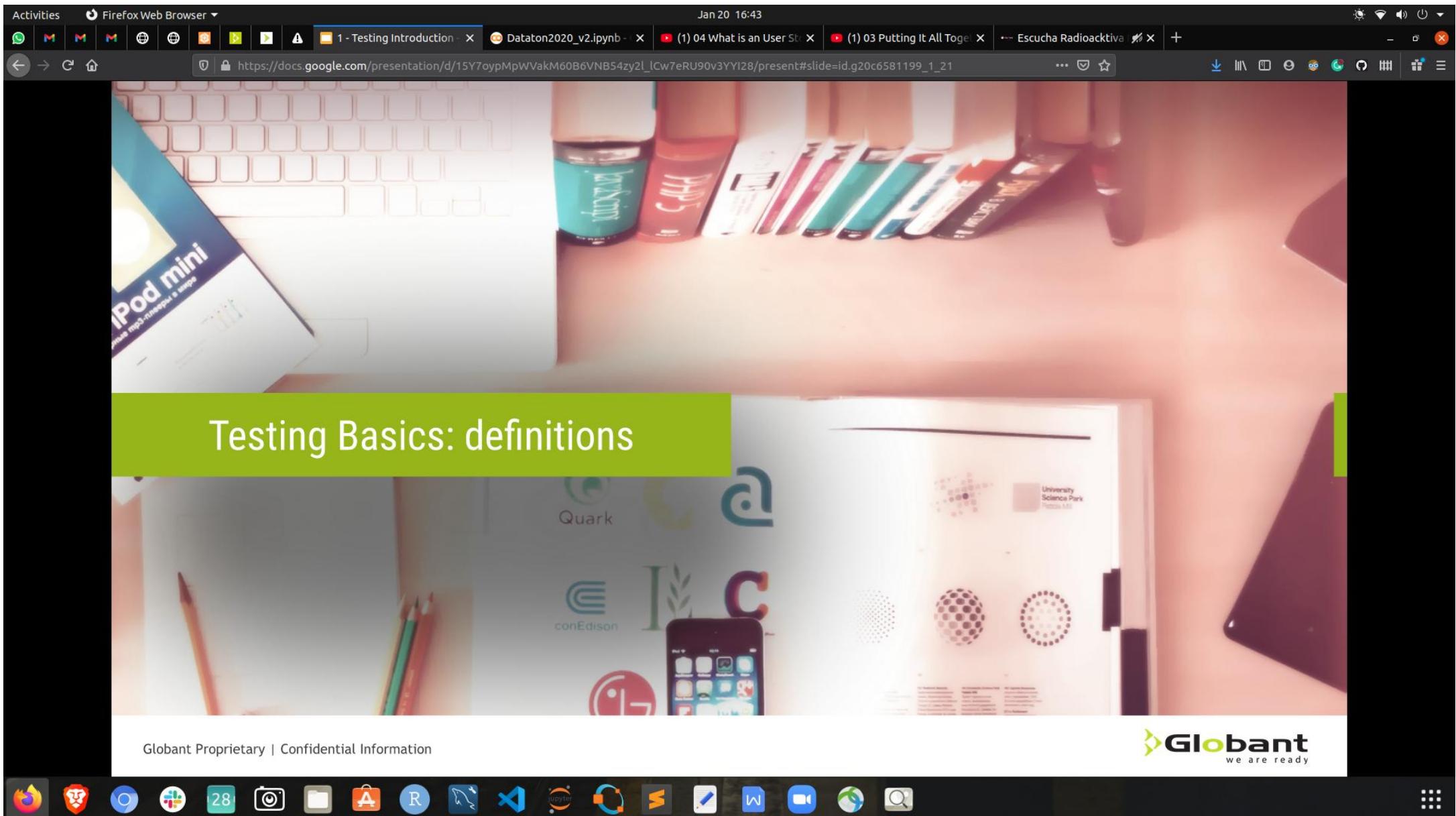




## Topics

- Testing Basics: definitions
- Testing Levels
- Testing Types
- Test Techniques Overview: Black and White Box
- Test Cases Design Techniques: introduction



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# Testing Basics

## IEEE's Definition

Is the process of operating a system or a system component to evaluate specific aspects under specific conditions, observing and registering the results

The testing of software is the process of executing a program with the intention of finding errors (Meyers)

"The process of executing a program with the intention of certifying its quality" (Mills)

Testing a program is exercising it with the worst intentions to find errors

Testing is the art of destroying something constructively

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# Testing Basics

## Economic Value (ROI) of a Test

\$

Cost generated by defects

Cost of testing

% eliminated errors

- To continue testing is an economic decision.
- Finding a balance between the cost of the pending tests and the cost that could be generated by the pending bugs to be yet discovered.

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# Testing Basics

## Economic Value (ROI) of a Test

\$

Cost generated by defects

% eliminated errors

Cost of testing

- Exhaustive testing: A test approach in which the test suite comprises all combinations of input values and preconditions.
- Exhaustive testing is frequently not possible hence it becomes an economic decision.

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# Testing Basics

## Why is testing necessary?

Because errors exist... Why?

- Everyone makes mistakes, errors or omissions
- Not having the required skills
- Poor communication
- Incomplete or changing requirements
- Too many assumptions
- Reduce Cost: As time passes, the cost of fixing a defect increases.

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# Testing Basics

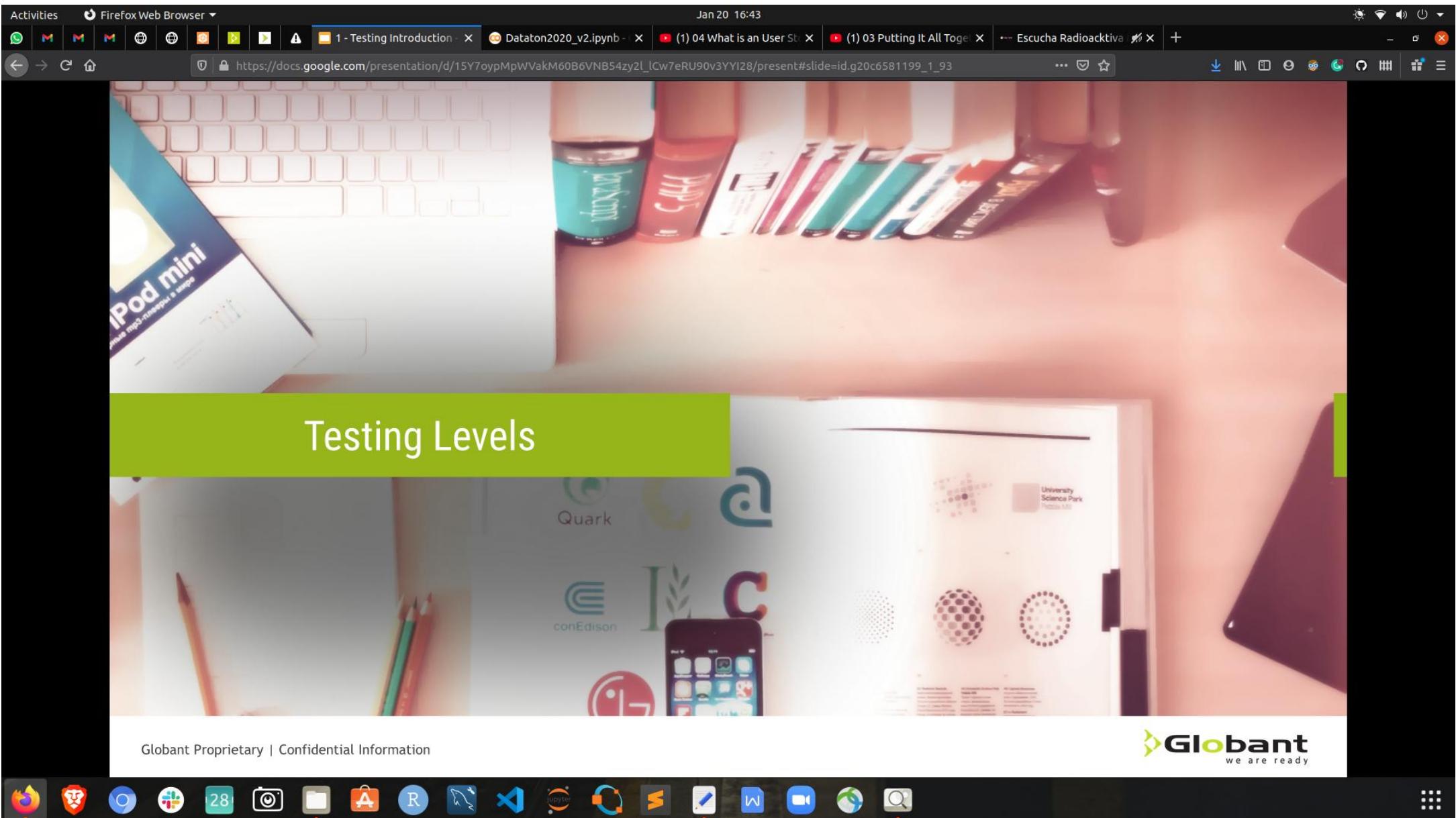
Now, you can see:

## Why Testing is Important

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# Testing Levels STLC (Software Development Life Cycle)

- A process that consists of a series of planned activities to develop or alter the Software Products.
  - The life cycle defines a methodology for improving the quality of software and the overall development process.
  - The following are the most important and popular SDLC models followed in the industry: **Agile Model**, RAD Model, Rapid Application Development, Prototyping Models, **Waterfall Model**, Iterative Model, Spiral Model, **V-Model**, Big Bang Model and many others.



