Novel Continuous Testing Framework for DevOps Model in Cloud Environment

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Abstract: Continuous testing (CT) is a process of evaluating the quality of software in which applications are tested continuously throughout the entire software development life cycle (SDLC). The objective of CT is to provide critical feedback earlier and enabling higher-quality software product and fast delivery. Modular automation framework follows the concept of Abstraction and It is easily expandable. Modular frameworks are flexible type and very much easy to maintain due to small test scripts. Here this paper will provide the new framework "Continuous Testing Modular Framework" which will provides the benefit of modular framework in continuous Testing.

Index Terms: Devops, Continuous Testing (CT),Modular Framework, Cloud providers, Continuous Development

1. Introduction

DevOps is the combination of development and operation that rises the growth of an organization's ability to deliver applications& improving products at an earlier than organizations using traditional software development process.

DevOps automation is becoming cloud-centric. Most public and private cloud computing providers maintain DevOps systemically on their platform, including continuous integration and continuous development tools. Now software Development has gone through a long journey from waterfall to DevOps. This journey contains Continuous Integration, Continuous testing, and Continuous Delivery and Continuous Deployment approach. Gradually IT organizations appreciated that recent approaches are improved than traditional approaches in every manner. Recent trends like DevOps are very common among software industry, but still facing several challenges in case of continuous delivery across multiple environments.

In software development, Continuous integration is important process of DevOps where developers repeatedly integrate their modified code into a central repository, after which automated builds and tests are executed. Continuous Testing is the procedure of running automated test cases in software delivery pipeline for obtaining the feedback/response on the business risks.Continuous Delivery is a ongoing approach of software. In this process, team creates software in small rotation, ensuring that the software can be reliably

released at any time. It purposes at building, testing, and releasing software with improvements to software code and user environments with the help of automated tools.Continuous Deployment is a software release approach in DevOps that uses automated test execution to make sure that if modified code are accurate and stable for instant deployment to a production environment and these changes are direct visible to the software's users[2][3].

2. Literature Survey

The cloud refers to software and services that run on the Internet, instead of locally on your computer. Some examples of cloud services include Google Drive, Apple iCloud, Netflix, Yahoo Mail, Dropbox and Microsoft One Drive.The cloud service providers are Google cloud platform, Microsoft azure and Amazon web services etc.

2.1. Google Cloud Platform:

Mohammed Ibrahim M. Almanea [26] proposed Cloud Advisor - A Framework towards Assessing the Trustworthiness and Transparency of Cloud Providers like Google Cloud Platform (GCP), which is offered by Google, is a suite of Cloud Computing services that runs on the same infrastructure that Google uses internally for its end-user products such as Google Search engine, YouTube, and more. Following is the testing strategy for GCP which is described in figure 1.

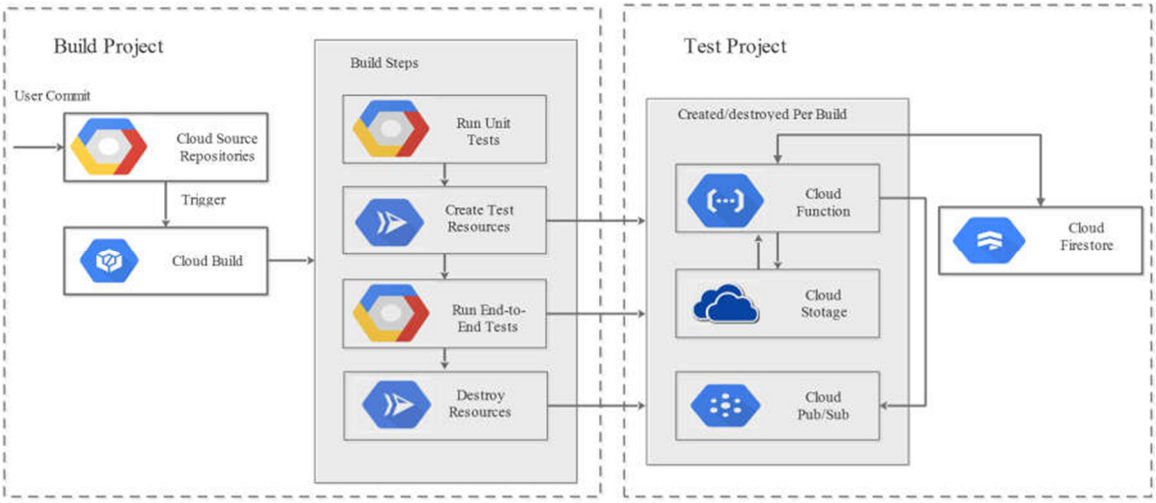

Figure1: Google Cloud Platform

2.2. Microsoft Azure:

Mohammed Ibrahim M. Almanea [26] proposed Cloud Advisor - A Framework towards Assessing the Trustworthiness and Transparency of Cloud Providers like Microsoft Azure, initially called Azure, was

