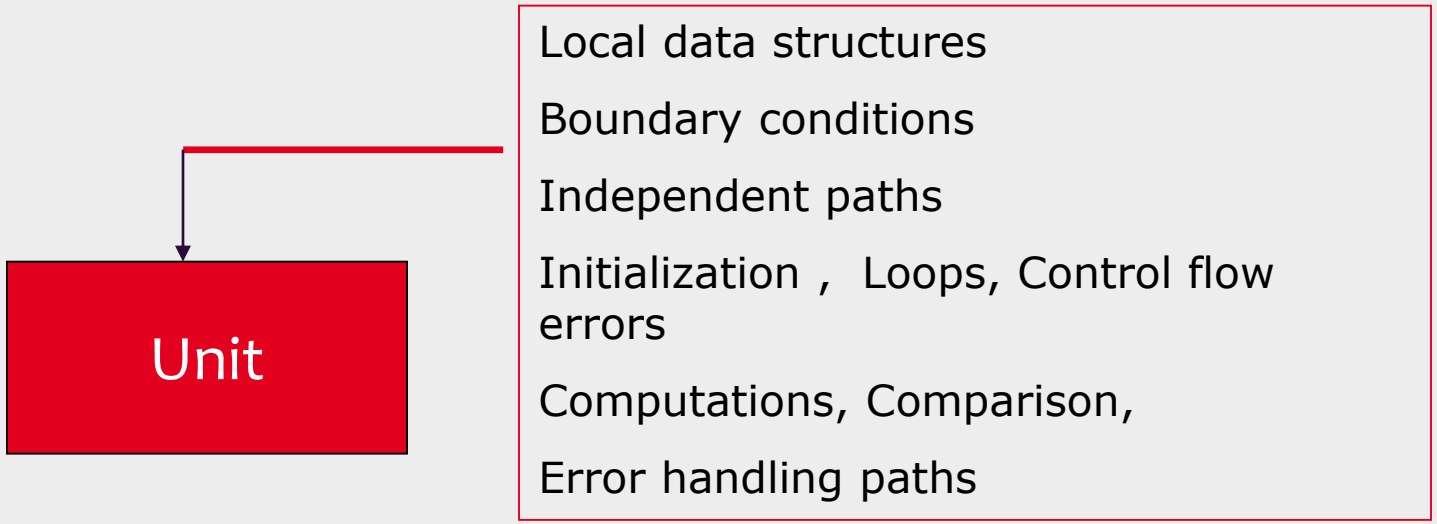
- Acceptance testing is conducted by business owners and users to confirm that the system does, in fact, meet their business requirements.

Introduction of Component Testing

- The most 'micro' scale of testing to test particular functions, procedures or code modules is called Component testing ; Also called as Module or Unit testing
- Typically done by the programmer and not by Test Engineers, as it requires detailed knowledge of the internal program design and code
- Purpose is to discover discrepancies between the unit's specification and its actual behavior
- Testing a form, a class or a stored procedure can be an example of unit testing

