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Database Testing - Google Slides https://docs.google.com/presentation/d/1ZodpXM8N498MD44qYmMPK5puQzv4K3a7sewf30FQMsE/present#slide=id.g35ab102c89_0_12

Testing Databases

01 What is Database Testing?

- Validating UI data against the records stored in the database meets the requirement and design
- Creating complex queries to test the database and check its responsiveness

The diagram illustrates the architecture of a web application. It shows a red 'browser' box containing a 'GUI' icon, which has a green double-headed arrow connecting it to a blue 'web server' box. Inside the 'web server' box, there are three components: 'business logic', 'data access', and 'data storage'. Another green double-headed arrow connects the 'web server' to the 'data storage' box, which is colored yellow.

A laptop screen displays a performance monitoring interface for 'timetoreply'. The dashboard shows various metrics and graphs, including a line graph titled 'Company Time to Reply vs Agent Time to Reply'. Next to the laptop is a silver stopwatch, symbolizing the measurement of response time.

Contd ...

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The taskbar at the bottom of the screen displays various application icons, including the Firefox browser, a terminal window, file manager, and other productivity tools.

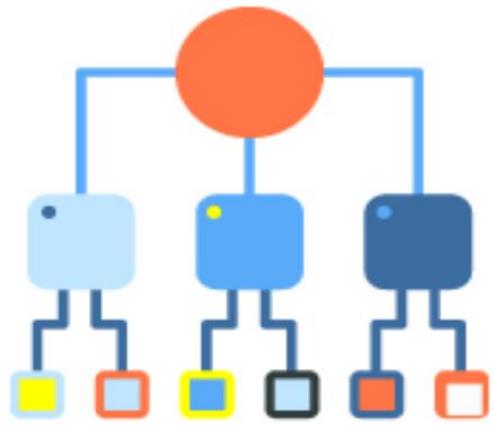
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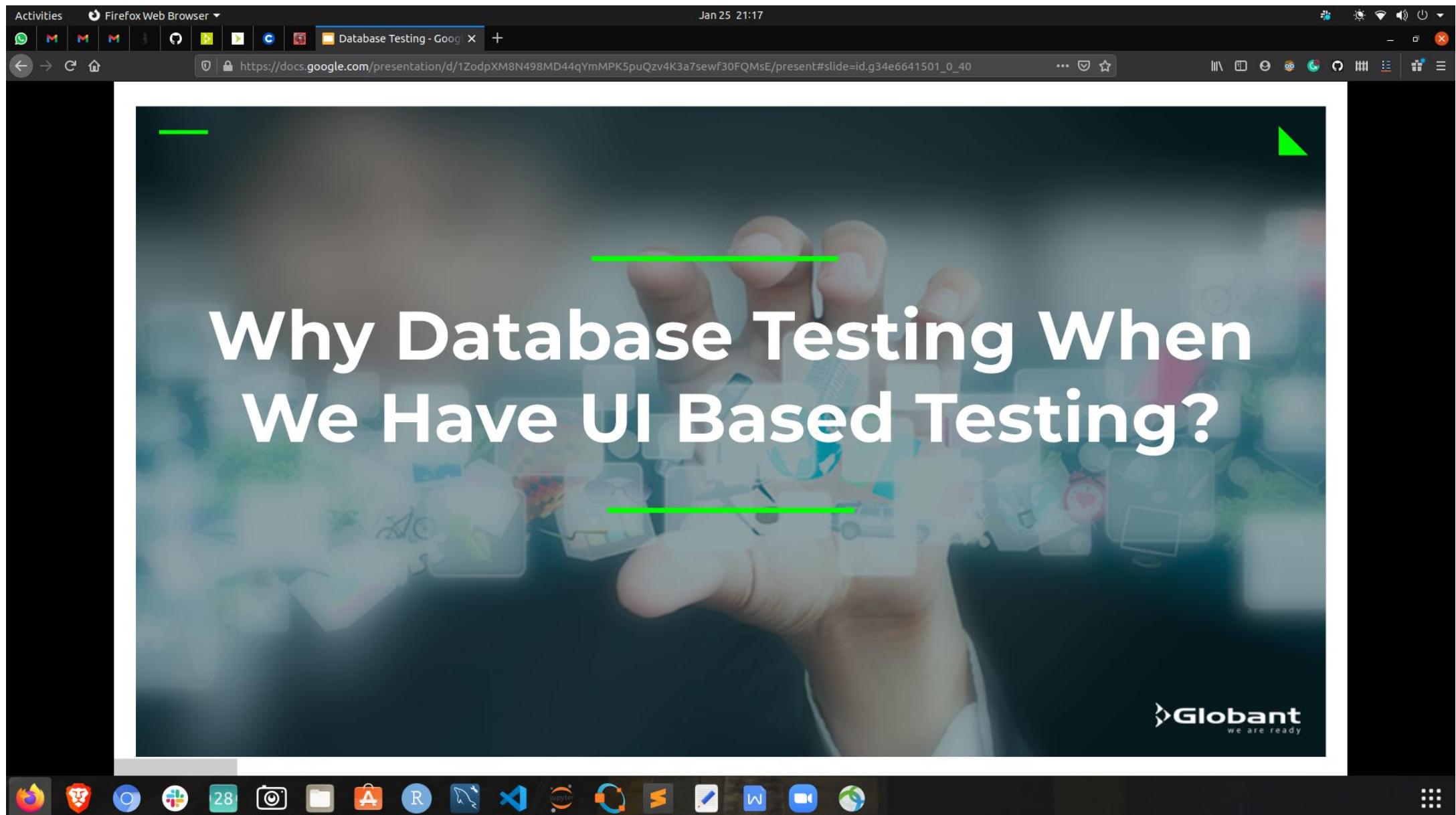
Testing Databases

01 What is Database Testing?

- Checking the schema, tables, triggers, etc. of the database under test
- To check data integrity and consistency



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Big Data Testing - Testing Databases

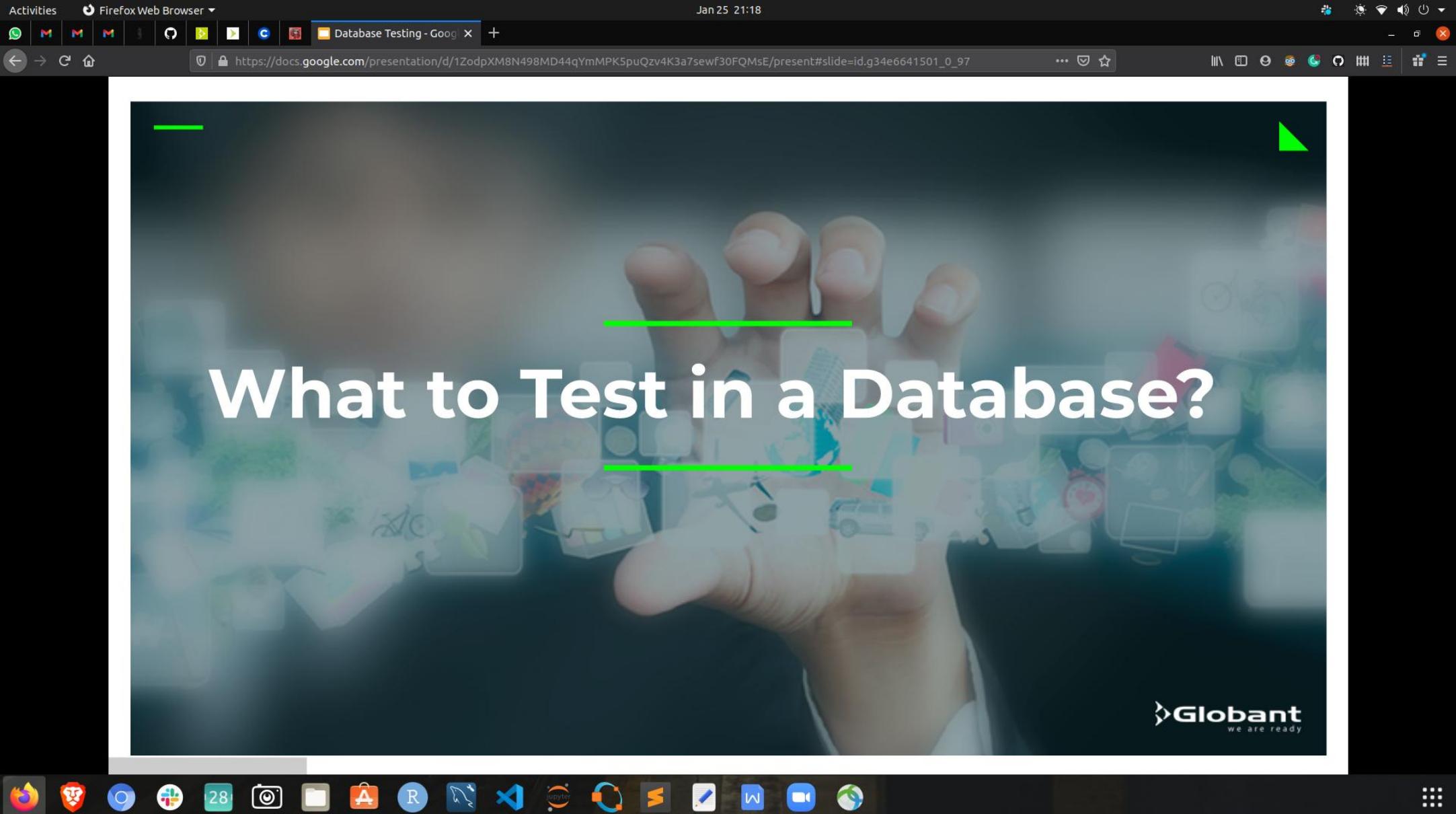
02 Why Database Testing When We Have UI Based Testing?