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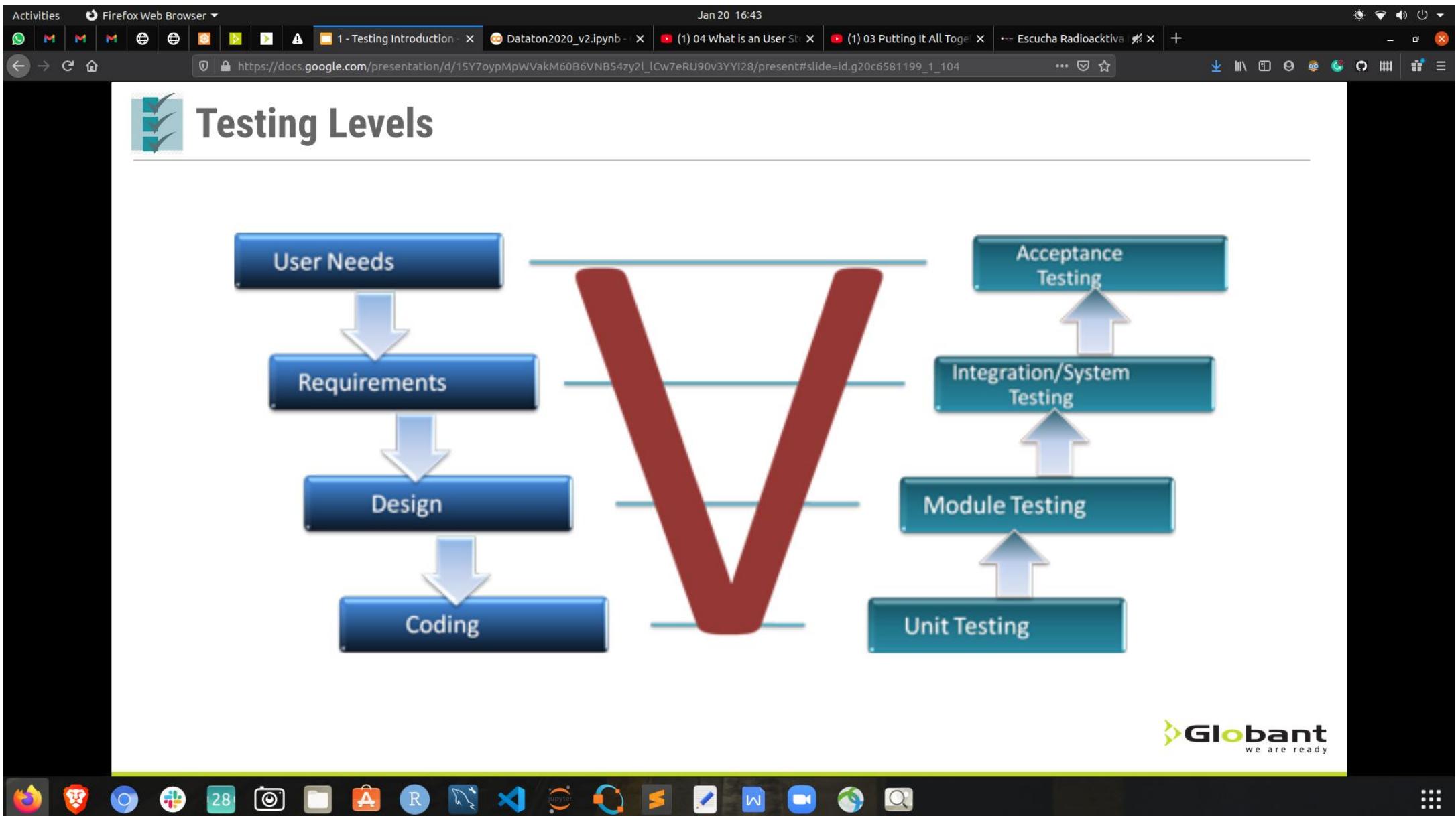
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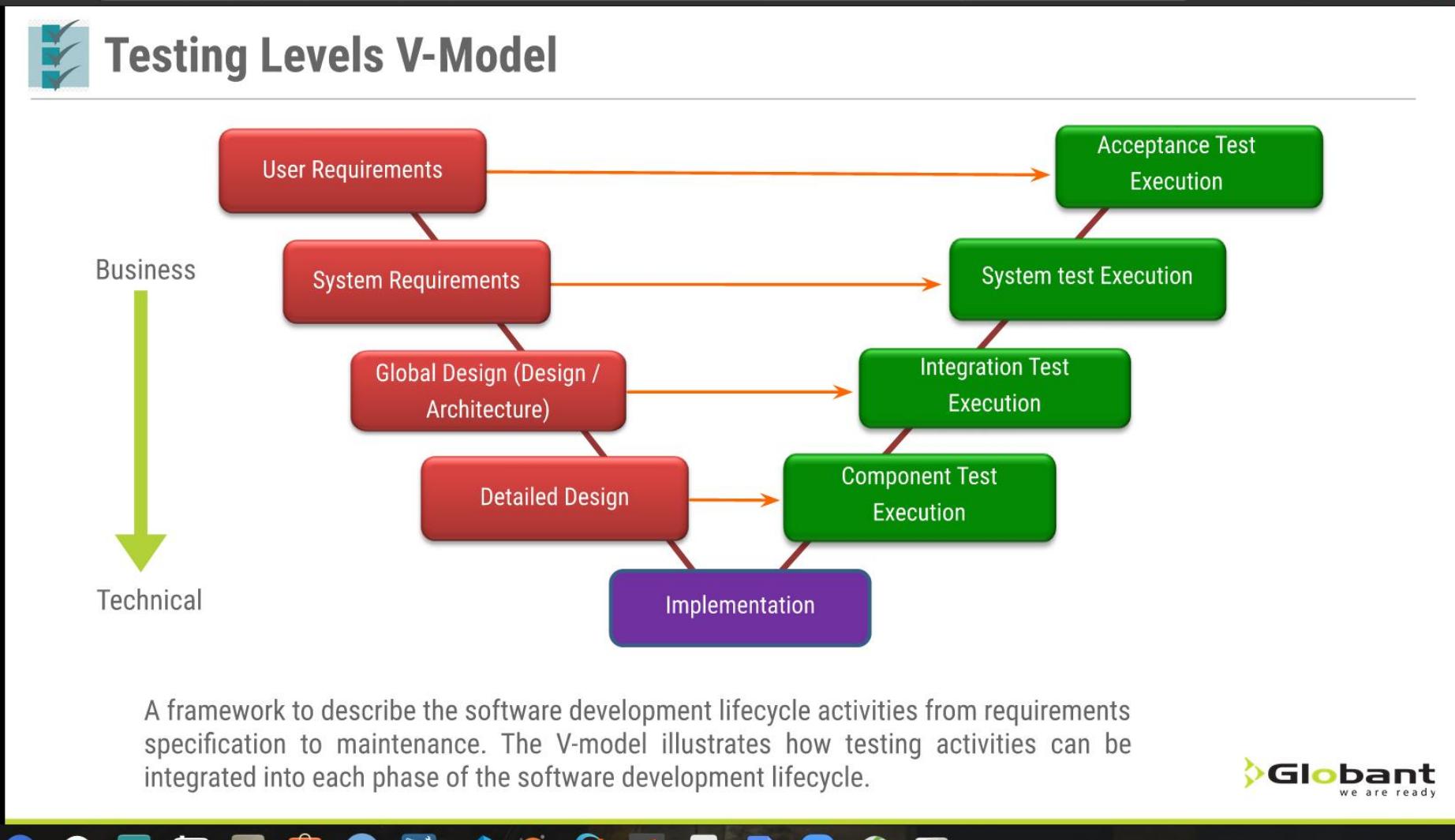
## Testing Levels STLC (Software Development Life Cycle)

- A testing process which has specific steps to be executed in a definite sequence to ensure that the quality goals have been met.
- Each activity is carried out in a planned and systematic way and each phase has different goals and deliverables.
- The following are the phases of STLC: Requirements phase, Planning Phase, Analysis phase, Design Phase, Implementation Phase, Execution Phase, Conclusion Phase, Closure Phase.

