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Automated Regression Testing on Network Embedded Systems

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Abstract:

One important step of software development life cycle is the testing phase. It is necessary to ensure quality and reliability of the software being built. Regression testing is done whenever there is a code change in the software to check if it is introducing any other bugs or issues in the system. Regression testing is necessary in such cases and it must be done. Conventional manual methods are not that efficient, they are time-consuming and not reusable. This paper first introduces to regression testing and its role in remote embedded systems. The paper brings out the importance and the need of automated regression testing for remote network embedded systems like optical line systems. This study examines and survey's some of the strategic regression testing methodologies and describes how they can be applied to network embedded systems, which, when combined with automation, reduces the execution time and effort.

Keywords **—regression, embedded, development, optical line system.**

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I. INTRODUCTION

Network demands have become increasingly sophisticated in recent years. Because people rely on smart devices like mobile phones and laptops for everything, from making video calls to online banking, networks must be secure, more reliable and robust. New Optical devices with sophisticated technologies are being used today in the network to increase the bandwidth available to the users. There is a growing requirement that the network embedded system is stable, reliable and robust. During the development phase of embedded software, regression testing is an important step to ensure quality and reliability. Carrying out traditional manual regression testing is time-consuming and expensive. Due to the complexity of initiating and monitoring tests on embedded targets, regression testing can be more difficult. Added to that fact, software development teams have restricted access to target hardware due to the high cost of these target systems. This paper gives a perspective on the automated regression testing on remote network devices. Second section introduces regression testing in embedded devices and how automation has a positive effect on it.

II. REGRESSION TESTING

A. Fundamental Concepts of Regression Testing

Each Regression is "a shift or trend towards lesser or lower than perfect state [1]. During the development of the software, development teams conduct regression testing whenever there is a code change in the end of the life cycle to check if the current bug fix is introducing any other bugs or not. It makes sure that it does not introduce any unwanted behaviour in the system. There are different types of regression tests which can be conducted. In network optical line systems for example, following are the types of regression tests which are suitable:

1) Test cases to independently test all the network components of the system by programming and validating the expected response from the components.
2) Sometimes the behaviour of one network component may logically depend on another component and it might not be possible to test the component independently. In this case functional use case testing can be conducted where tests are written and executed in a logical sequence in order to validate the behaviour of the system.

B. Automated Regression Testing Approach

Since conventional manual methods are inefficient and error prone, automation is the solution. The usually way is to write scripts and define test suites which are reusable and efficient. The suggested and most used language to write automation script is python or c++. Python provides a lot of libraries like unittest, pytest and other frameworks to efficiently develop the software for regression testing. The testing involves executing commands or programming parameters on the target device and validating the response. Python provides frameworks like Netmiko or Paramiko to connect to the remote device using secure shell hash or telnet and run the commands. Configuration and input files are written in a json file and input to the automation scripts.

C. Automated Regression Testing in Agile Environment

In Agile development environment, teams collaborate and iteratively develop the software and bring out solutions as and when new requirements occur. It is an iterative process and hence there will cycles of software releases and code changes in each cycle. Embedded devices are critical to the working of the system. In a network the embedded devices play a very important role and hence its crucial for it to be reliable and robust. In agile development methodology of remote embedded devices, regression testing is very critical. Since it is crucial to check if code changes in every cycle is bringing side effects to the system. Automating the regression testing process makes it even more efficient. The test suite evolves in tandem with the software. Implementation of good automation frameworks would eliminate the pipeline's bottleneck. The automation frameworks will be usually customised for the remote embedded systems. Hence good approaches would help testers and developers to implement an efficient regression testing framework.

D. Regression Testing in Remote Hardware Devices and its Challenges

Testing in hardware embedded devices adds another level of challenge since access to these devices are limited and costly. It is hard to initiate and monitor verification and validation of these devices. Putting into a place an efficient and reliable automation framework would cut the cost of time and expense. As the time for testing in these devices reduce, development teams and testing teams can share the limited resources and cut down the cost of extra hardware required just for testing.

Development teams can use the efficient libraries provided by languages like c++ and python and implement efficient frameworks. Figure 1 shows a generic design of automated testing frameworks which can be customised based on the domain and hardware devices being used. Regression testing is crucial in testing of these remote embedded devices.