The diagram illustrates the interaction between an Application and a central database. The Application performs OLTP Access to the database. The database receives Batch Data from both a Data Load process and a Data Extract process. It also receives Test Data from a Test Data Generator. A dashed red circle highlights the database itself. To the right of the database, two testing approaches are described:

- Clear-box testing:**
 - Stored procedures/functions
 - Triggers
 - Views
 - Constraints
 - Existing data quality
 - Referential integrity/data consistency
- Black-box testing:**
 - Data values being persisted
 - Data values being retrieved
 - Stored procedures/functions

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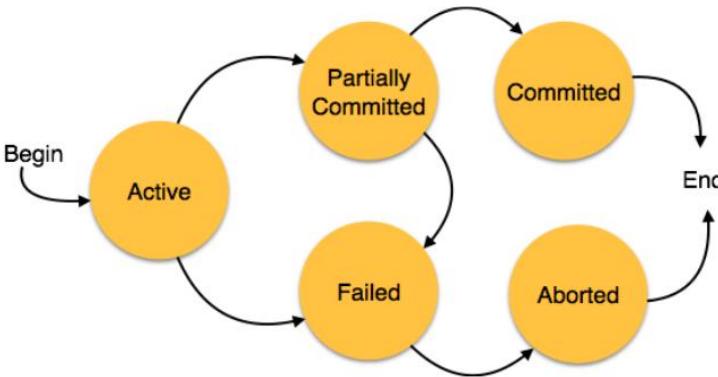
Big Data Testing - Testing Databases

03 What to Test in Database?

A. TRANSACTIONS



- By using ACID Properties
- BEGIN & END TRANSACTIONS
- COMMIT & ROLLBACK method



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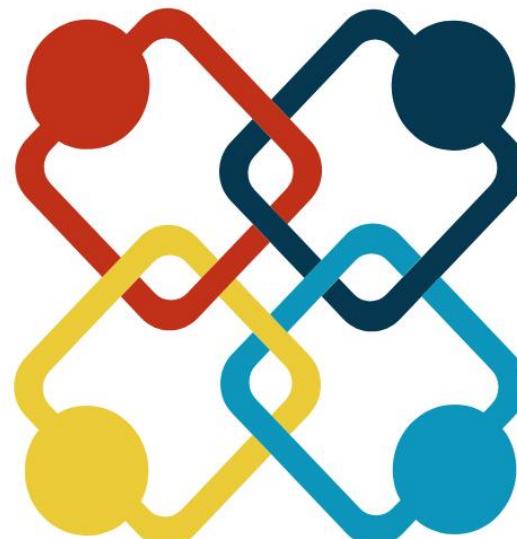
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Big Data Testing - Testing Databases

03 What to Test in Database?

B. ACID PROPERTIES



Atomic
“ALL or NOTHING”. Transaction cannot be subdivided.

Isolated
Transactions execute independently of one other. DB changes not revealed to user until after transaction has completed.

Consistent
Transfer DB from one consistent state to another consistent state. Any data must be valid according to the established rules.

Durable
The permanence of the DB consistent state. DB changes are permanent.

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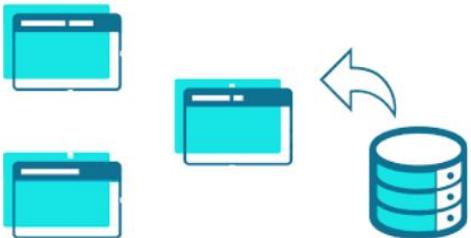
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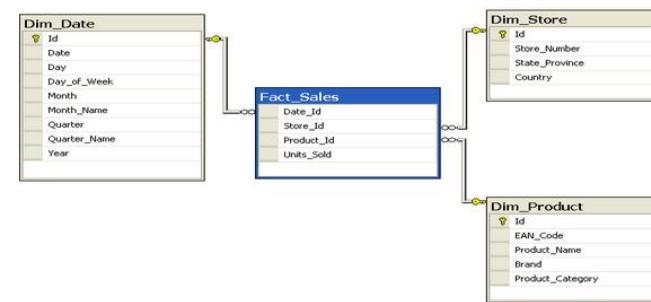
Testing Databases

03 What to Test in Database?

C. DB SCHEMA



- Tables / Views are created in the corresponding schema
- The table / view definition
- Validating expected domain attribute
- Validation of Column count
- Validation of Column data type
- Validation of Length of column
- DESC command



Dim_Date

- Id
- Date
- Day
- Day_of_Week
- Month
- Month_Name
- Quarter
- Quarter_Name
- Year

Fact_Sales

- Date_Id
- Store_Id
- Product_Id
- Units_Sold

Dim_Store

- Id
- Store_Number
- State_Province
- Country

Dim_Product

- Id
- EAN_Code
- Product_Name
- Brand
- Product_Category

Dim_Country

- Id
- Country_Name
- Continent
- Region
- Language
- Currency

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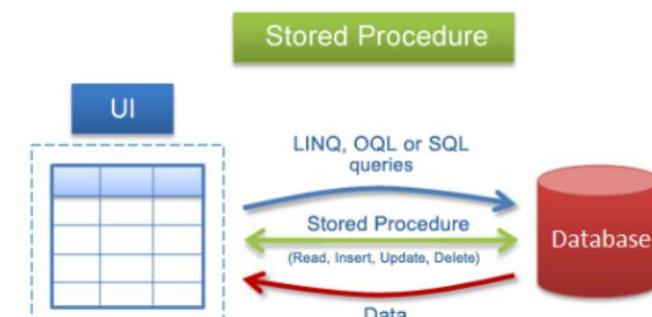
Testing Databases

03 What to Test in Database?

D. TRIGGERS



- White Box Testing:
 - Without integration invoke the trigger using Stubs & Drivers
- Black Box Testing:
 - Integrate with GUI and invoke trigger by satisfying the condition
 - Bulk load data direct to DB to invoke the trigger



Stored Procedure

UI

LINQ, OQL or SQL queries

Stored Procedure (Read, Insert, Update, Delete)

Data

Database

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Testing Databases

03 What to Test in Database?

E. CONSTRAINTS



Constraint	Column	Row	Table	External
Not Null	✓	✗	✗	✗
Check	✓	✓	✗	✓
Unique	✗	✗	✓	✗
Primary Key	✓	✗	✓	✗
Foreign Key	✓	✗	✗	✓
Index	✗	✗	✓	✗
Trigger	✓	✓	✗	✓

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Testing Databases

03 What to Test in Database?

F. DATA MAPPING

The diagram shows a central grey box labeled 'Retrieve/Update' with two arrows pointing away from it. One arrow points left to a stack of blue cylinders labeled 'Data Store', and another points right to three windows labeled 'Application'. The top window shows a circular icon.