Component /Unit Testing

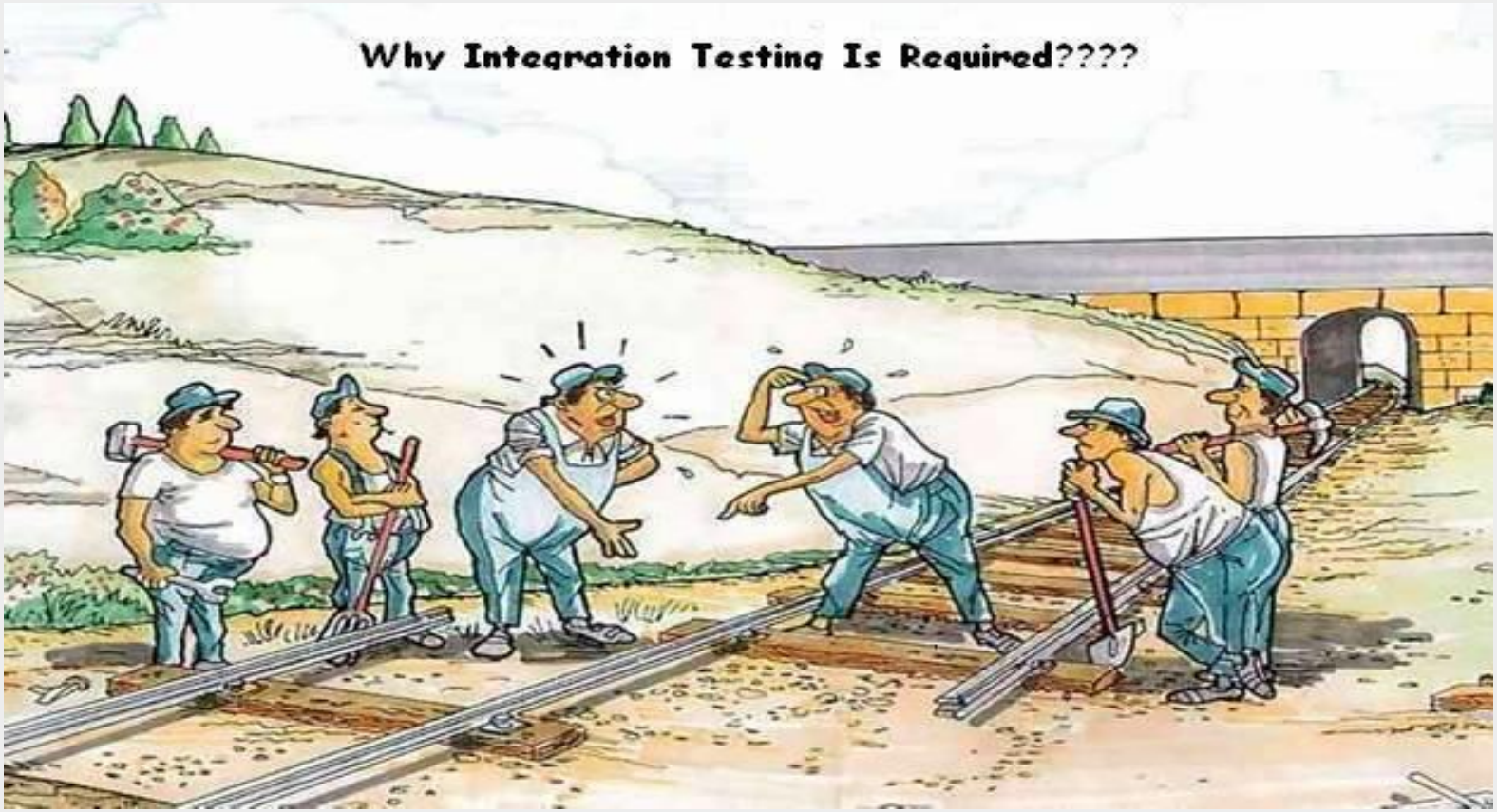
Unit testing uncovers errors in logic and function within the boundaries of a component.



Introduction of Integration testing

- Testing of combined parts of an application to determine if they function together correctly
- The main three elements are interfaces, module combinations and global data structures
- Attempts to find discrepancies between program & its external specification (program’s description from the point of view of the outside world)
- Testing a module to check if the component of the modules are integrated properly is example of integration testing

Why Integration Testing is Required?