launched in 2010 with the intent to provide a competent Cloud Computing platform for businesses. Azure was renamed as 'Microsoft Azure' in 2014, though the name 'Azure' is still commonly used. Since its inception, Microsoft Azure has shown great progress among its competitors. Following is the testing strategy for Microsoft azure which is described in figure 2.

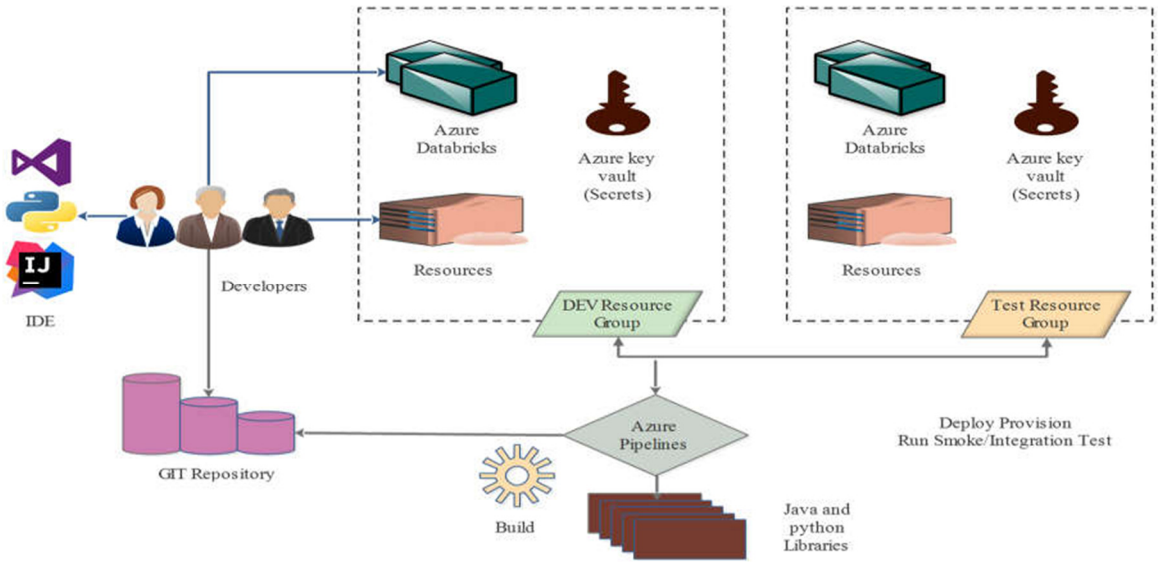

Figure 2: Microsoft Azure

2.3. Amazon Web Services:

Mohammed Ibrahim M. Almanea [26] proposed Cloud Advisor - A Framework towards Assessing the Trustworthiness and Transparency of Cloud Providers like Amazon Web Services is a subsidiary of amazon.com, which provides an on-demand Cloud Computing platform to individuals, companies, and governments on a paid-subscription basis. Amazon Web Services is the oldest and the most experienced player in the cloud market. As one of the oldest cloud providers, it has established a bigger user base, as well as bigger trust and reliability factors. Following is the testing strategy for AWS which is described in figure 3.