Data Store Application

- Data Mapping is mapping a specific data field in the GUI to backend DB
- Data Travels Back and Forth (DB->Application->DB) by mapping application fields to DB columns

This diagram illustrates the validation of data mappings. It shows two tables: 'Available Input Col...' and 'Available Destinati...'. Arrows connect corresponding columns between the two tables. The 'Available Input Col...' table has columns: Name, src_LSNTime, __\$start_lsn, __\$seqval, __\$operation, and __\$update_mask. The 'Available Destinati...' table has columns: Name, src_LSNTime, __\$start_lsn, __\$seqval, __\$operation, __\$update_mask, and RowId.

- Validating Mappings amongst Application Interface and DB is critical to maintain data consistency
- Validate Mapping correctness by firing CRUD actions from Front end and check for corresponding changes at backend

CRUD: Create, Retrieve, Update, Delete

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Testing Databases

03 What to Test in Database?

F. DATA MAPPING

CREATE READ UPDATE DELETE

CRUD

- Table mapping, column mapping, and data type mapping
- Lookup data mapping
- Correct CRUD operation is invoked for every user action at User Interface

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The screenshot shows a Firefox browser window with a Google Slides presentation. The title of the slide is "What to Test in Database?". The slide number is "03". There is a section titled "F. DATA MAPPING" which includes icons for CREATE, READ, UPDATE, and DELETE operations, and the acronym CRUD below them. To the right of this section is a bulleted list of items related to data mapping. The bottom of the slide has the Globant logo. The browser's toolbar and address bar are visible at the top, and the desktop taskbar is visible at the bottom.

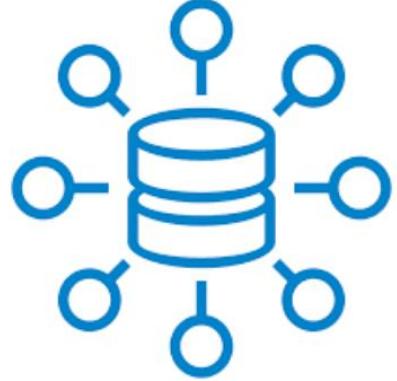
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Testing Databases

03 What to Test in Database?

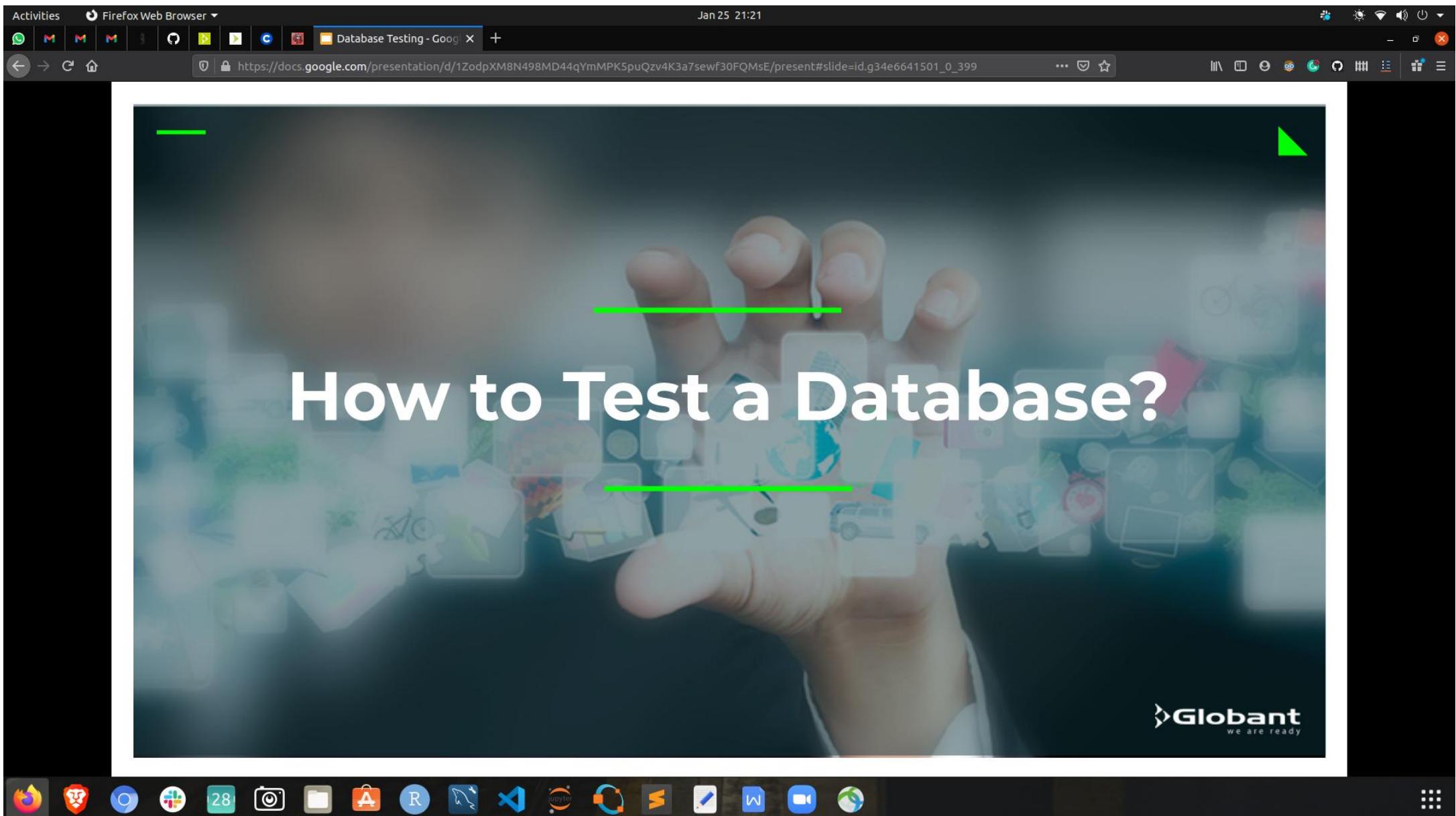
G. INTEGRITY



- Data integrity is the overall completeness, accuracy and consistency of data
- Logically well organized data
- Data is correct and as per the business requirements
- Unnecessary data present in the application under test
- Data Concurrency in respect to GUI input
- TRIM operations performed on the data before inserting data
- Data has been properly committed
- Data has been rolled back successfully if the transaction is unsuccessful
- Transactions have been executed by using the required design procedures

Contd ... 

Firefox, Docker, Google Chrome, 28, Camera, File, App, R, Python, VS Code, Jupyter, S, Notepad, WPS, Video, Map



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Testing Databases

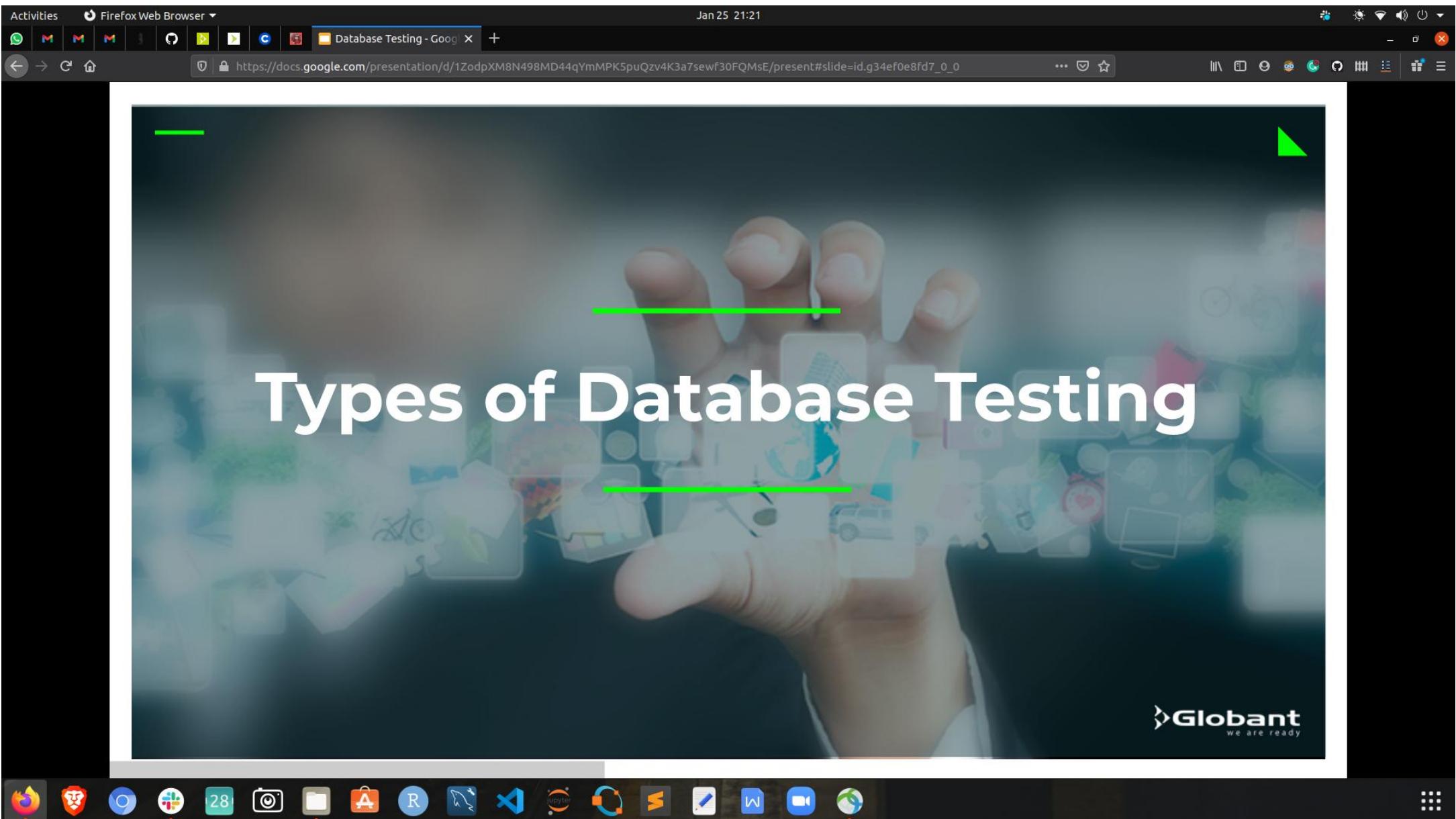
04 How to Test Database?