Types of Integration testing

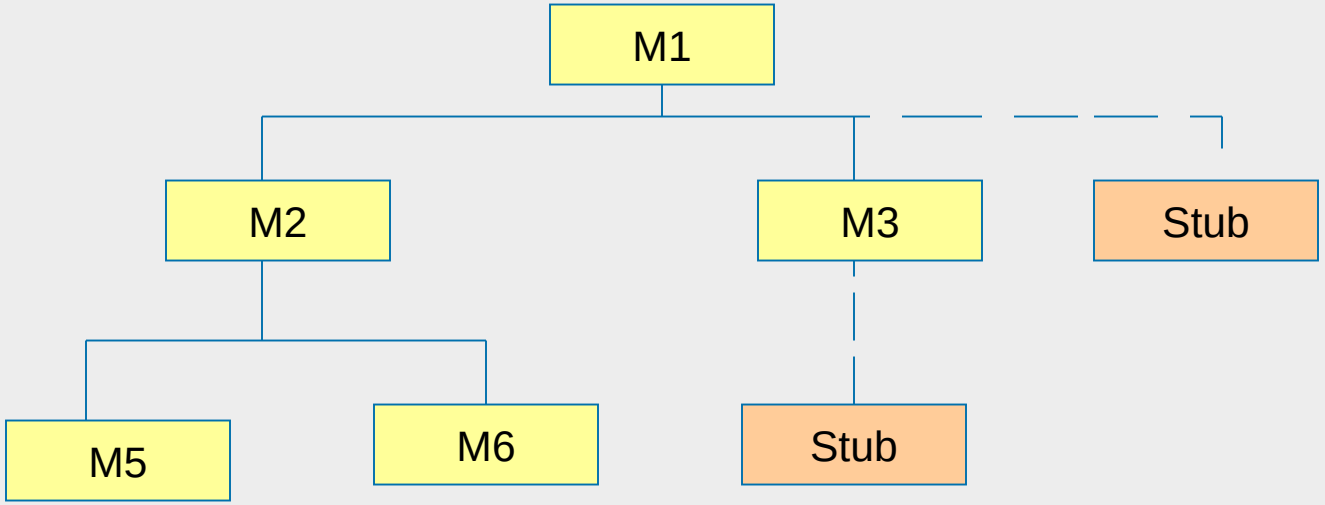
Modules are integrated by two ways.

- Non-incremental Testing (Big Bang Testing)
- Each Module is tested independently and at the end, all modules are combined to form a application
- Incremental Module Testing.
  - There are two types by which incremental module testing is achieved.
- Top down Approach
- Bottom up Approach

Top Down Integration Testing

Top Down Incremental Module Integration:

- Firstly top module is tested first. Once testing of top module is done then any one of the next level modules is added and tested. This continues till last module at lowest level is tested.



Top Down Integration Testing (Cont.)

Integration approach can be done Depth first or Breadth-first.

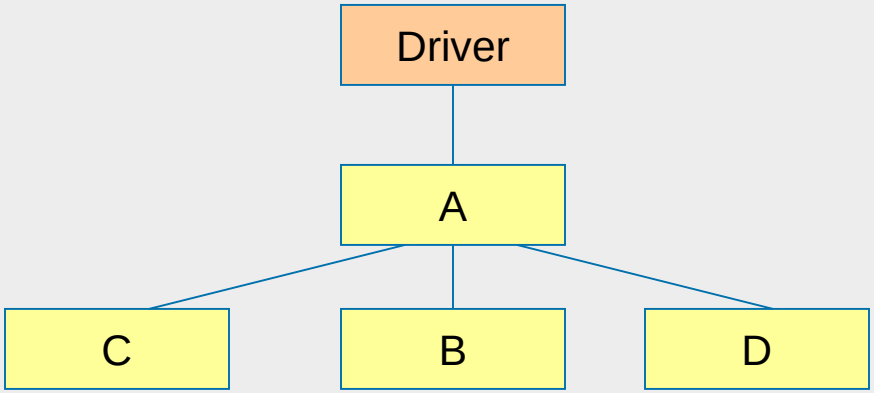
Top down testing

- The main control module is used as a test driver
- Stubs are substituted for all components directly subordinate to the main control module
- Depending on the approach subordinate stubs are replaced by actual components

Bottom Up Integration Testing

Bottom Up Incremental Module Integration:

- Firstly module at the lowest level is tested first. Once testing of that module is done then any one of the next level modules is added to it and tested. This continues till top most module is added to rest all and tested



Bottom Up Integration Testing (Cont.)