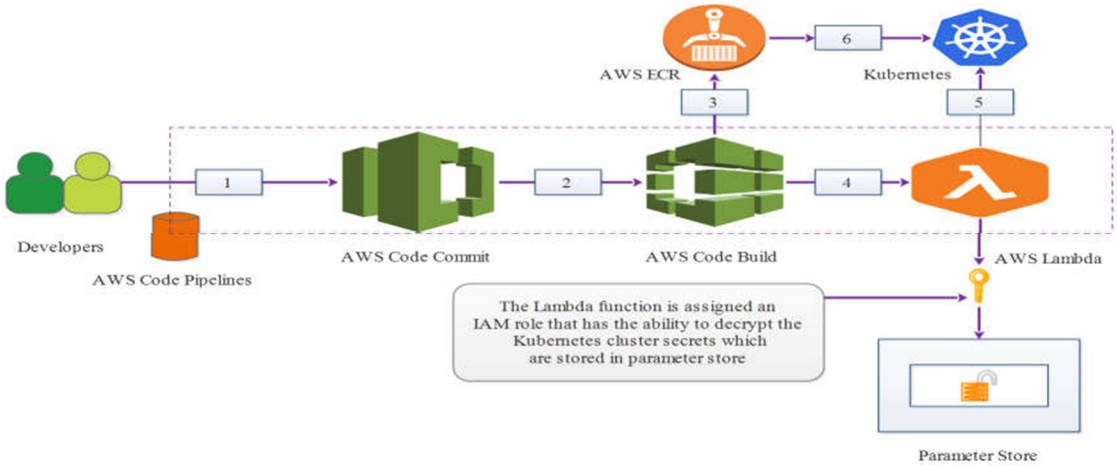

Figure 3: Amazon web services

Table1 is describing the difference between existing cloud providers like AWS, Microsoft Azure and Google cloud platform, This table has described strengths and weakness of respective cloud providers[26][29][30].

Table1. Latest Testing Tools Information

S.No	Tools Name	Best suited for	Feature	Free Trial	Price
1	Kobiton	Medium to Large size businesses.	Agile & DevOps Test Automation.	Integrating UI and end-to-end testing into the CI pipeline, Robust Integrations with 3rd Party Solutions.	Available (Starts at $10 per month)
2	Avo Assure	Teams of any size.	Real-device Testing & Intelligent Test Automation.	Scriptless test automation, JIRA integration, Advanced reporting & analytics.	Available (It starts at $50 per month.)
3	Bamboo	Any team size.	Builds	Dedicated agents Any language and popular technologies are supported, Real-time collaboration, Visibility on code changes.	30 days (Small Teams: $10 for 10 jobs Growing Teams: $1100 for unlimited)
4	Docker	Small to large businesses and individuals.	DevOps	Code building collaboratively, Integration with any stack or CI tool, Supports Windows and Linux.	Docker Hub: (Individuals) Free plan Docker Hub: (Organizations) Starts at $7 per month
5	JIRA	Small to large businesses.	Planning	Kanban boards Customizable workflows, Custom filters, Rich APIs, etc.	Self-managed: 30 days, Cloud-based: 7 days

6	Tricentis Tosca	Small to large businesses	Continuous Testing	No Code Approach, Model-based Test automation, Distribution execution.	Limited time for free trial
7	Puppet Enterprise	small to large businesses	Devops	It has features of managing infrastructure as code, versioning, automated testing, CI/CD, etc	Puppet Enterprise offers a free trial for the product for 10 nodes. Standard ($112 per node per year) and Premium ($199 per node per year).
8	GitHub	small to large businesses, freelancers, non-profits, and public administrators.	project management	It is popular software development platforms and review the code, manage projects, and develop software.	GitHub offers a free plan with the basics of GitHub. It offers three more plans i.e. Pro ($7 per month), Team ($9 per user per month), and Enterprise (Get a quote).
9	Testsigma	small to large businesses	Agile and DevOps	Automated testing of Web Applications and iOS & Android Web Applications.	Testsigma offers a free trial of 30 days for an Enterprise plan. There are three pricing plans i.e. Basic ($198 per month), Pro ($288 per month), and Enterprise (Get a quote).
10	Selenium	small to large businesses	Devops	Selenium is used for automation testing of web applications.	Free

Table 2: Strengths and Weakness of different existing cloud providers

Vendor	Strengths	Weakness
AWS	leading Market position	hard to use
	Extensive, Mature offering	Cost management
	Support for large organization	Overwhelming Option
	Extensive training	Price Variation
	Global reach	
Microsoft Azure	Second largest provider	Issue with documentation
	Integration with Microsoft tool and	Incomplete management

	software	tool
	Broad feature set	Complicated Pricing
	Hybrid cloud	
	Support for open source	
Google Cloud Platform	Designed for cloud native business	Fewer feature and service
	Commitment to open source and portability	Historically not as enterprise focused
	Deep discounts and flexible contracts	Pricing after 15Gb
	Devops expertise	Late entrant to laas market

DevOps is the combination of development and operation that rises the growth of an organization's ability to deliver applications& improving products at an earlier than organizations using traditional software development process.