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# Testing Levels V-Model

Now, you can see:

SDLC V s STLC

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## Testing Levels Overview vs Roles

The diagram shows a pyramid divided into five horizontal sections, each representing a different testing level:

- Acceptance Testing (top section)
- System Integration Test
- System Testing
- Component Integration Testing
- Component Testing (bottom section)

Three green brackets on the right side group the levels by role:

- End Users (Acceptance Testing)
- Testers (System Integration Test, System Testing, Component Integration Testing)
- Developers (Component Testing)

A cartoon robot wearing a blue and white suit is standing on a surface made of binary code, holding a magnifying glass over it.

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# Testing Levels

## Component/Unit Testing

- Testing at the code level to help eliminate bugs at an early stage.
- All defects/bugs cannot be uncovered by unit testing, however is a critical testing step in most modern models such as the V-Model.
- Component/Unit Testing sample bugs:
  - A method or function that fails or not working as expected.
  - A flow of code that is never executed.

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# Testing Levels

## Integration Testing

- Testing program units are combined and tested as groups in multiple ways.
- In this context, a unit is defined as the smallest testable part of an application.
- Integration Testing sample bugs:
  - Inconsistencies in interactions or interfaces
  - Bad exception management
  - Wrong I/O rules in the interfaces

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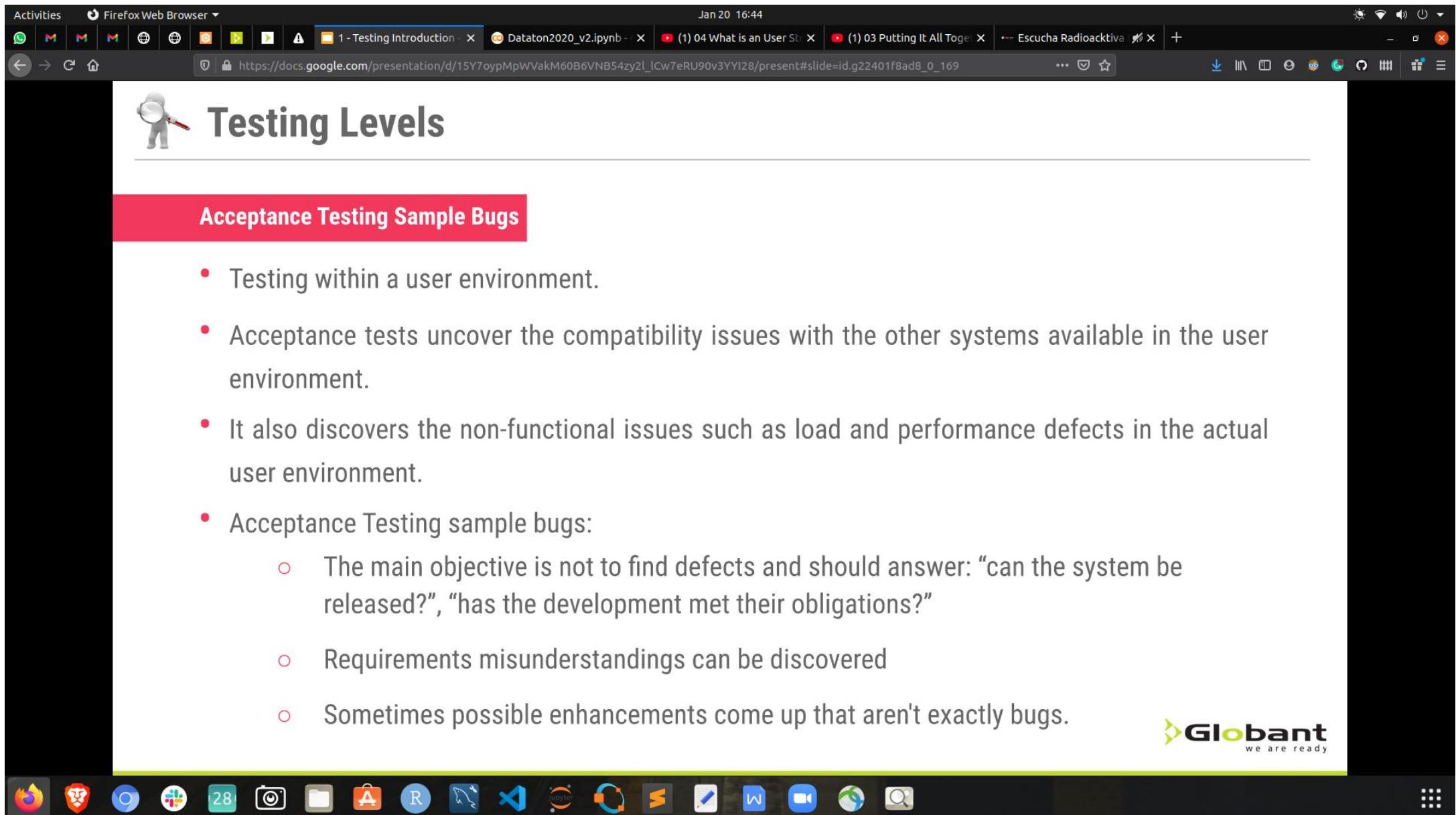
# Testing Levels

## System Testing

- Testing of the entire system functionality and the communication of the system under development with external systems.
- Most of the software and hardware compatibility issues can be uncovered during this system test execution.
- System Testing sample bugs:
  - All types of bugs, functional, non-functional
  - Client requirement not met
  - Slow performance
  - Incompatibility with certain browser

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## Component/Unit Testing

- The tests are executed against static code.
- The developer who developed the code is involved.
- The defects are fixed as soon as they are detected, without needing to go through the bug reporting formalities.
- The goal is to find defects and to verify the software works by separately checking: Modules, Objects, Classes or Functions
- The coverage is measured in **% of code covered**.
- A failing unit test can go undiscovered by QC.



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# Component/Unit Testing

Now, you can see:

## Component/Unit Testing

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## Integration Testing

- Identifies problems that may arise when the different units are combined.
- Two levels of integration testing exist:
  - Component Integration:** Looks for defects around the interfaces and interaction between integrated components.
  - System Integration:** Tests the interaction between different systems, can be part of the System Testing.
- When the integration between the different components is greater, it becomes harder to identify the interface causing the error.
  - Approaches:** Big Bang, Incremental, Top-Down, Bottom-Up.



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# Integration Testing

Now, you can see:

## What is Integration Testing

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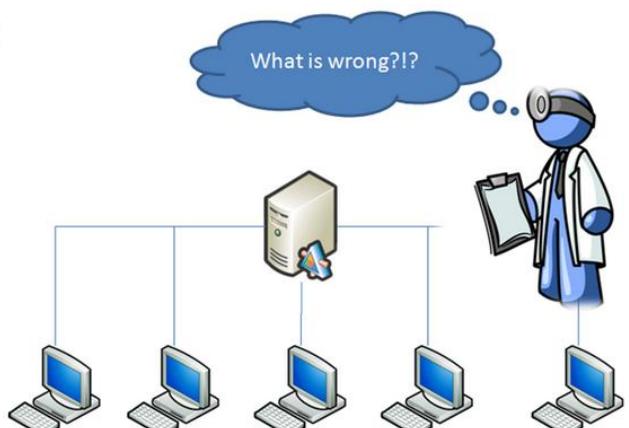
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# System Testing

- Executed by a team of testing specialists based on:
  - Requirements
  - Use Cases or User Stories
  - Risks
  - Business processes
- Is the final test to verify and validate that the system meets the specifications.
- The goal is to find the most defects.
- Must include functional and non-functional requirements.
- Must be executed in a controlled environment.



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## Acceptance Testing



- Focuses mainly in validating the system meets the operational expectations.
- Is executed by the client himself or by system users.
- QCs often have to provide support to the users in this phase.
- The goal in this case is not to find defects, but to gain confidence on the system.
- There are two types of **Acceptance Tests**:
  - Alpha Test:** is executed in a controlled development environment
  - Beta Test:** is executed in the client's environment, under real world conditions.

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# Integration Testing

Now, you can see:

## 05 - What is System Testing & Acceptance Testing

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# Manual vs Automated

**Manual**

Tests that are manually executed by testers, which walk through the system step by step in search of defects.

**Automated**

Tests that are automatically executed by specially designed tools, which require minimum tester supervision.  
Nevertheless, there is always some degree of manual testing needed.

