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Software Testing & Debugging

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Non-functional Testing



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Software Testing

- ▶ **Functional Testing:** verifies the operational execution of a software
 - unit, integration, and system testing
 - ❖ typically starts before non-functional testing
- ▶ **Non-functional Testing:** tests aspects of the software other than its functionality
 - ❖ making sure interests of the end-user are respected
 - ❖ **vital to add market value to the product**
 - ❖ is a blackbox testing

**** Non-functional testing must be measurable; there is no place for subjective characterizations like good, better, best, etc. ****

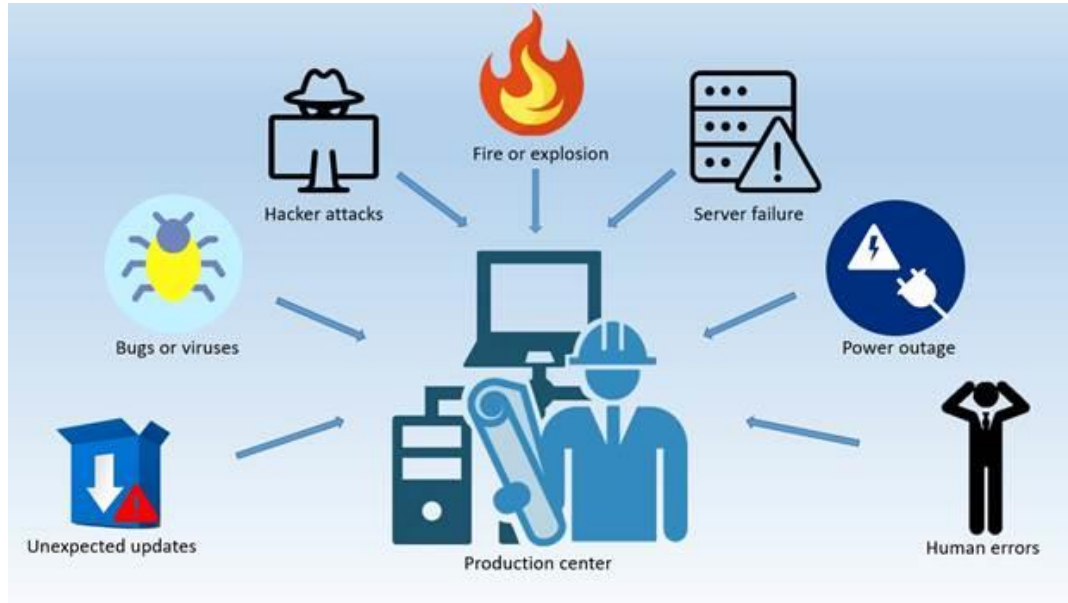
Load Testing

How does the application behave when too many users access it concurrently?