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Maximiliano Agustin Mascheroni, EmanuelIrrazabal&GustavoRossi ,"Continuous Testing Improvement Model" , introduced new continuous testing framework which is called CTIM(Continuous Testing Improvement Model).This model is used as a solution for implementing Continuous Testing gradually at companies using Continuous Deployment or Continuous Delivery and measuring its progress [1].

MojtabaShahina , Muhammad Ali Babara , Liming Zhub"Continuous Integration, Delivery and Deployment: A SystematicReview on Approaches, Tools, Challenges and Practices", described the implication thet what are the challenges for adopting continuous deployment environment [2].

Maximiliano A. Mascheroni and Emanuel Irrazábal“Continuous Testing and Solutions for Testing Problems in Continuous Delivery: A Systematic Literature Review”, described “new approaches and tool to face the open issues of Continuous Testing " [3].

Roberto Pietrantuono,RobertoPietrantuono,AntoniaBertolino,Guglielmo De Angelis & Stefano Russo “Towards Continuous Software Reliability Testing in DevOps” , described reliability testing in devops and its benefits [5].

SriniketanMysari&VaibhavBejgam “Continuous Integration And Continuous Deployment PipelineAutomationUsing Jenkins Ansible” , described how to perform automation testing using Jenkins and its future work[6].

Ahmad Alnafessah,AlimUlGias&Runan Wang “Quality-Aware DevOps Research: Where Do We Stand” IEEE Access PP(99):1-1 Follow journal , described quality oriented software in devops model[7].

Louis S, Wheat craft &,Layne Lewis “Concept Maturity Level (Article)” INCOSE International Symposium 28(1) , described maturity levels in software development[8].

Ravi TejaYarlagadda “DevOps and Its Practices”SSRN Electronic Journal 9(3):2320-2882, described Devops and its tools [9].

RamtinJabbari,Nauman Bin Ali & Kai Petersen Towards a Benefits Dependency Network for DevOps based on a Systematic Literature Review (JOURNAL OF SOFTWARE: EVOLUTION AND PROCESS) Journal of Software: Evolution and Process 30(06):e1957 , provided Systematic Literature Review on Dependency Network for DevOps [10].

MayankGokarnaRaju Singh “DevOps: A Historical Review and Future Works” ,provided Systematic Literature Review and future work on devops [11].

MayankGokarna “DevOps phases across Software Development Lifecycle”, Provided Systematic Literature Review on devops phases on software development life cycle [11].

2.1 Motivation and Research Gap

DevOps tools allow for increased innovation at a faster rate, shortening the time it takes for a product to enter the market. By working in small teams and using automation software to limit monotonous tasks, projects can be developed, deployed, and adjusted much more quickly that’s why mostly IT organizations are using it. Continuous Testing is the process of executing automated tests as part of the software delivery pipeline in order to obtain feedback on the business risks associated with a software release candidate as rapidly as possible. There are some challenges in Continuous Testing and Continuous integration which may lead the late delivery or poor quality or poor customer satisfaction. DevOps is a methodology which is

used to frequently deliver apps to customers by introducing automation into the stages of app development. The main concepts attributed of DevOps are continuous integration, continuous testing, continuous delivery and continuous deployment. There is a need to introduce new tool and approaches of CI/CD in DevOps for better improvement and Need to prepare the continuous testing framework for cloud environments.

According to Literature survey ,got some following gaps which will be taken as future work, there is need to introduce new approaches and tool to face an open issues of Continuous Testing , How to Control Continuous Deployment across Multiple Environments?[2] and there is need to introduce new framework for multiple cloud environment[1].

So here is the problem statement

1) Which Testing Tool and approaches to support CI/CD in DevOps?

2) How to Control Continuous Deployment across Multiple Environments?

3) Need a Solution for testing problem in Continuous development environment.

4) Which framework is required for Continuous Testing in cloud environment?

3. Proposed Methodology

Local verification is the process of checking that software achieves its goal without any bugs. It is the process to ensure whether the product that is developed is right or not. It verifies whether the developed product fulfills the requirements that we have. After it develop build passes to the proposed framework and at the end we will be able to perform continuous testing on cloud environment and this framework will be used as open source.