- Prepare the test environment
- Run a test
- Check the result
- Validate
- Report the findings

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Big Data Testing - Testing Databases

05 Types of Database Testing

STRUCTURAL TESTING



It deals with table and column testing, schema testing, stored procedures and views testing, checking triggers, etc

FUNCTIONAL TESTING



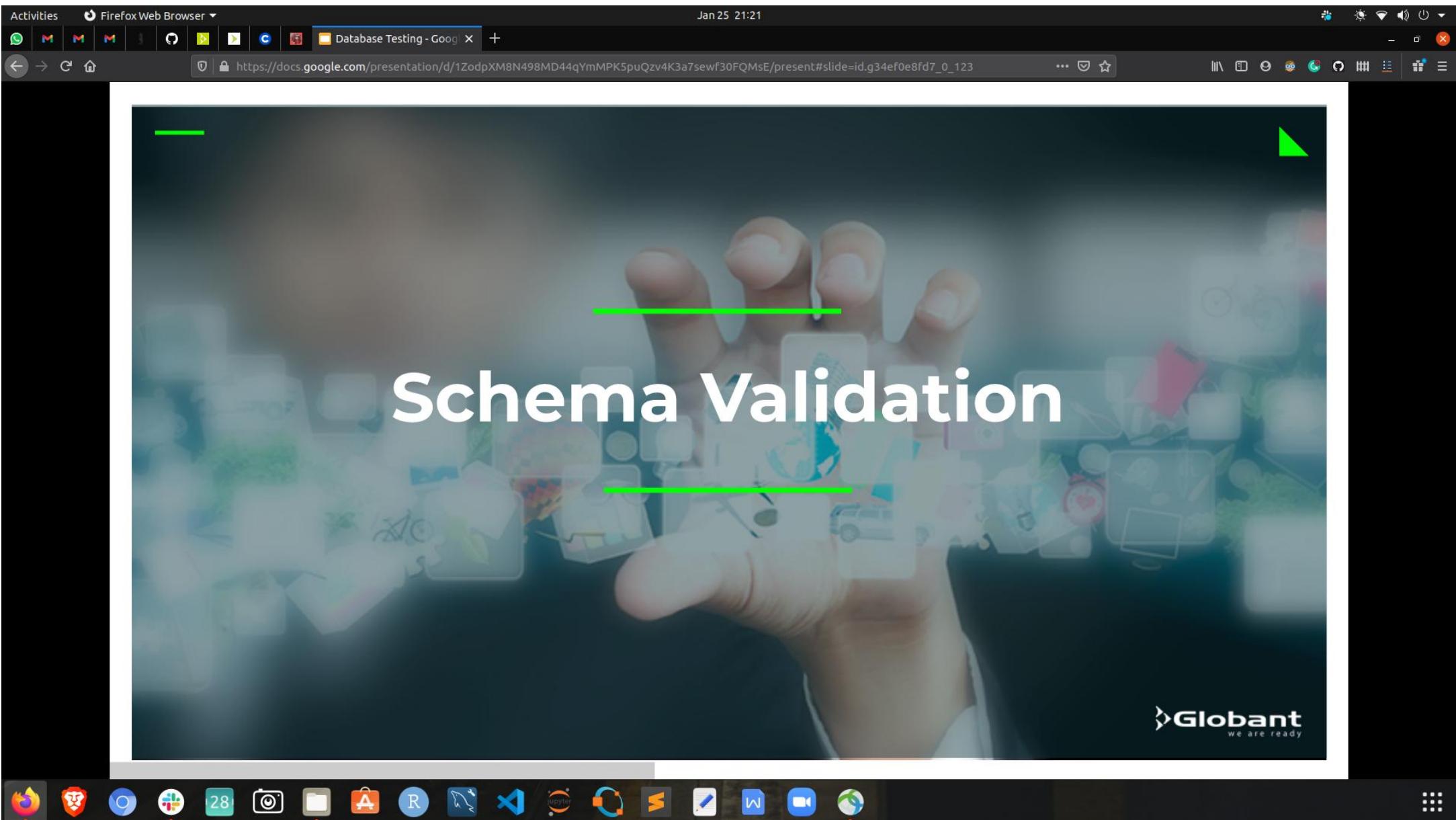
It involves checking the functionality of a database from the user point of view

NON-FUNCTIONAL TESTING



It involves load-testing, risk testing in database, stress testing, minimum system requirements, and deals with the performance of the database

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Big Data Testing - Testing Databases

06 Schema Validation

A. STRUCTURE VALIDATION FOR TABLES AND VIEWS

Create statements	Alter statements	Drop statements
CREATE SCHEMA		DROP SCHEMA
CREATE DOMAIN	ALTER DOMAIN	DROP DOMAIN
CREATE TABLE	ALTER TABLE	DROP TABLE
CREATE VIEW		DROP VIEW
CREATE INDEX		DROP INDEX

- Most DDLs are mentioned in Flat files
- DDLs are manually updated by the developers
- DDLs are hard coded
- Provided to the data loader during run time
- Validation of the DDLs and the table structure is important
- Mismatch in the DDLs and the Table structure causes record drops

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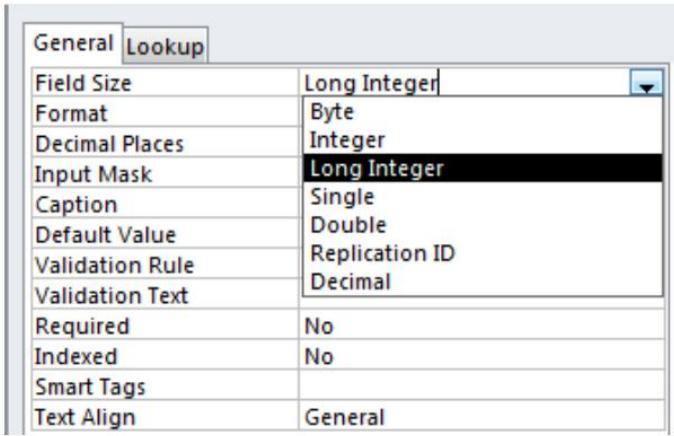
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06 Schema Validation