Bottom-Up testing

- Low-level components are combined into clusters (builds) that perform a specific sub function
- A driver is written to coordinate test case input and output
- Drivers are removed and clusters are combined moving upward in the program structure

Top Down vs. Bottom Up Testing

Top Down Testing	
Advantages	**Disadvantages**
Advantageous if major flaws occur toward the top of the program	Stub modules must be produced
Once the I/O functions are added, representation of test cases are easier	Stub Modules are often more complicated than they first appear to be.
Early skeletal Program allows demonstrations and boosts morale	Before the I/O functions are added, representation of test cases in stubs can be difficult
	Test conditions may be impossible, or very difficult, to create
	Observation of test output is more difficult
	Allows one to think that design and testing can be overlapped
	Induces one to defer completion of the testing of certain modules.

Top Down vs. Bottom Up Testing

Bottom Up testing	
Advantages	**Disadvantages**
Advantageous if major flaws occur toward the bottom of the program	Driver Modules must be produced
Test conditions are easier to create	The program as an entity does not exist until the last module is added
Observation of test results is easier	

Introduction to System Testing

- Test the software in the real environment in which it is to operate. (hardware, people, information, etc.)
- Observe how the system performs in its target environment, for example in terms of speed, with volumes of data, many users, all making multiple requests.
- Test how secure the system is and how can the system recover if some fault is encountered in the middle of procession.
- System Testing, by definition, is impossible if the project has not produced a written set of measurable objectives for its product.

Types of System Testing

- Functional Testing
- Performance Testing
- Volume Testing
- Load Testing
- Stress Testing
- Security Testing
- Web Security Testing
- Localization Testing
- Usability Testing
- Recovery Testing
- Documentation Testing
- Configuration Testing
- Installation Testing
- User Acceptance Testing
- Testing related to Changes : Re-Testing and Regression Testing
- Re-testing (Confirmation Testing)
- Regression Testing
- Exploratory Testing
- Maintenance Testing

Functional Testing

The main objective of functional testing is to verify that each function of the software application / system operates in accordance with the written requirement specifications

It is a black-box process

- Is not concerned about the actual code
- Focus is on validating features
- Uses external interfaces, including Application programming interfaces (APIs), Graphical user interfaces (GUIs) and Command line interfaces (CLIs)

Testing functionality can be done from two perspectives :

- Business-process-based testing uses knowledge of the business processes
- Requirements-based testing uses a specification of the functional requirements for the system as the basis for designing tests

Performance Testing

Performance

- Performance is the behavior of the system w.r.t. goals for time, space, cost and reliability

Performance objectives:

- Throughput : The number of tasks completed per unit time. Indicates how much work has been done within an interval
- Response time : The time elapsed during input arrival and output delivery
- Utilization : The percentage of time a component (CPU, Channel, storage, file server) is busy

Performance Testing (Cont.)

- The objective of performance testing is to devise test case that attempts to show that the program does not satisfy its performance objectives.
- To ensure that the system is responsive to user interaction and handles extreme loading without unacceptable operational degradation.
- To test response time and reliability by increased user traffic.
- To identify which components are responsible for performance degradation and what usage characteristics cause degradation to occur.

Volume Testing

This testing is subjecting the program to heavy volumes of data. For e.g.

- A compiler would be fed a large source program to compile
- An operating systems job queue would be filled to full capacity
- A file system would be fed with enough data to cause the program to switch from one volume to another.

Load Testing

Volume testing creates a real-life end user pressure for the target software. This tests how the software acts when numerous end users access it concurrently. For e.g.

- Downloading a sequence of huge files from the web
- Giving lots of work to a printer in a line

Stress Testing

Stress testing involves subjecting the program to heavy loads or stresses.

The idea is to try to “break” the system.

That is, we want to see what happens when the system is pushed beyond design limits.

It is not same as volume testing.

A heavy stress is a peak volume of data encounters over a short time.

In Stress testing a considerable load is generated as quickly as possible in order to stress the application and analyze the maximum limit of concurrent users the application can support.

Stress Testing(Cont.)