In-depth  
Fast  
Reusable  
Efficient  
Reliable

**QualityTesting**

Manual Testing Automation Testing

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# Manual vs Automated

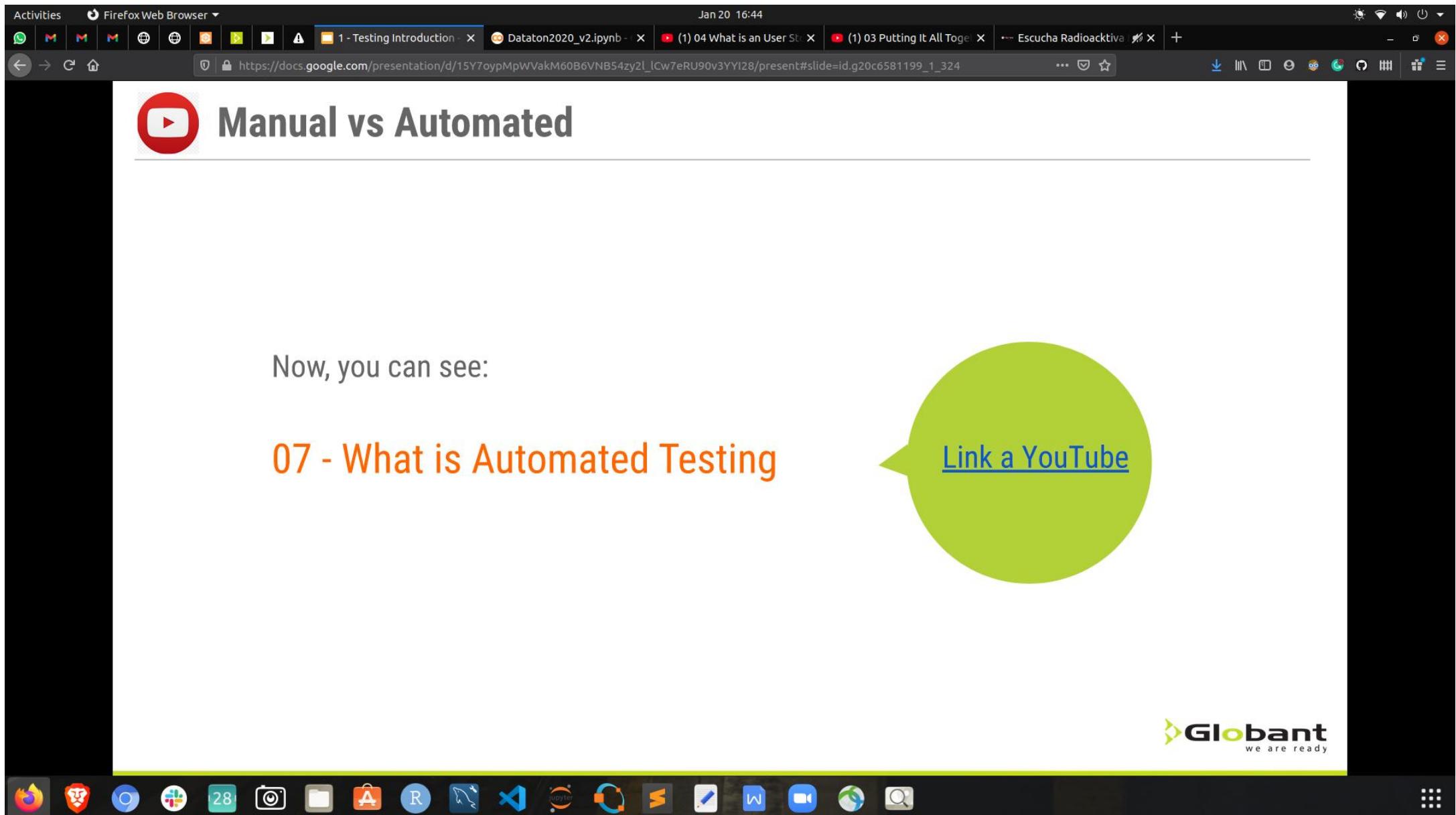
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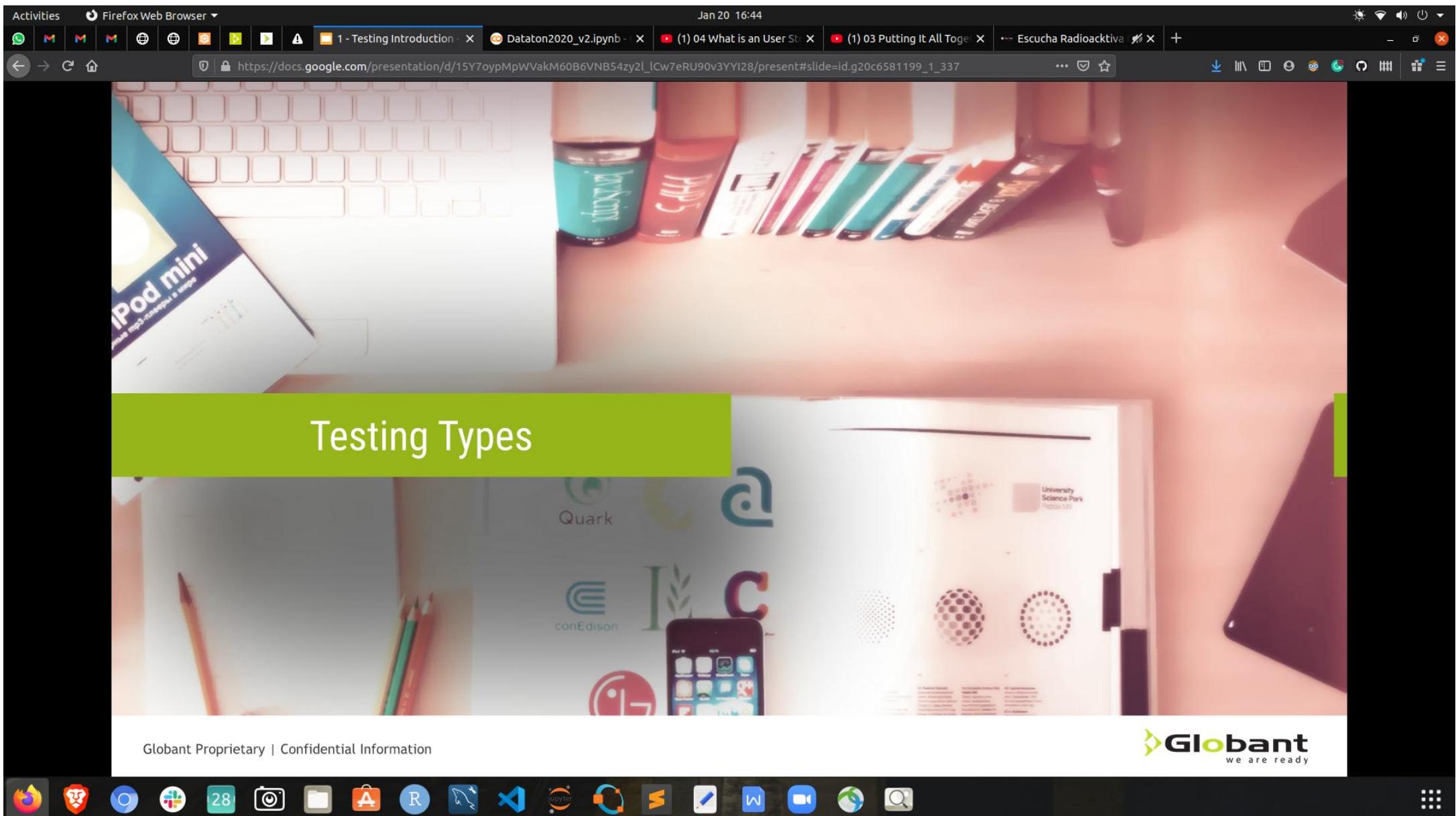
## What is Manual Testing

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# Testing Types

## According to the test's objective

- A functionality executed by a system or component
- A non-functional characteristic
- The system's structure or architecture
- The system after a change

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# Testing Types

There are many Testing Types including the following:

- Unit Testing
- Integration Testing
- Functional/Non Testing
- System Testing
- Stress Testing
- Performance Testing
- Usability Testing
- Acceptance Testing
- Regression Testing
- Alpha/Beta Testing

Let's look into some Testing Types!

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# Functional Testing

Requirements  
Defining project goals and deadlines, building test roadmap

Analysis

Test Cases

Manual testing  
Test case development, performing tests

Test Automation  
Composing automated test scripts for process acceleration

Exploratory Testing  
Investigation testing for broader app coverage

Defect Lifecycle Management C

Issue Reporting & Bug Tracking  
Documenting defect status and interpreting test results

Regression Testing

- Testing based on the analysis of functional requirements of a system or a system component.
- Is generally described within the functional requirements specification.
- Refers mostly to "What the system does".
- These tests fit into the Black Box category.