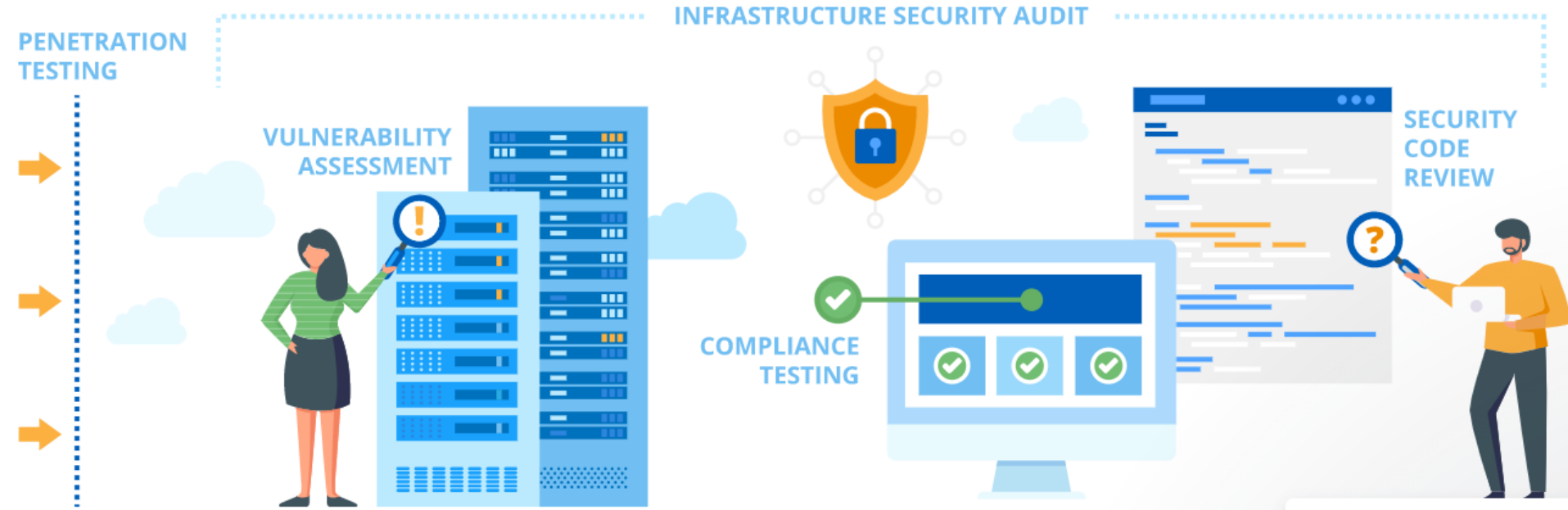
Recovery Testing

Can the application recover from a crash or a failure?



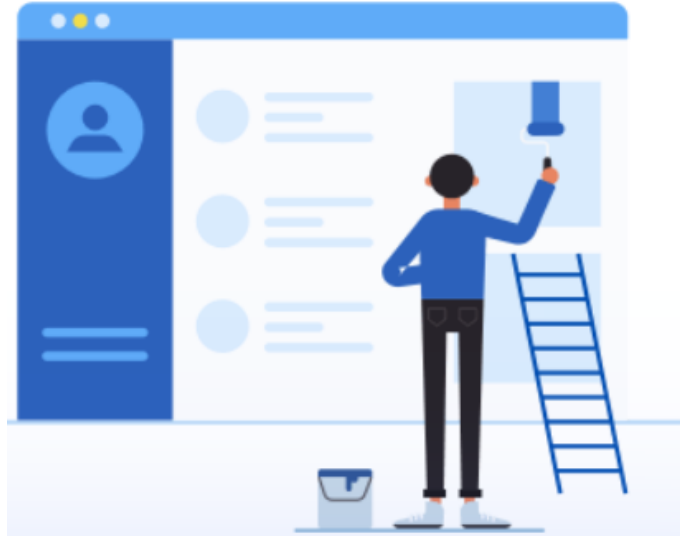
Security Testing

How secure is the application?



Usability Testing

Is the user interface of the application intuitive and user-friendly enough?



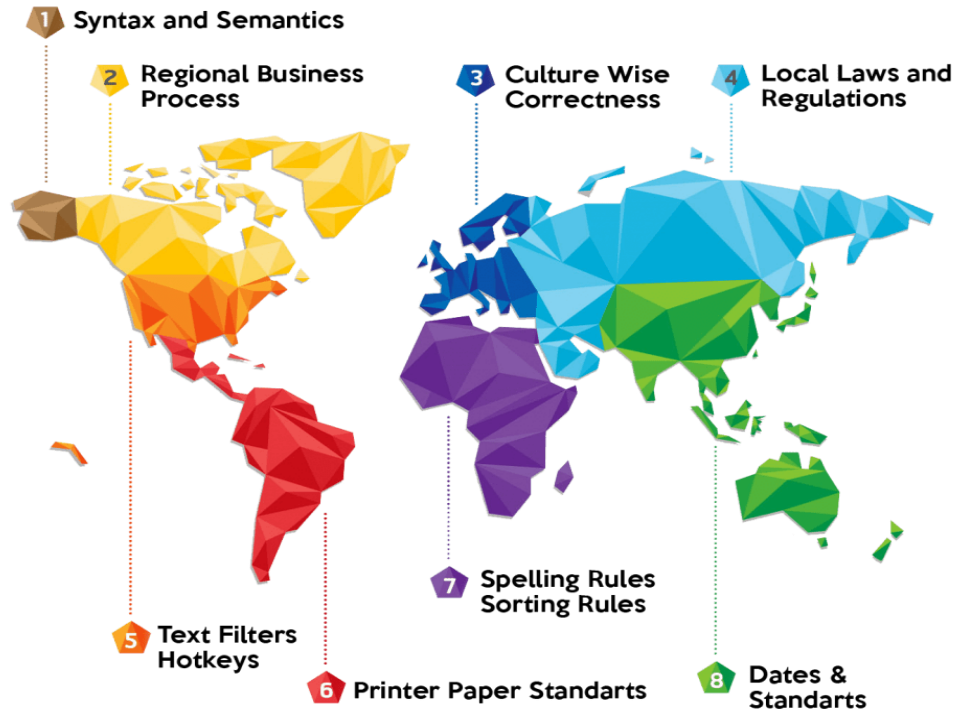
Accessibility Testing

Can disabled people use the application too?