Stress tests executes a system in a manner that demands resources in abnormal quantity, frequency, or volume

Example :

- Generate 5 interrupts when the average rate is 2 or 3
- Increase input data rate
- Test cases that require max. memory

Stress Tests should answer the following questions

- Does the system degrade gently or does the server shut down
- Are appropriate messages displayed ? E.g. Server not available
- Are transactions lost as capacity is exceeded
- Are certain functions discontinued as capacity reaches the 80 or 90 percent level

Security Testing

Security Testing verifies that protection mechanisms built into the system will protect it from improper penetration.

Security testing is the process of executing test cases that subvert the program's security checks.

Example :

- One tries to break the operating systems memory protection mechanisms
- One tries to subvert the DBMS's data security mechanisms
- The role of the developer is to make penetration cost more than the value of the information that will be obtained

Web Security Testing

Web application security is a branch of Information Security that deals specifically with security of web applications.

It provides a strategic approach in identifying, analyzing and building a secure web applications.

It is performed by Web Application Security Assessment.

Localization Testing

Localization translates the product UI and occasionally changes some settings to make it suitable for another region.

The test effort during localization testing focuses on

- Areas affected during localization, UI and content
- Culture/locale-specific, language specific and region specific areas

Usability Testing

Usability is

- The effectiveness, efficiency and satisfaction with which specified users can achieve specified goals in a particular environment ISO 9241-11
- Effective–- Accomplishes user's goal
- Efficient-- Accomplishes the goal quickly
- Satisfaction–- User enjoys the experience

Test Categories and objectives

- Interactivity (Pull down menus, buttons)
- Layout
- Readability
- Aesthetics
- Display characteristics
- Time sensitivity
- Personalization

Usability Testing (Cont.)

Using specialized Test Labs a rigorous testing process is conducted to get quantitative and qualitative data on the effectiveness of user interfaces

Representative or actual users are asked to perform several key tasks under close observation, both by live observers and through video recording

During and at the end of the session, users evaluate the product based on their experiences

Recovery Testing

A system test that forces the software to fail in variety of ways, checks performed

- recovery is automatic (performed by the system itself)
- reinitialization
- check pointing mechanisms
- data recovery
- restarts are evaluated for correctness

This test confirms that the program recovers from expected or unexpected events. Events can include shortage of disk space, unexpected loss of communication

Documentation Testing

This testing is done to ensure the validity and usability of the documentation

This includes user Manuals, Help Screens, Installation and Release Notes

Purpose is to find out whether documentation matches the product and vice versa

Well-tested manual helps to train users and support staff faster

Configuration Testing

Attempts to uncover errors that are specific to a particular client or server environment

Create a cross reference matrix defining all probable operating systems, browsers, hardware platforms and communication protocols

Test to uncover errors associated with each possible configuration

Installation Testing

Installer is the first contact a user has with a new software!!!

Installation testing is required to ensure:

- Application is getting installed properly
- New program that is installed is working as desired
- Old programs are not hampered
- System stability is maintained
- System integrity is not compromised

User Acceptance Testing

A test executed by the end user(s) in an environment simulating the operational environment to the greatest possible extent, that should demonstrate that the developed system meets the functional and quality requirements

Not a responsibility of the Developing Organization

To test whether or not the right system has been created

Usually carried out by the end user

Two types are :

- User Acceptance Testing
- Operational Acceptance Test / Production Acceptance Test
- Contract Acceptance Testing
- Compliance acceptance testing / Regulation Acceptance Testing
- Alpha Testing
- Beta Testing

Testing related to Changes : Re-Testing and Regression Testing

The target of testing is the testing of changes.