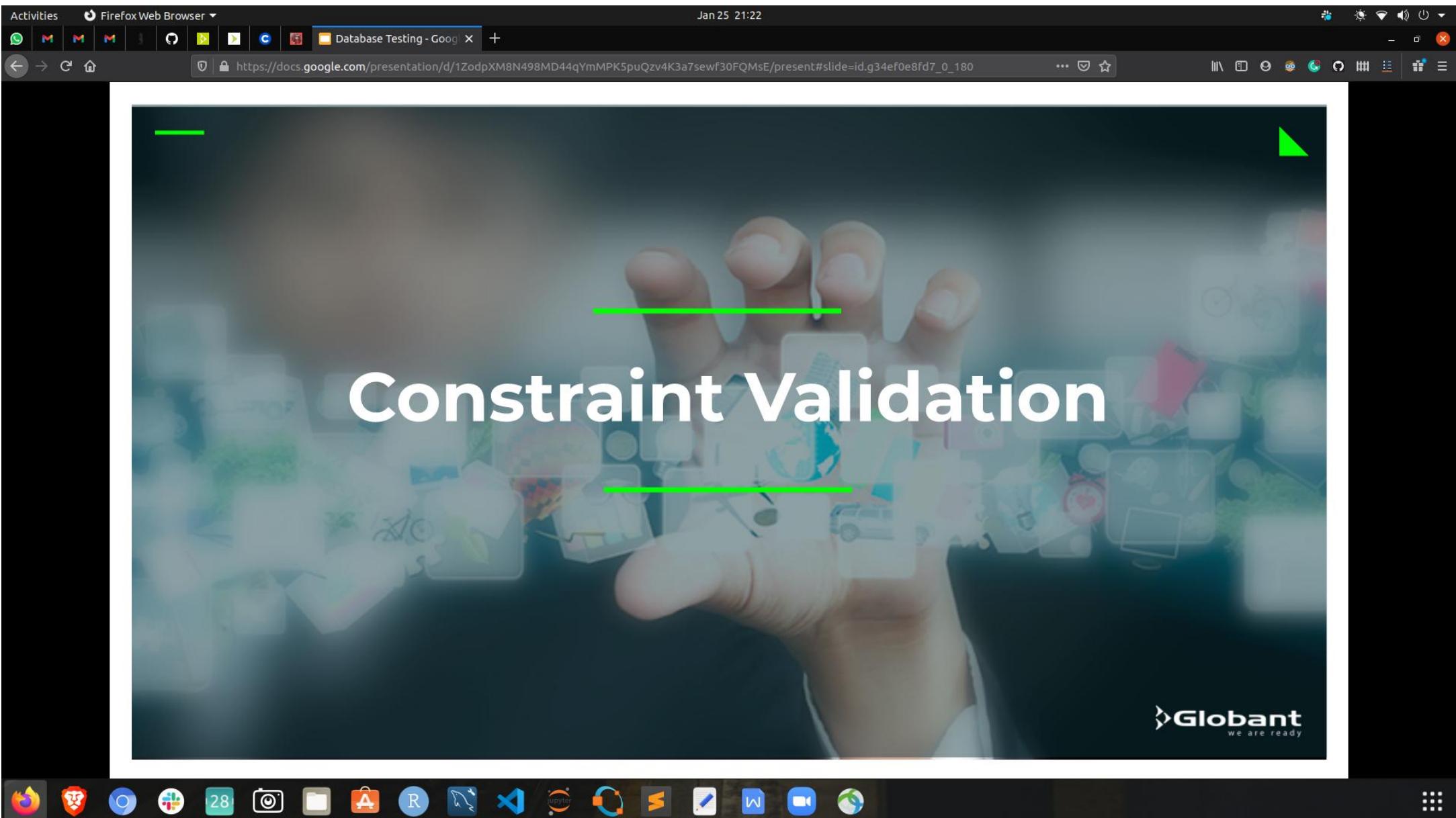
B. DATA TYPE & LENGTH VALIDATION



Field Size	Long Integer
Format	Byte
Decimal Places	Integer
Input Mask	Long Integer
Caption	Single
Default Value	Double
Validation Rule	Replication ID
Validation Text	Decimal
Required	No
Indexed	No
Smart Tags	
Text Align	General

- Data type validation is necessary due to changeable nature of the data type
- An int variable can be changed to string variable and vice versa
- Data drop during loading and fetching can occur due to bad data type
- Data truncation can occur due to column length being short
- Performance issue if the column length is greater than required

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Testing Databases

07 Constraint Validation

Example

Create EMPLOYEE Table

```
DEPARTMENT(DepartmentName, BudgetCode, OfficeNumber, Phone)
EMPLOYEE(EmployeeNumber, FirstName, LastName, Department, Phone, Email)
```

IDENTITY(x,y): Surrogate key. Start from x, increment by y Default value for Department

```
CREATE TABLE EMPLOYEE(
    EmployeeNumber Int NOT NULL IDENTITY (1, 1) PRIMARY KEY,
    FirstName Char(25) NOT NULL,
    LastName Char(25) NOT NULL,
    Department Char(35) NOT NULL DEFAULT 'Human Resources',
    Phone Char(12) NULL,
    Email VarChar(100) NOT NULL UNIQUE,
    CONSTRAINT EMP_DEPART_FK FOREIGN KEY(Department)
        REFERENCES DEPARTMENT(DepartmentName)
        ON UPDATE CASCADE
);
```

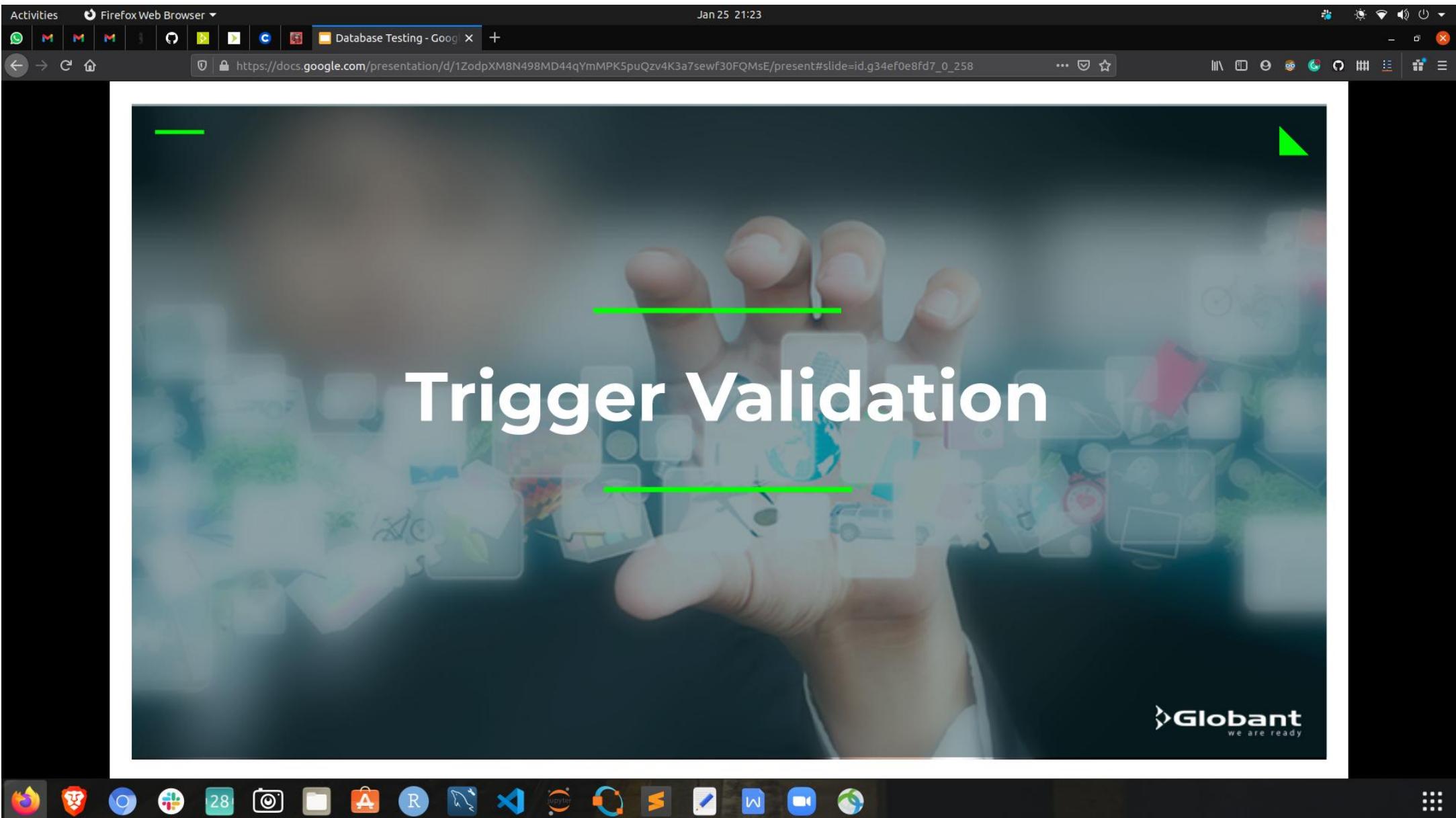
Allow NULL values
Can be omitted

UNIQUE: requires unique value for Email

Define Foreign Key

Varchar(100) and Char(100) both defines a string with length up to 35
Varchar(35) the storage is the actual length
Char(35) the storage is fixed 35

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Testing Databases

08 Trigger Validation

A trigger is an object related to tables and stored in DB. Its name derives from its behaviour as it is executed automatically when an event occurs in the database server.