Internationalization/localization Testing

Can people with different languages and regional peculiarities use the application?



Documentation Testing

Are the documents/user manual provided with the application easy to understand?



Software Requirements

- ▶ **Non-functional** (aka quality) requirements can be as important as functional requirements, if not more important!
 - ❖ security of a banking app
 - ❖ user friendliness of a web app for kids or tech illiterate
 - ❖ responsiveness of an app with lots of concurrent users
 - ❖ Etc.
- ▶ Can use the same “user story” cards for non-functional requirements

Performance Testing

“Determine how a system performs in terms of responsiveness and stability under a particular workload.”

► Kinds of Performance Testing:

- ❖ **Load Testing**
- ❖ Stress Testing
- ❖ Spike Testing
- ❖ Soak Testing
- ❖ Configuration Testing

Load Testing

“Modeling the **expected usage** of a software **by simulating multiple users** accessing the software **concurrently**”

GOAL: improve *performance bottlenecks* and ensure smooth functioning

Examples:

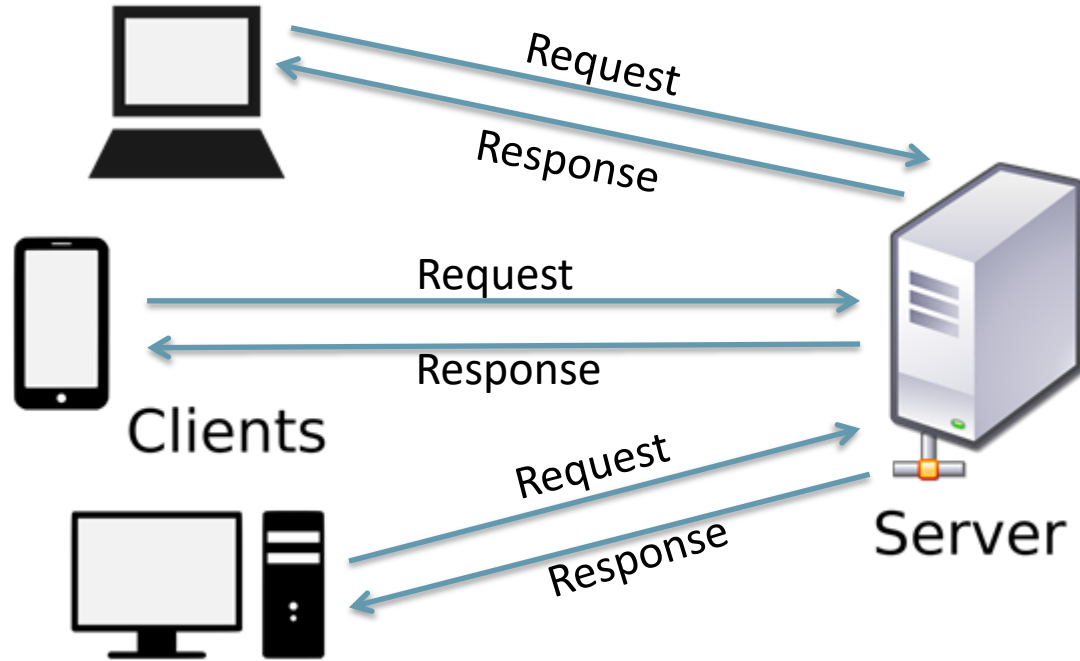
- ❖ **Printer:** Testing a printer by transferring a large number of documents for printing concurrently
- ❖ **Hard Disk:** Concurrent transfer of multiple files to and from the disk
- ❖ **A government web portal:** thousands/millions concurrent users

Importance of Load Testing

“According to a survey, **75% users** said that if a **site crashed** or if it was slow, they would **leave the site**”