Modular Testing framework is like creation of small and independent individual blocks that represents modules, small sections and functions of the application under test. Testers use Modular testing framework to divide an application into multiple clusters and create independent test scripts.

If we divide our application into module than it is easy to maintain and scripts are independent to write. Finding the bugs are also very easy. Testers use Modular testing framework to divide an application into multiple modules/clusters and create test scripts individually. These individual test scripts can be integrated to make huge test scripts by using a master script to perform the required scenarios. This master script is used to invoke the individual modules to execute end to end test scenarios.
Test Data: Test data is the Input feed for Testing the Application. Test Data helps the developers to find the problem during fixes

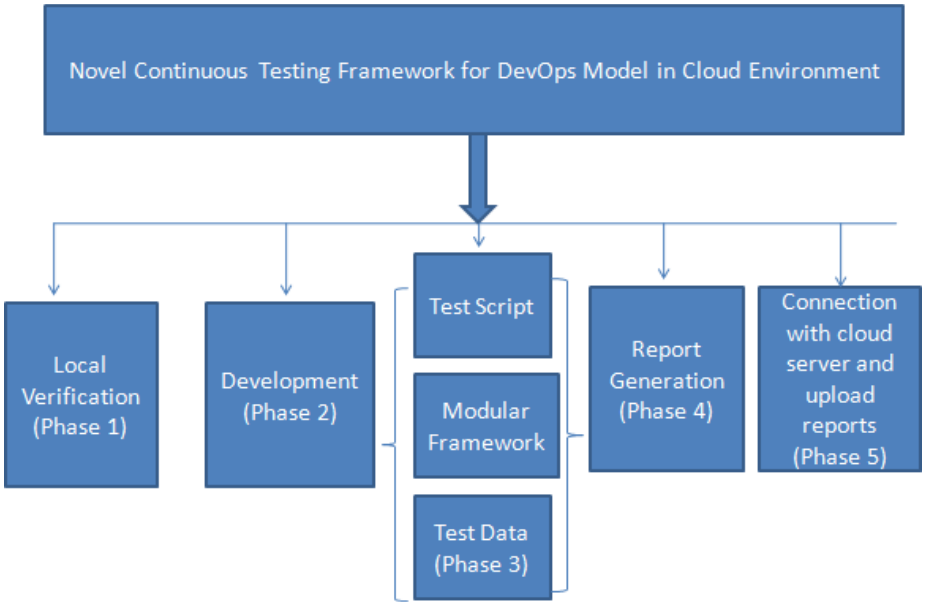

Figure 4: Phases of proposed framework

Java Code Coverage plug-in is an open-source code coverage tool for Java. It creates code coverage reports and integrates well with IDEs .It is easy to add the this plugin to all types of builds, including ANT, Maven, and Gradle. It can also be integrated with CI/CD tools like Jenkins, Circle CI, etc. This makes it versatile for a lot of use cases.The code coverage report generated by plugin is a simple and informative HTML file that can be viewed in any browser or IDE. Automation Testing on the cloud helps you attain better browser coverage, increased test coverage, and accelerated time to market.

This plugin also provides offline instrumentation (i.e. all the classes are instrumented before running any tests).Analysis of a report is also quite easy, as it is color-based and provides the exact percentage of code coverage.

Projektor supports automatically gathering and publishing the XML test results to the Projektor server. It listens to the end of the build, gathers up all the XML results generated by Test tasks in the build, and then sends those to the Projektor server. And Now connect with the cloud server and upload the generated reports on cloud.