Development

Continuous integration

Source control

Trigger

Build

Test

Feedback mechanism

- Whether the required coding conventions have been followed during the coding phase of the Triggers
- Check whether the triggers executed for the respective DML transactions have fulfilled the required conditions
- Whether the trigger updates the data correctly once they have been executed
- Validation of the required Update/Insert/Delete triggers functionality in the realm of the application under test

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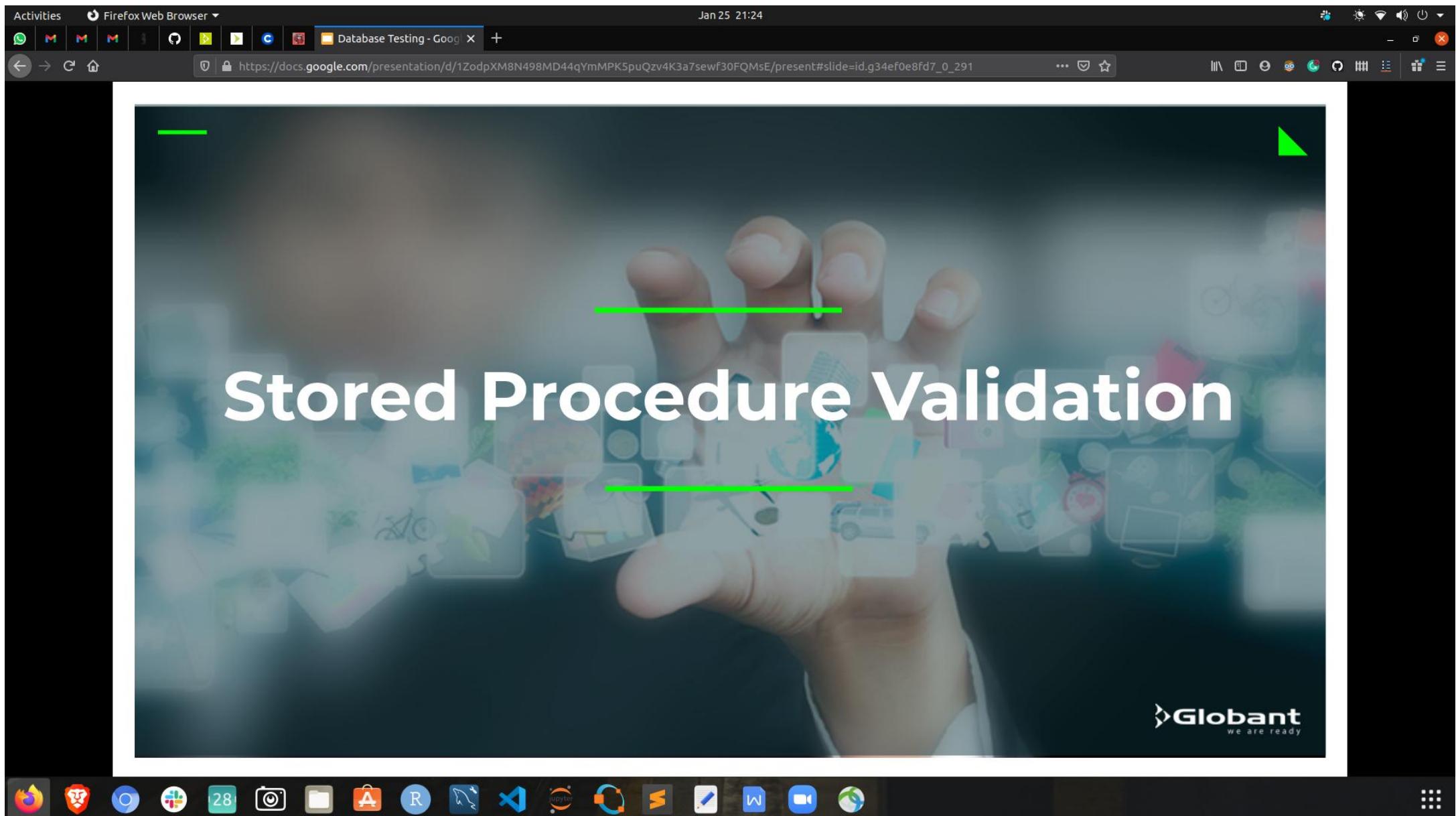
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The slide has a teal header with the title 'Trigger Validation'. To the left, there's a green circular icon with a magnifying glass over a person icon, and a teal box containing the number '08'. The main content area has a teal background with the word 'EXAMPLE' in white.

- Audit data received “New employee name XYZ is added at Mar 04 2018 10:10 AM” is an example of INSERT Trigger
- Audit data received “An existing employee name XYZ is updated Phone Number at Mar 05 2018 16:05 PM” is an example of Update trigger
- Audit data received “An existing employee name XYZ is deleted at Mar 10 2018 20:00 PM” is an example of DELETE trigger

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Firefox, Google Chrome, Microsoft Edge, 28, Camera, File, R, Python, VS Code, Jupyter, S, Notepad, Video, Map icons.



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Testing Databases

09 Stored Procedure Validation

A stored procedure is a set of SQL statements with an assigned name, which are stored in a relational database management system as a group, so it can be reused and shared by multiple programs.

- Whether the development team did adopt the required coding standard conventions and exception and error handling
- Whether the development team did cover all the conditions/loops by applying the required input data to the application under test
- Whether the manual execution of the Stored Procedure provides the end user with the required result
- Whether the manual execution of the Stored Procedure ensures the table fields are being updated as required by the application under test
- Validation of the fact that all the Stored Procedures and Functions have been successfully executed when the Database under test is blank.
- Validation of the overall integration of the stored procedure modules as per as the requirements of the application under test

Some of the interesting tools for testing stored procedures are LINQ , SP Test tool etc

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The slide has a teal header with the title 'Stored Procedure Validation'. On the left, there's a green circular icon with a magnifying glass over a person icon, and a teal box containing the number '09'. The main content area has a teal background with the word 'EXAMPLE' in white.

If I have an 'Employee' table →

Employee ID	Name	Age	Mobile
001	Mickey	30	1234567890
002	Mouse	25	9876543210

First I am retrieving the Employee table:

```
Create Procedure Employee details  
As  
Begin  
Select * from Employee  
End
```