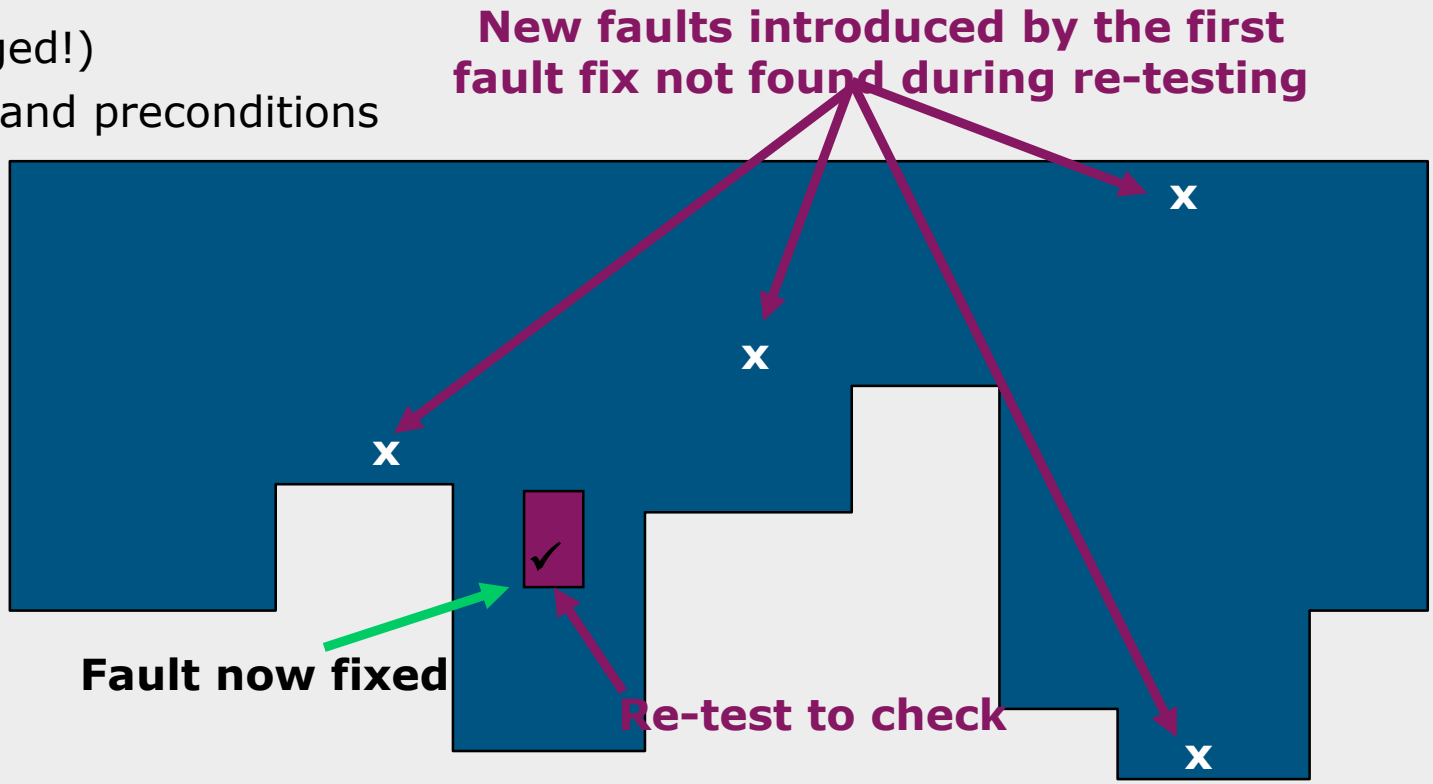
It includes below Test Types :

- Confirmation testing (Re-testing) – Re-execution of the test after defects are fixed. The test is executed in exactly the same way as it was the first time
- Regression testing – Ensures that the software is not adversely affected by the changes and critical functionality of the software is still intact. Generally there will be a regression test suite or regression test pack and executed whenever the software changes

Re-testing (Confirmation Testing)

Re-Running failed tests:

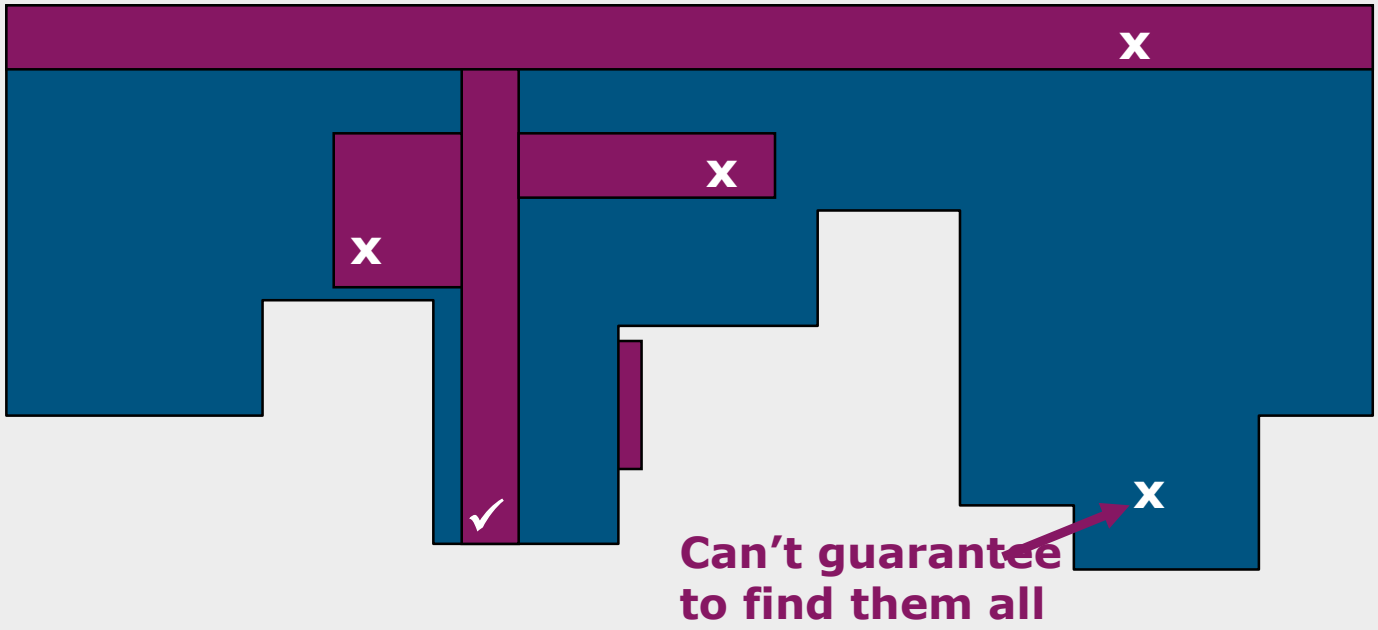
- Must be exactly repeatable
- Same environment, versions (except for the software which has been intentionally changed!)
- Same inputs and preconditions



Regression Testing

Regression tests are performed:

- To look for any unexpected side-effects
- After software changes, including faults fixed
- When the environment changes, even if application stays same
- For emergency fixes (possibly a subset)



Maintenance Testing

Testing done after the system is deployed or on existing system is called Maintenance testing

It is different from maintainability testing, which defines how easy it is to maintain the system

It consists of two parts:

1. Testing the changes and defects
2. Regression tests

Impact and risk analysis is important activity performed to determine Test efforts

It is triggered by planned modifications, Ad-hoc corrective modifications, migration, or retirement of the system

Summary

In this lesson, you have learnt:

- Verification refers to a set of activities which ensures that software correctly implements a specific function.
- Validation refers to a different set of activities which ensures that the software that has been built is traceable to customer requirements.
- Different testing phases are
  - Unit testing
  - Integration testing
  - System testing
  - Acceptance testing
- Exploratory testing is simultaneous learning, test design and test execution.

Review Question

Question 1: _____ is a Quality improvement process

Question 2: To test a function, the programmer has to write a _____, which calls the function to be tested and passes it test data

Question 3: Volume tests executes a system in a manner that demands resources in abnormal quantity, frequency, or volume

- True/False

Question 4: Acceptance testing is not a responsibility of the Developing Organization

- True/False

Question 5: Difference between re-testing & regression testing is :

- re-testing is running a test again; regression testing looks for unexpected side effects
- re-testing looks for unexpected side effects; regression testing is repeating

Review Question: Match the Following

1. Beta testing	A. Volume testing
2. Response time	B. Exploratory testing
3. Aesthetics	C. Acceptance testing
	D. Documentation testing
	E. Performance testing
	F. Usability testing