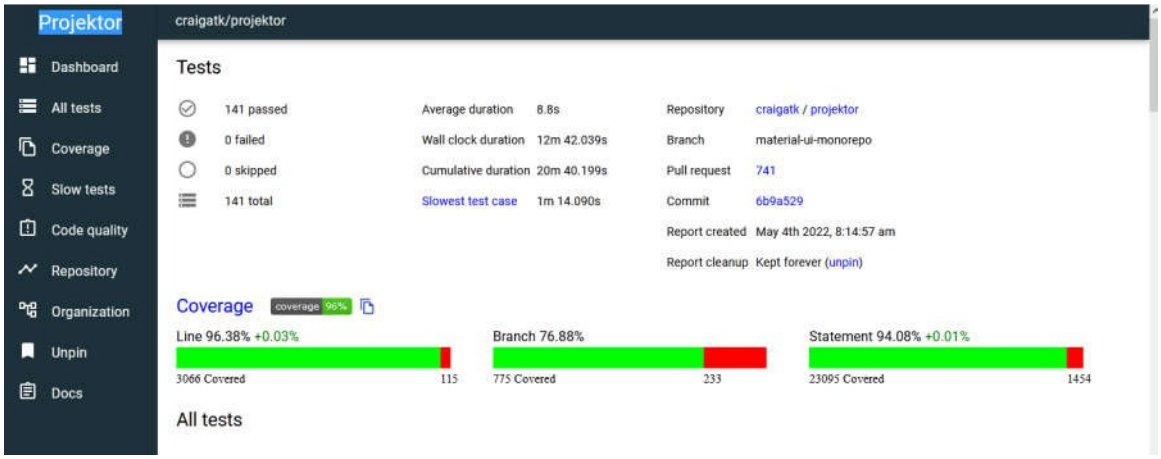

Diagram: projektor Coverage Report

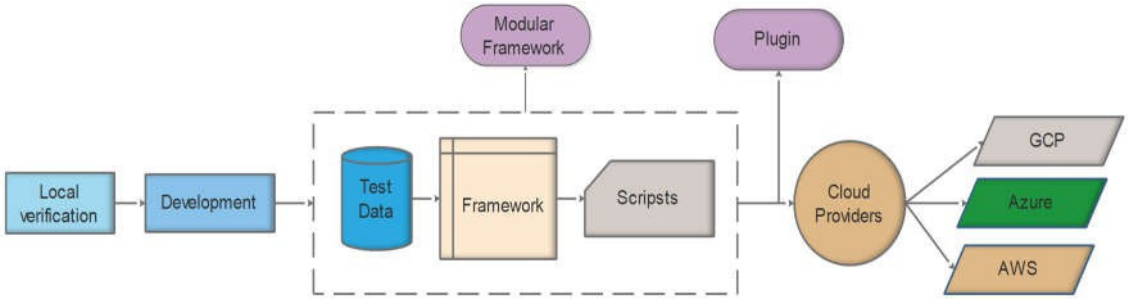

Figure5: proposed Framework of Continuous Testing Modular Framework

Algorithm 1: Proposed Algorithm Phase

Results:-

Input:-

Output:-

Procedure:

1. **Phase-1**:- All the static approaches are needed for review, inspection and walkthrough to understand the customers requirement
2. **Phase-2**:- Now Create New Package which will be creating different packages for Page Objects, Utilities, Test Data, Test Cases and Modular actions
   For Example "package framework.appModule;"
3. **Phase-3**:- Add new class under the above created package.
4. **Phase-4**:- Create New Test cases and pass the data under the above package
5. **Phase-5**:- Add the JaCoCo maven plugin.
   <plugin>
   <groupId>org.jacoco</groupId>
   <artifactId>jacoco-maven-plugin</artifactId>
   <version>0.8.6</version>
   </plugin>
6. **Phase-6**:- Need to update code after adding the JaCoCo plugin.
7. **Phase-7**:- After adding the dependency click on the Maven option.
8. **Phase-8**:- Execute it and Navigate for code coverage.
9. **Phase-9**:- Just click on the Run As button and set the configuration as Maven Test.
10. **Phase-10:-** Instead, you can open cmd(Command Line), traverse to the project folder, and run the maven command, “mvn test.”
11. **Phase-11:-**Config and Deploy generated with projector and connect with the cloud servers like Azure,GCP and AWS .
    For example, mvn com.microsoft.azure:azure-webapp-maven-plugin:2.2.0:config and mvn package azure-webapp:deploy
12. **Phase-12:-**End