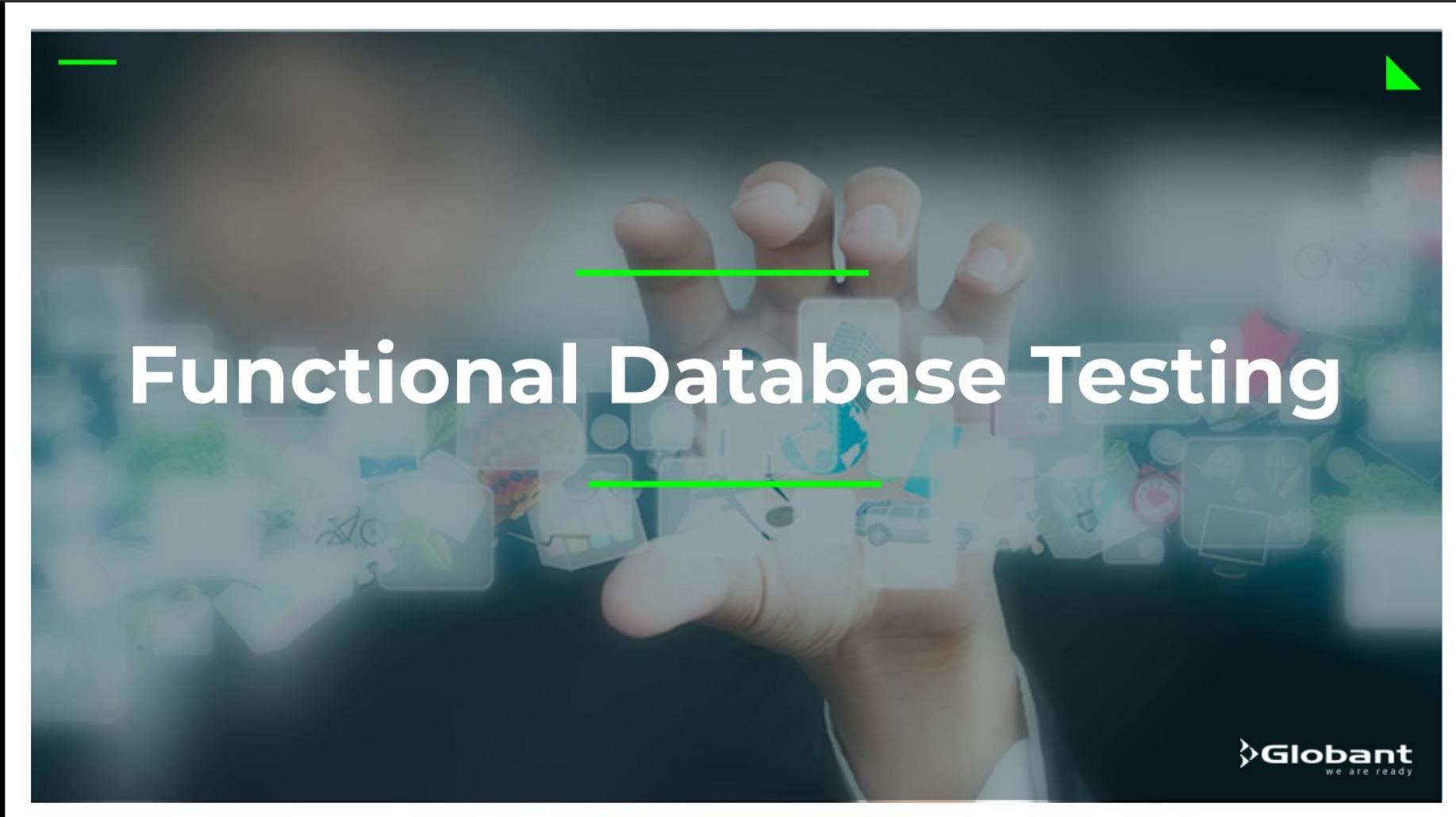
To run the procedure on SQL Server:

```
Execute Employee details
```

--- ('Employee details' is a user defined name, give a name as you want)

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The slide has a teal header with the title 'Functional Database Testing'. To the left, there's a sidebar with a magnifying glass icon and the text 'Testing Databases'. A large green box contains the number '10'. The main content area has a teal background with white text.

The Functional DB testing as specified by the requirement specification needs to ensure most of those transactions and operations as performed by the end users are consistent with the requirement specifications.

Following are the basic conditions which need to be observed for database validations.

- Whether the field is mandatory while allowing NULL values on that field?
- Whether the length of each field is of sufficient size?
- Whether all similar fields have same names across tables?
- Whether there are any computed fields present in the Database?

This particular process is the validation of the field mappings from the end user viewpoint. In this particular scenario the tester would perform an operation at the database level and then would navigate to the relevant user interface item to observe and validate whether the proper field validations have been carried out or not.

The vice versa condition whereby first an operation is carried out by the tester at the user interface and then the same is validated from the back end is also considered to be a valid option.

Contd ...

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Testing Databases

10 Functional Database Testing

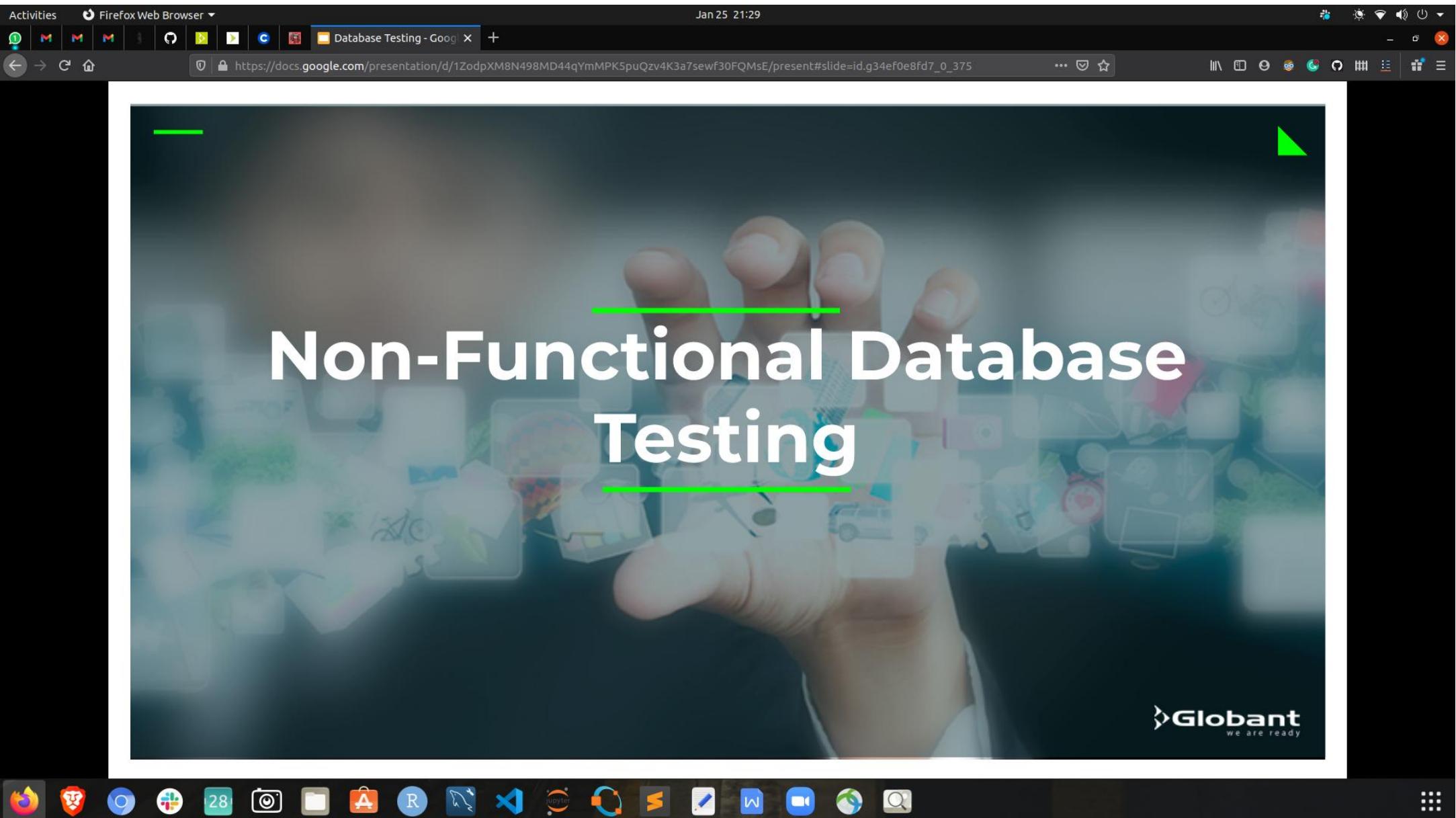
You can use the built-in functions or create your own user-defined functions. SQL has many built-in functions for performing processing on string or numeric data.

Following is the list of all useful SQL built-in functions

- **AGGREGATE FUNCTIONS:** It perform a calculation on a set of values and return a single value
- **ANALYTIC FUNCTIONS:** It compute an aggregate value based on a group of rows
- **RANKING FUNCTIONS:** It return a ranking value for each row in a partition
- **SCALAR FUNCTIONS:** It operate on a single value and then return a single value. Scalar functions can be used wherever an expression is valid
- **ROWSET FUNCTIONS:** It return an object that can be used like table references in an SQL statement

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Testing Databases

11 Non-Functional Database Testing

The Non-functional DB testing involves performing load testing, stress testing, checking minimum system requirements to meet business specification, risk finding and performance optimization of database.