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# Functional Testing

Please watch the following video:

## Functional Testing Type

[Link a YouTube](#)

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# Non Functional Testing

- Tests system or component attributes that are not related to functionalities.
- May include:
  - Performance
  - Efficiency
  - Portability
  - Usability
  - Reliability
  - Recoverability

Testing

Functional Testing

Non functional testing

Usability Testing

Security Testing

Performance testing

Load and Stress Testing

Scalability Testing

Data Integrity Testing

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## Non Functional Testing

- Performance testing: the process of testing to determine the performance of a software product.
- Efficiency: the process of testing to determine the efficiency of a software product.
  - (1) The capability of the software product to provide appropriate performance, relative to the amount of resources used under stated conditions. [ISO 9126]
  - (2) The capability of a process to produce the intended outcome, relative to the amount of resources used
- Portability: is compatible with different operating systems, with different browsers? How easy is the system installed?

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## Non Functional Testing

- **Usability:** how easy is the system to use? to learn by new users? is it intuitive? Is it consistent (steps to complete tasks, how messages are displayed)?
- **Reliability:** the ability of the software product to perform its required functions under stated conditions for a specified period of time, or for a specified number of operations.
- **Recoverability:** the capability of the software product to re-establish a specified level of performance and recover the data directly affected in case of failure. [ISO 9126] See also reliability.



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# Non Functional Testing

Now, you can see:

## Non-functional Testing Type

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# Performance Testing

**Performance Testing:** the goal is to evaluate the system's performance. There can be pre existent requirements or the tests can be used to evaluate, document and prepare benchmarks and comparisons while the system grows or changes.

The diagram illustrates a performance testing setup. At the top, a laptop labeled "Controller" sends a "Command" to two groups of servers: "Cloud Load Generators" and "On-premise Load Generators". Arrows from these groups point to a central yellow box labeled "Load". Inside this box is an "Application Server" containing an "APP" icon. Below the "Load" box is a "Database Server". A "Monitor" component is connected to both the "Application Server" and an "optional" "NeoLoad Monitoring Engine". Dashed green arrows indicate the flow of monitoring data from the monitoring engine back to the monitor.

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# Performance Testing



**Load Testing:** testing conducted to evaluate the behavior of a component or system with increasing load, e.g. numbers of parallel users and/or numbers of transactions, to determine what load can be handled by the component or system. The common goal is to use real ranges of workload similar to those expected in production.

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# Performance Testing

**Stress:** testing conducted to evaluate a system or component at or beyond the limits of its anticipated or specified workloads, or with reduced availability of resources such as access to memory or servers. This way bottlenecks can be identified as well as evaluating how the system responds and recovers from these situations.

Examples: Response Time, MIPS, CPU, memory and disk usage.



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## Structural Testing

This type of testing is based on the analysis of the internal structure of a system or component.

- The coverage for this type of tests is measured in % of tested items.
- These tests qualify as white box tests.

The diagram illustrates five common control flow structures:

- Sequence:** A linear path from one node to another.
- IF-THEN-ELSE:** A diamond node branching into two sequential paths.
- WHILE LOOP:** A node with a self-loop arrow, with an incoming path and an outgoing path.
- Switch statement:** A diamond node branching into multiple sequential paths.
- REPEAT-UNTIL LOOP:** A node with a self-loop arrow, with an incoming path and an outgoing path.

**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.

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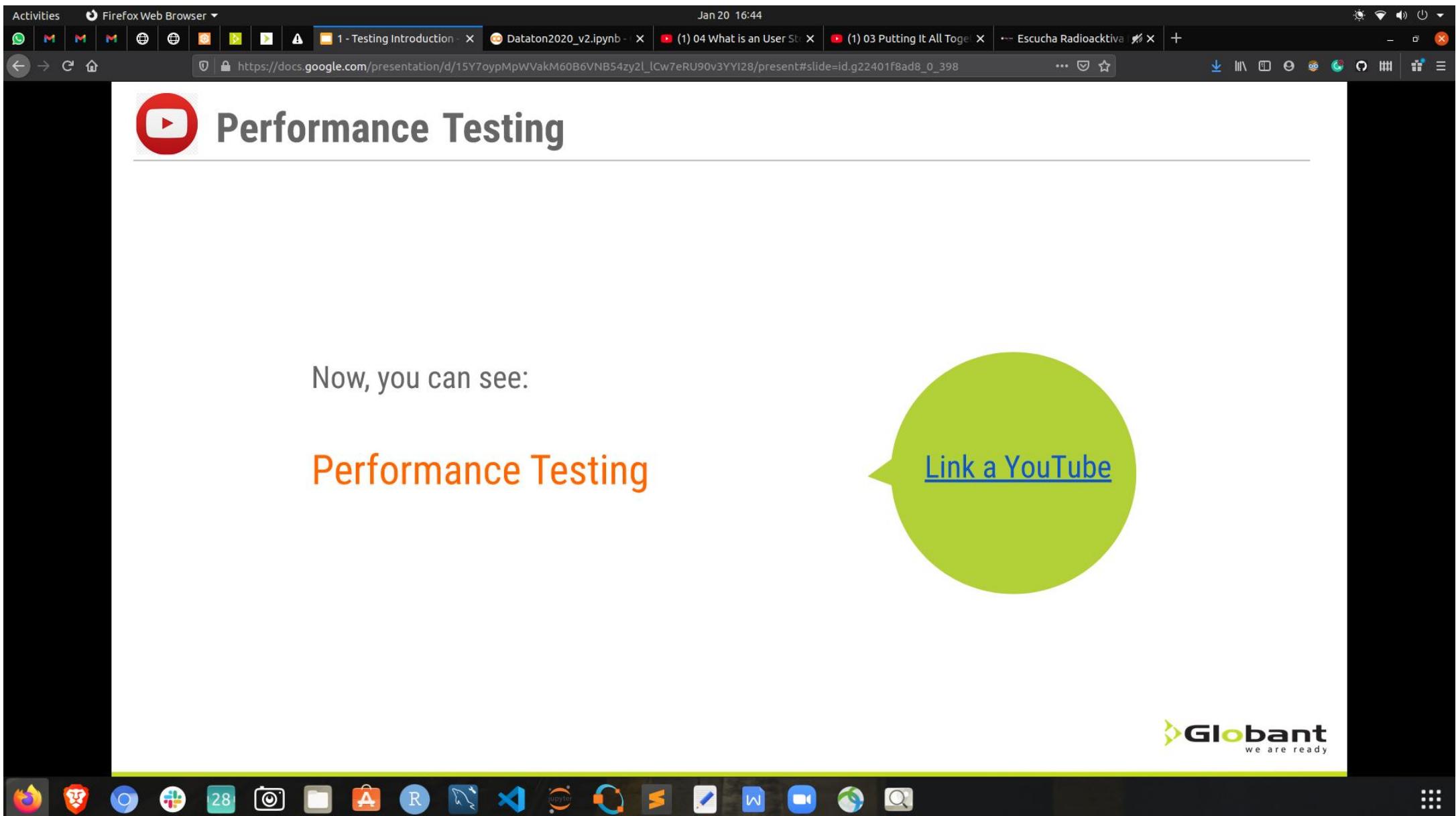
# Performance Testing

Now, you can see:

## Performance Testing

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# Stress Testing

Now, you can see:

Stress Testing

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# Load & Structural Testing

Now, you can see:

## Load & Structural Testing

[Link a YouTube](#)

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# Regression Testing



Consists in testing a system after a modification has taken place to verify that no new defects have been introduced or affected the previous correct functionality.

- By modifications we understand any changes to the software or its working environment.
  - It is performed when the software or its environment is changed.
  - Confirmation tests are executed to verify that these defects have been correctly fixed.

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## Maintenance Testing

A system may need some more new features which could require modifications to be done in the existing software and these modifications need to be tested.

- The modifications can include new functionalities, bug fixing, changes in the environment like a new operating system or database version.
- Not only the new or changed functionality must be tested but regression tests must be executed as well to verify the rest of the system continues to work correctly.
- Impact Analysis are done frequently during this testing.



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# Maintenance Testing

Now, you can see:

## Maintenance & Regression Testing

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## Smoke Test & Sanity Test



**Smoke  
Test**



**Sanity  
Test**

- Refers to the first tests that are excluded to provide **quick feedback** regarding if the system under test is stable and won't fail drastically.
- It can be as simple as **checking that the system is up and running** and or that its interface are accessible and responding.
- A smoke test **can be executed after each build** before moving to the next step of the process, may it be further coding or testing.

- Refers to the suite of tests that is excluded to **verify the main functions of a system** are working without any errors to determine if it is reasonable to continue with further more detailed tests.
- This way if a major functionality is failing **no time is wasted testing** further and the system is rejected
- If the SMOKE TEST fails it is **impossible to conduct Sanity tests**.