Figure2: Proposed Framework

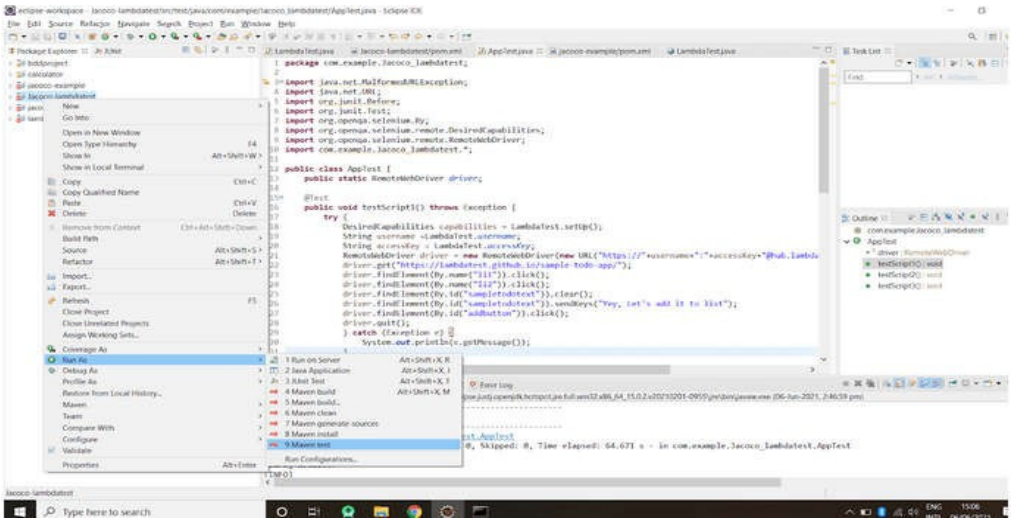

Figure6: Set the configuration as Maven Test

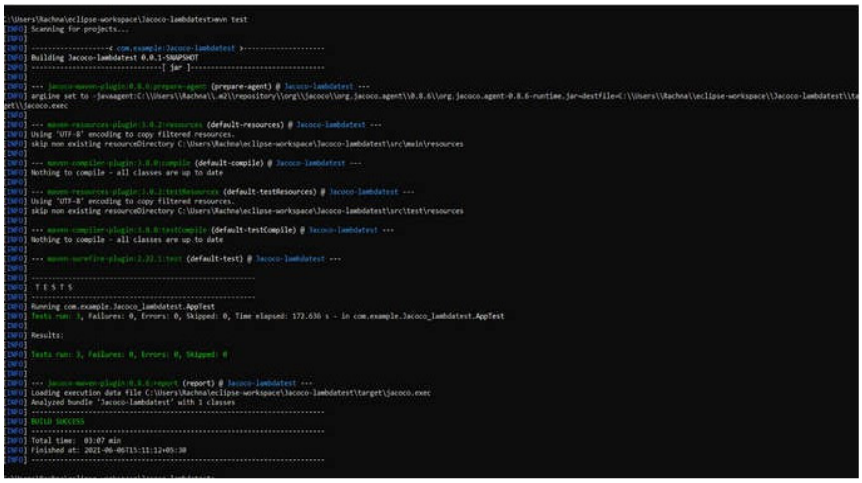

Figure7: Execute mvn test in Jacoco

4. Results and Discussion

- Introduction of New Testing Tool and approaches comparison to support CI/CD in DevOps [Table 1].
- Provided the literature survey to Control Continuous Deployment across Multiple Environments : A microservices environment has a cascading effect when changes are made.
  One single change made with CI/CD in a microservices context can affect numerous different interactions. Although a change might be successful for the intended microservices operation, it might have negative effects on other service chains.
  Orchestration can then help to guarantee that any change does not influence other streams and that development teams can roll back changes if necessary. Configuration management keeps track of any dependencies between various microservices.
- Provided the literature survey to give the solution for testing problem in Continuous development environment ie Security : DOI: 10.1109/ICOSNIKOM56551.2022.10034883 “Implementation of DevSecOps by Integrating Static and Dynamic Security Testing in CI/CD Pipelines”

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Published in: 2018 IEEE/ACM 4th International Workshop on Rapid Continuous Software Engineering (RCoSE)

- Developed the new Continuous Testing framework for clouds environment.

5. Conclusion

In this paper, the Continuous Testing Modular Framework is presented as part of a Doctoral Thesis Research.

The model is proposed as a solution for the reported testing problems in projects which are using continuous development & testing approaches.

Our First goal was to provide the systematic review of Available Testing Tool and approaches & Its comparison.

Our Second & Third Goal was to provide literature survey on Control Continuous Deployment across Multiple Environments and to give the solution for testing problem in Continuous development environment that is Security.

Our final and forth goal is to provide Testing Framework "The Continuous Testing Modular Framework" which provide the execution result on the cloud.

By using a continuous testing modular framework, it is possible to fix the test scripts for a single module after an application change rather than having to rerun all of the application's test cases. The ability to apply the test scripts for various application modules and display the results in the cloud environment is another benefit of the modular testing framework.

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