Following testing should be considered in non-functional testing types:

- Availability Testing
- Baseline testing
- Compatibility testing
- Compliance testing
- Configuration Testing
- Documentation testing
- Endurance testing
- Interoperability Testing
- Installation Testing
- Load testing
- Stress testing

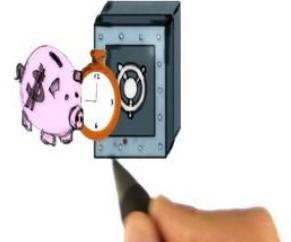
- Localization testing and Internationalization testing
- Performance testing
- Recovery testing
- Reliability Testing
- Resilience testing
- Security testing
- Scalability testing
- Usability testing
- Volume testing

FUNCTIONAL AND NON-FUNCTIONAL REQUIREMENTS

Functional



Non-functional



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Firefox Camera R jupyter S W M

The screenshot shows a Firefox browser window with the address bar displaying a URL from Google Docs. The main content is a slide from a presentation titled "Testing Databases". The slide features a large green circle icon with a magnifying glass and user profile icon, followed by a teal box containing the number "11". To the right, the title "Non-Functional Database Testing" is displayed in white text on a teal background. Below the slide, a section titled "A. LOAD TESTING" is visible, along with a descriptive text and a bulleted list of configuration requirements for load testing.

A. LOAD TESTING

The process of putting demand on a software system or computing device and measuring its response. It is performed to determine a system's behavior under both normal and anticipated peak load conditions.

The following types of configurations are a must for load testing:

- The most frequently used user transactions have the potential to impact the performance of all of the other transactions if they are not efficient
- At least one non-editing user transaction should be included in the final test suite, so that performance of such transactions can be differentiated from other more complex transactions
- The more important transactions that facilitate the core objectives of the system should be included, as failure under load of these transactions has, by definition, the greatest impact

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Testing Databases

11 Non-Functional Database Testing

- At least one editable transaction should be included so that performance of such transactions can be differentiated from other transactions
- The observation of the optimum response time under huge number of virtual users for all the prospective requirements
- The observation of the effective times for fetching of various records



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Testing Databases

11 Non-Functional Database Testing

B. STRESS TESTING

It is used to test the stability & reliability of the system. This test mainly determines the system on its robustness and error handling under extremely heavy load conditions. This helps in identifying breakdown points of the system.



The following types of configurations are a must for stress testing:

- **SQL EXTRACTION** - We extract a representative sample of actual SQL and DML from the production database
- **SQL PREPARATION** - We create PL/SQL wrappers around the SQL to pass-in valid values for the host variables, using data from the application tables

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Testing Databases

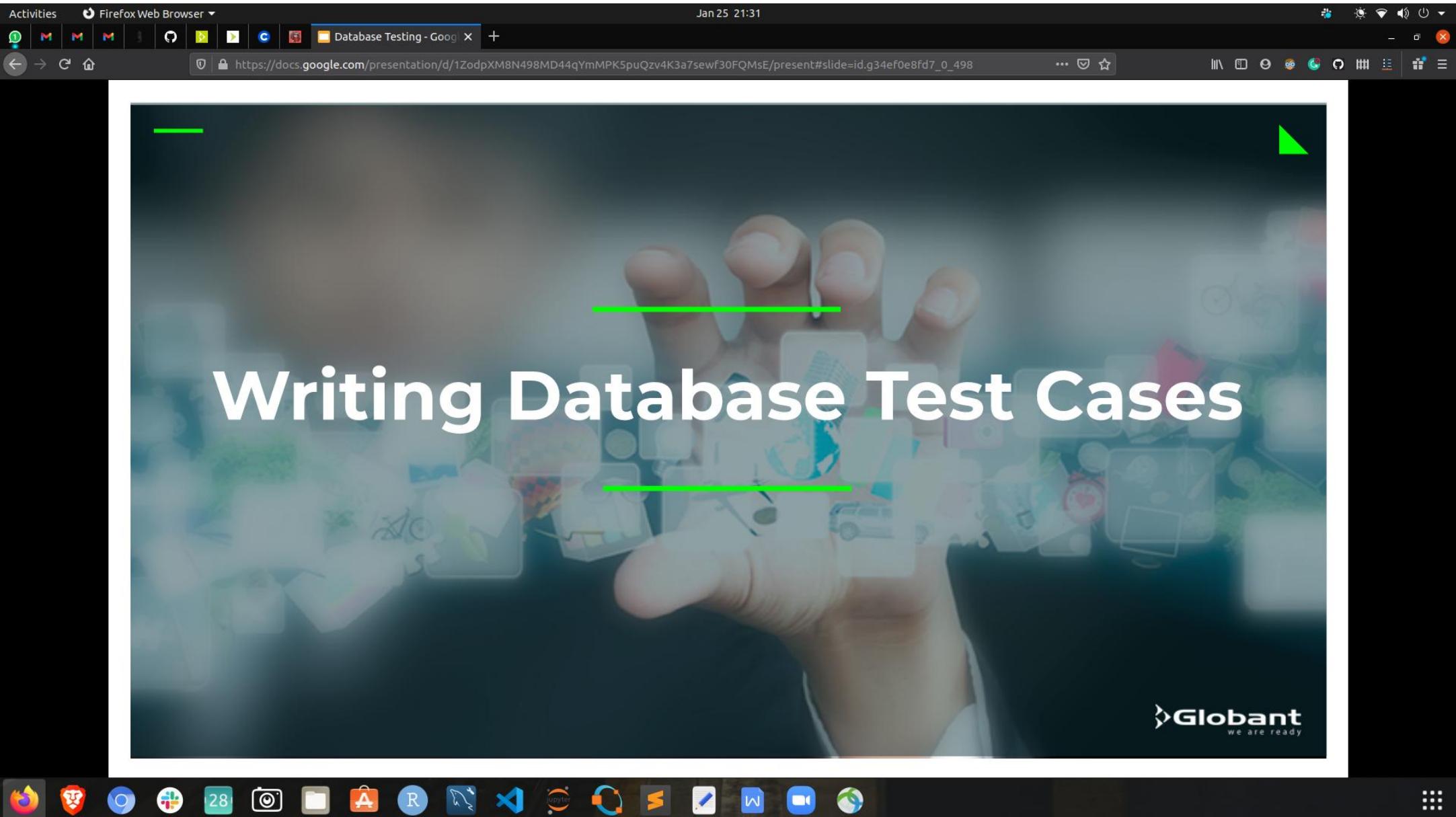
11

Non-Functional Database Testing

- **LOAD PREPARATION** - Benchmark factory allow us to submit up to 2000 transaction threads per TNS client, however the practical limit is based on network bandwidth of the client, for example 60 users tends to saturate a 100Mbit line. We will configure 2 clients, installing BF Agent software and TNS in order to set-up a load of 200 transaction threads
- **TEST EXECUTION** - We then start the server data capture (vmstat, iostat) and take an AWR snapshot. After a pre-designated interval we will step up the user load by 10 users at each step
- **POST-HOC ANALYSIS** - We plot the overall response_time and correlate the drop-off with internal Oracle metrics (e.g. wait events) and external server metrics (CPU enqueues, RAM swapping)

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Testing Databases

12 Writing Database Test Cases

There's no magic when it comes to writing a database test, you write them just like you would any other type of test.

Database tests are typically a three-step process:

- **SETUP THE TEST**- You need to put your database into a known state before running tests against it (WORKING DATABASE)
- **RUN THE TEST**- Using a database regression testing tool, run your database tests just like you would run your application tests
- **CHECK THE RESULTS**- You'll need to be able to do "table dumps" to obtain the current values in the database so that you can compare them against the results which you expected



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Testing Databases

13 Popular Database Testing Tools

The slide displays a grid of logos for 13 popular database testing tools and databases. The tools include Oracle SQL Developer, Microsoft SQL Server, mongoDB, sql TEST (Powered by tSQLt), SQLite, nosql unit, SQL EDIT (DTM Data Generator), DATA FACTORY, HammerDB, and MySQL (Globant). Each logo is accompanied by its respective name.

- Oracle SQL Developer
- Microsoft SQL Server
- mongoDB
- sql TEST
Powered by tSQLt
- SQLite
- nosql unit
- SQL EDIT
DTM Data Generator
- DATA FACTORY
- HammerDB
- MySQL
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