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# Smoke Test & Sanity Test

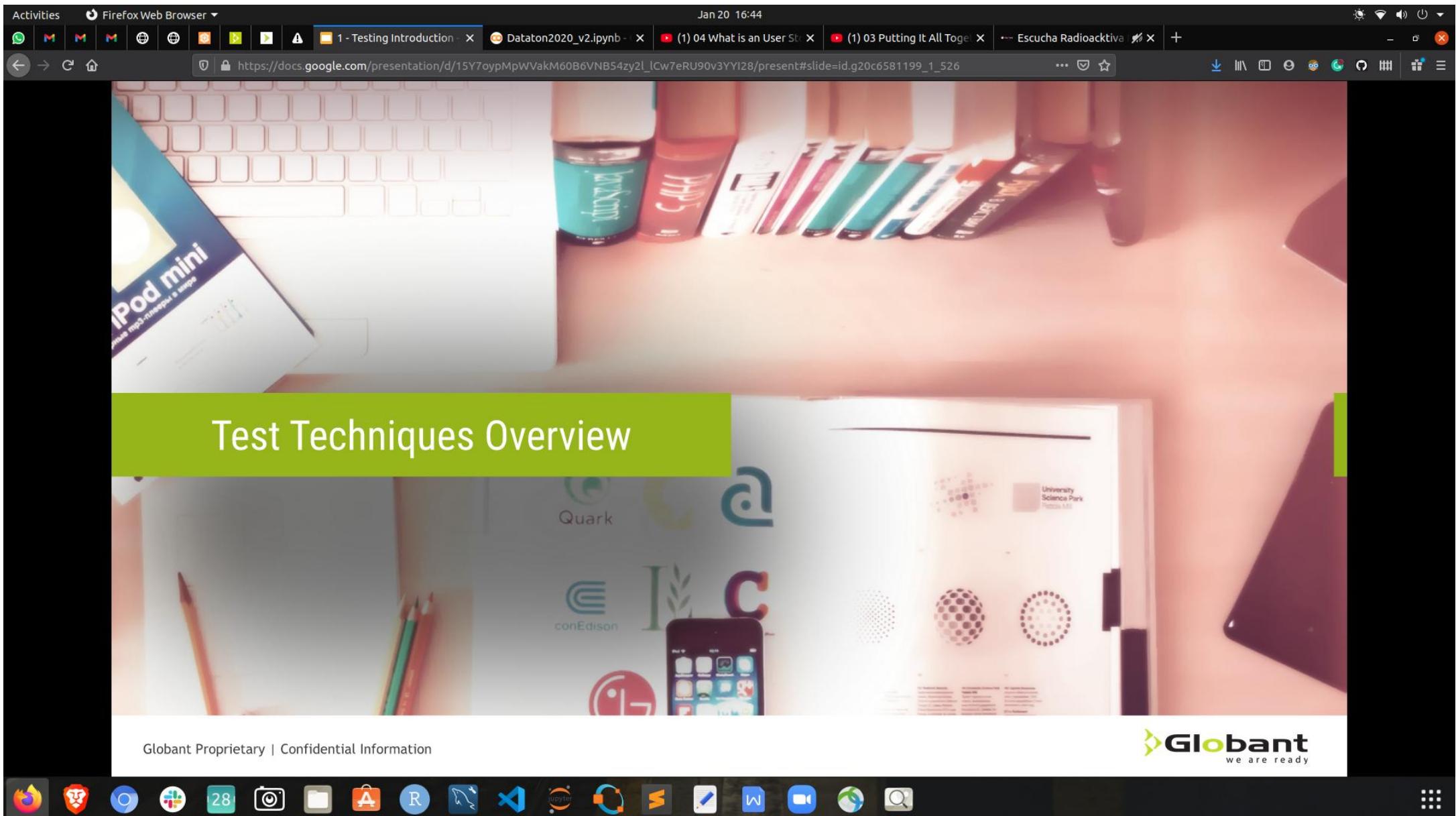
Now, you can see:

Sanity & Smoke Testing

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## Test Techniques Overview

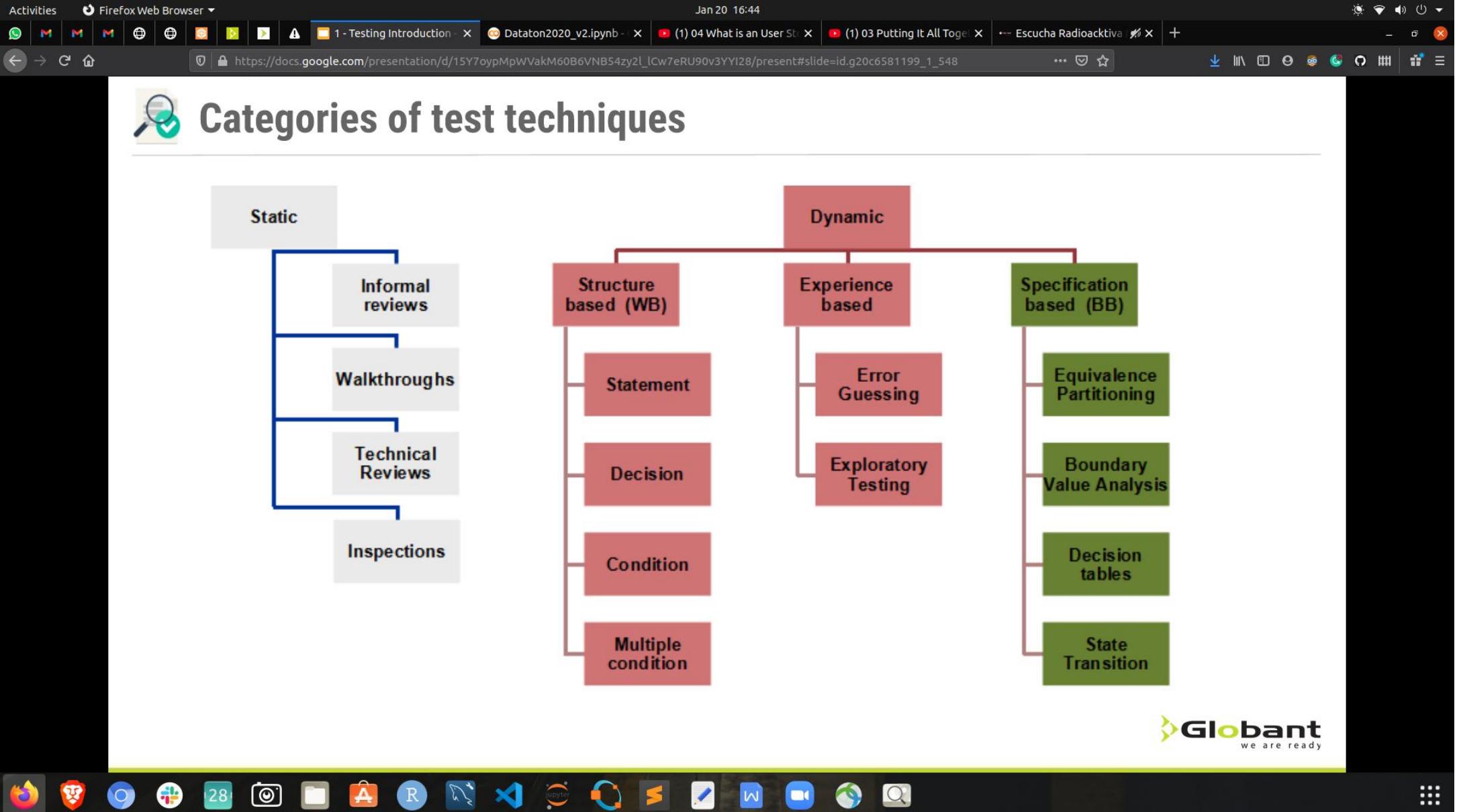
### There are static tests and dynamic tests

- **Static tests:** is the testing of the software work products manually, or with a set of tools, but they are not executed. It starts early in the Life cycle and so it is done during the verification process. It does not need computer as the testing of program is done **without executing the program**.  
Specifications review is part of the black box testing.
- **Dynamic tests:** requires the code to be executed. This kind of software testing using which the dynamic behavior of the code is analyzed. It may begin before the code is 100% finished. For example testing program functions. Involve running (executing) the test object.