“**50% of the users** said that they will shop elsewhere if the website or app did **not load in 3 seconds**”

Client-Server



Client-Server

- ▶ The **Client** is the application that runs on the end-user computer that sends “**requests**” to the server.
 - ❖ E.g., browser
- ▶ The **Server** is the application that receives requests from the clients and contains the logic to send the appropriate “**response**” back to the client. The server usually has an application programming interface (API), and often includes a database, which will persistently store the data for the application

Load Testing a Website

Load Testing typically involves **simulating the load!**

► **Steps:**

1. creating a pertinent scenario,
2. scripting the scenario as a test,
3. creation of virtual users,
4. having the (virtual) users replay the test,
5. analyzing test results

Load Testing Metrics

► Response Metrics

- ❖ Average Response Time
- ❖ Peak Response Time (PRS)
- ❖ Error Rate

► Volume Metrics

- ❖ Concurrent Users
- ❖ Request Per Second (RPS)
- ❖ Throughput

Response Metrics



Response Time Metrics

- **Average Response Time:** Mean of every roundtrip request/response cycle
- **Peak Response Time:** longest response time
- **Error Rate:** percentage of problem requests compared to all requests.



Acceptable Response Time Range

- **0.1 second:** “Instant” Response
- **1.0 second:** Acceptable, but not ideal
- **5+ seconds:** User will avoid website or app

Volume Metrics

- ▶ **Concurrent Users:** number of (virtual) users active at any point in time.
- ▶ **Request Per Second:** Number of requests being sent to the target server in 1 second
- ▶ **Throughput:** a measurement of bandwidth consumed during the test typically calculated as:

$$\frac{\text{kilobytes}}{\text{time}}, \text{ or}$$

$$\frac{\text{\# of requests}}{\text{time}}$$

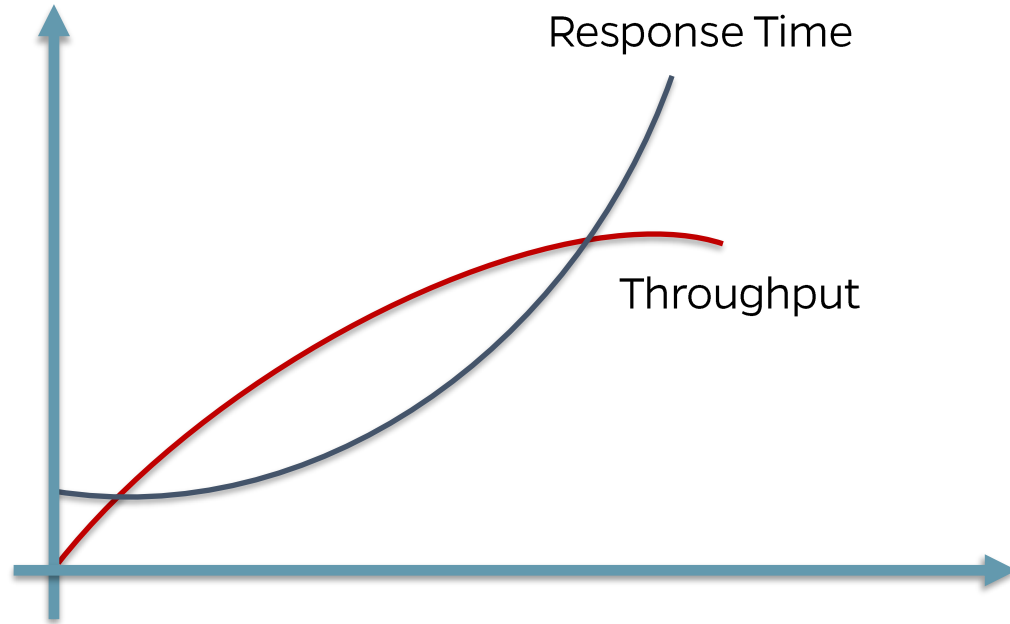
Throughput



3 Trucks
3 Gas Pumps

Throughput = 3 / minute
(no waiting)

Response Time vs. Throughput



Tools

- ▶ Commercial:
 - ❖ LoadNinja, WebLOAD, LoadView, StresStimulus, etc.
- ▶ Open Source:
 - ❖ **Apache JMeter**, Locust, Gatling, etc.



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