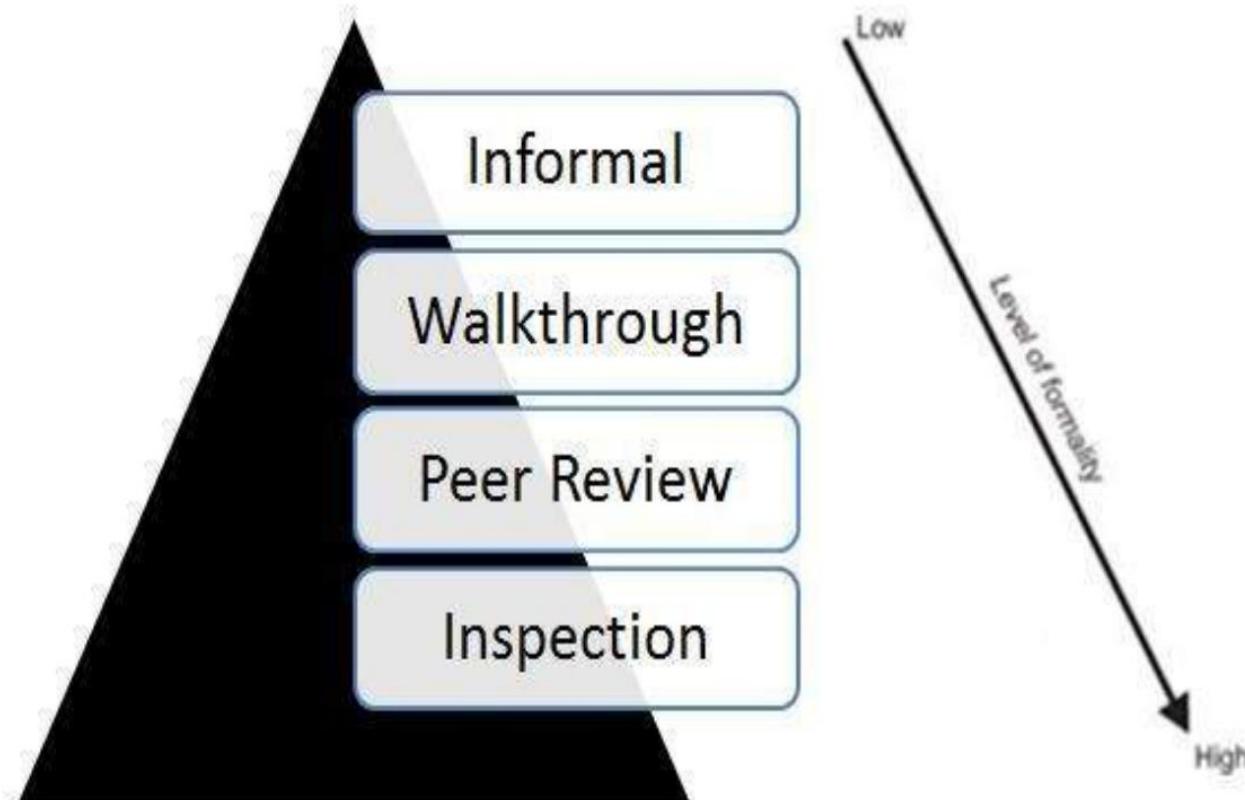
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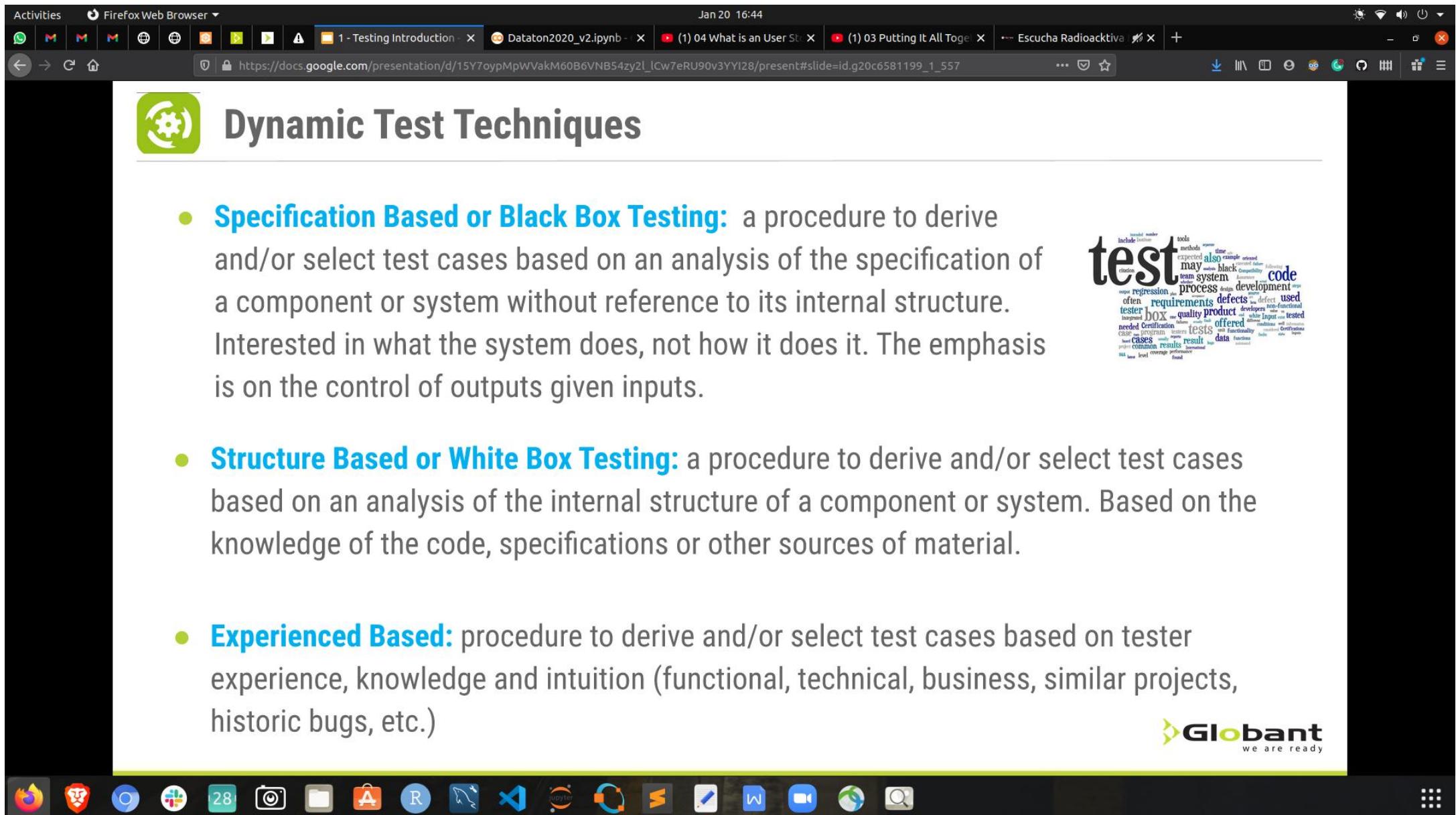




# Static Test Techniques



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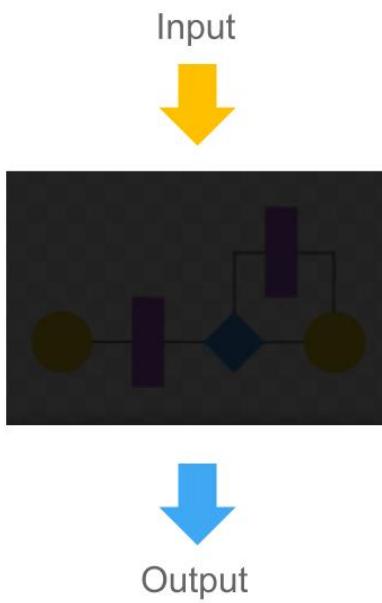


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## Specification Based or Black Box

**Black box testing:** Testing, either functional or non-functional, without reference to the internal structure of the component or system.



**Black box test design technique:** Procedure to derive and/or select test cases based on an analysis of the specification, either functional or non-functional, of a component or system without reference to its internal structure.

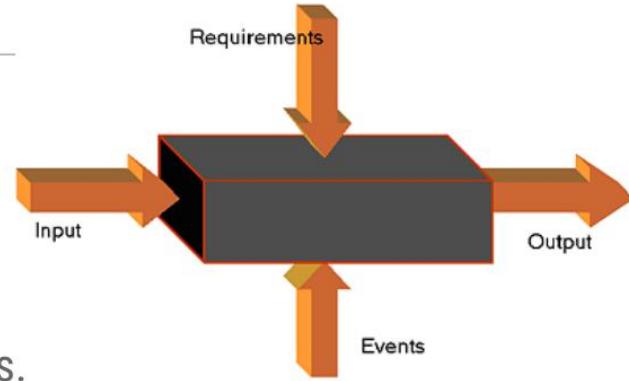
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## Specification Based or Black Box

- Tests what the software should do.
- It is based on the module's definitions and specifications.
- It does not care about the program's internal structures or behaviors. The code of the tested object is not considered.
- Functional test, produced by data, inputs and outputs.



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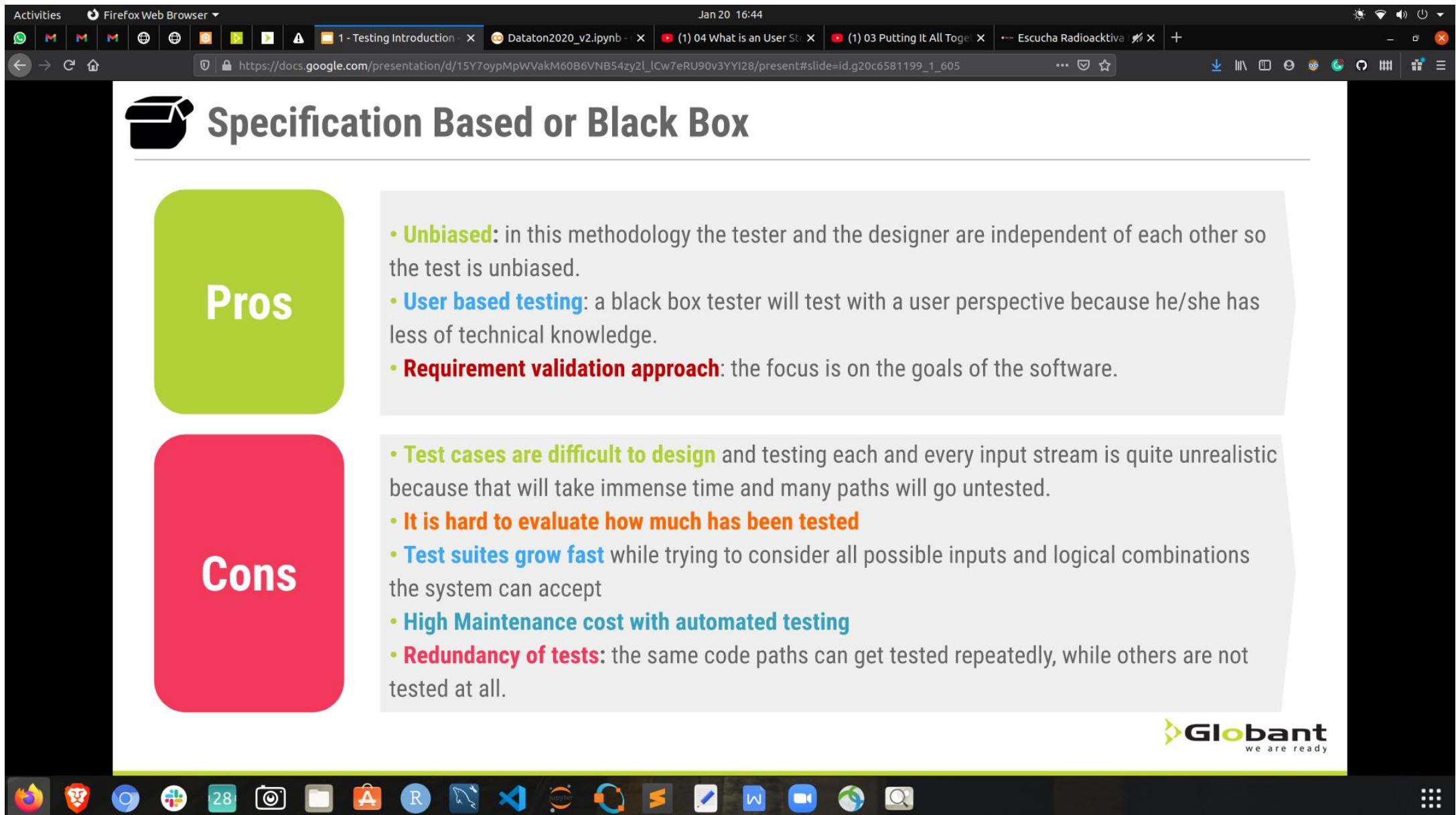
## Black Box Techniques

- Black-box techniques are divided into two main subtypes:
  - Functional : what the system does?
  - Non functional: how the system does what it does?
- Black-box techniques are a way to derive and select test conditions, test cases, or test data:
  - Based on an analysis of the test basis documentation
  - Also called specification-based or behavioral techniques
  - Tests are based on the way the system is supposed to work

```
graph LR; 1((1)) --> 2((2)); 2 --> UNKNOWN[UNKNOWN]; 3((3)) --> 4((4)); 4 --> UNKNOWN;
```

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# Specification Based or Black Box

Now, you can see:

## Black Box Testing

[Link a YouTube](#)

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## Structure Based or White Box

- Tests what the software does.
- Testing based on an analysis of the internal structure of the component or system.

```
graph LR; Requirement[Requirement] --> Box(( )); Box -- Input --> Flowchart[Flowchart: 4 nodes]; Flowchart -- Output --> Output[Output]
```

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## Structure Based or White Box

**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. e.g.:



- **Branch testing:** a white box test design technique in which test cases are designed to execute branches.
- **Condition testing:** a white box test design technique in which test cases are designed to execute condition outcomes.
- **Data flow testing:** a white box test design technique in which test cases are designed to execute definition-use pairs of variables.

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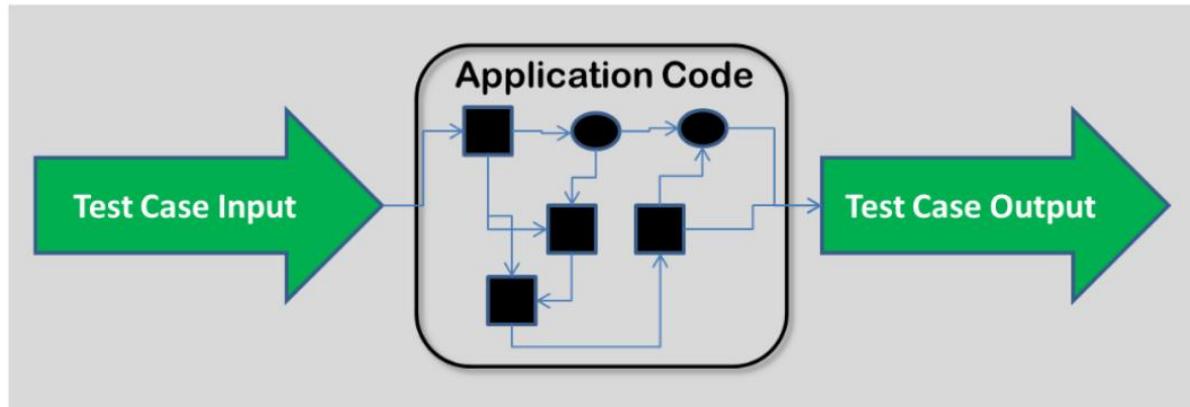
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## Structure Based or White Box

- **Decision condition testing:** a white box test design technique in which test cases are designed to execute condition outcomes and decision outcomes
- **Path testing:** a white box test design technique in which test cases are designed to execute paths.



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# Structure Based or White Box



## Pros

- **Logical:** provides a degree of sophistication as the tester is able to refer to and interact with the objects that build an application rather than only having access to the user interface.
- **Detail Oriented:** focuses on the details of an application and the internal working of a system.
- **Thoroughness:** is the only viable method to know that every path has been thoroughly tested and that every possible internal interaction has been examined
- **More efficient debugging of problems** : when a regression error is introduced during development, the source of the error can be more efficiently found.

## Cons

- **Harder to use** to validate requirements
- **Development skills** are necessary.
- **Test are designed based on the written code.** It is not possible to detect absence of functionality that hasn't been implemented or to catch misinterpretation of requirement.
- At times **it becomes extremely complex and fragile** as high degree of script maintenance is required.

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# Structure Based or White Box

Now, you can see:

## White Box Testing

[Link a YouTube](#)

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# Positive vs Negative

# Positive

**Verifies the ability of the system  
to implement a solution to the  
business needs under normal  
conditions.**



## Negative

**Verifies the ability of the system  
to detect, document and resolve  
user errors or any other condition  
not considered normal**





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## Methods for Deriving Test Cases

The major goal when applying test cases design techniques is to design tests that systematically uncover errors with the minimum amount of time and effort

Goals and Advantages

- The exhaustive testing (100%) is impossible! but we need a controlled testing coverage
- Get a good “hit rate”, to find the most errors with the smallest number of test cases
- Offer an approach that can ensure completeness
- Offer the highest likelihood of uncovering errors in software
- Reduce the number of irreproducible Test Cases
- Select the best Test Cases that cover the most scenarios
- Avoid Redundancy and Inconsistency
- All methods complement each other

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# Test Cases Design Techniques

Each technique requires different effort, but also provides different amounts of tests with different levels of sophistication.

- Equivalence Class Partitioning
  - Boundary Value Analysis (BVA)
  - Decision Table Based Testing
  - State Transition Testing



Note: you can learn about these techniques by joining the [Testing Advanced training](#) (Acamica)