Firmware upgrades are continuously done in hardware devices like optical devices in a network, or a washing machine or any hardware embedded device. So, it is important to check if the applications which are built on top of these firmware are working without any issues after each firmware drop or upgrade. For example, network embedded devices are installed with a firmware and custom network operating system. These operating systems, using the management plane try to program these devices for configuration purposes. So, there is a need to check, after each software release of either the operating system or the firmware of the device, if the system as a whole is working seamlessly.

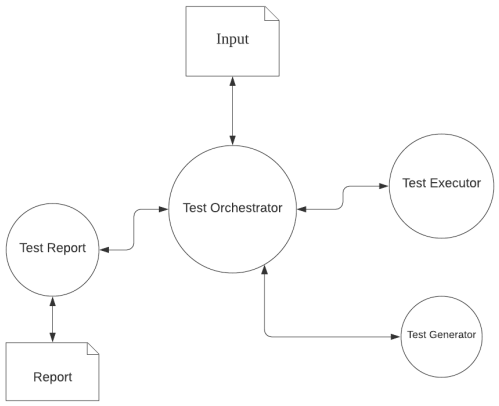

Fig. 1Generic design of automated testing frameworks.

III. EFFICIENT APPROACH TO IMPROVE REGRESSION TESTING IN EMBEDDED DEVICES.

Previous sections summarised and highlighted the importance in performing automated regression testing on remote embedded devices for the reasons mention above. There is a requirement for building a automation frameworks. Integrating efficient regression testing approaches is necessary. Following subsections summarises different approaches used currently in regression testing.

A. Functionality based regression testing

An embedded device is not always a single monolithic device. For example, in an optical line system, there are different devices like Optical line terminal(OLT) which is responsible in multiplexing the incoming signal or de-multiplexing the outgoing optical light signal. OLT will be available as single line card in a chassis. This device is composed of different devices which works together to provide the functionality of OLT optical device. In functionality-based regression testing these devices after each

firmware upgrade, are tested with a test suite which is generated by modelling the functionality in a flow diagram to decide the sequence of tests to be done. In this way the atomic tests can be identified and generated. The sequence is decided by the modelled flow diagram. An example use case scenario of an OTDR would help understand this approach of regression testing. The functionality of OTDR device is to scan the network fiber for any kinds of bends or breakage. So,network management plane provides interfaces to program and trigger the scan and get all events in the fiber cable. This functionality is modelled using a graph or flow diagram which helps in identifying the tests to be done on the device. This type regression testing will make sure that after each firmware release or application software release which programs the device is not affecting or causing issues in the flow of this functionality.

B. Review of Optimisation Techniques to Reduce the Size of Test suites and its application in Regression Testing of Network Embedded Devices

In [2], the author states that additional dependencies in the program elements are considered for generating test suites which might increase the number of test cases. But for minor code changes running a large test suite would result unnecessary extra time of execution. To reduce the size and time of execution in such cases some optimization techniques are stated by the author. In RTS technique the size of regression test suite is reduced by picking only a subset of the critical elements of the program. The main aim is to increase the number of times the critical components are executing in the regression testing. And also, the critical score can be given based on the importance or priorities of the tasks which are being done on the embedded systems. Author also states that criteria for optimization of the regression test suite is based on the following:

1) Sum of priorities of the selected test cases should be maximised.
2) Different model elements should be covered and maximized in proportion to their priorities.
3) The cost of testing should be minimized.

Sometimes the critical components having high priorities can have higher execution costs than low priority lower execution cost components. So proper analysis has to be made using the 3 criteria provided above.

If the above optimization technique is automated and integrated in a test framework the test selection processwill eased out and also the execution time will be reduced by a large factor.

C. Importance of Automation

This study found that automation solutions are critical in the field of testing, particularly for regression testing, which is performed regularly after each release. Regression testing by manual process is prone to human mistake.

As a next step toward rigorous, repeatable testing, automated testing and regression testing methodologies are being used. This type of testing might be used on a regular basis to check for exceptions at each stage of an automation, ensuring that nothing is lost in the process. It could also be utilized after any network or related system changes.

IV. CONCLUSIONS

In embedded software testing, regression testing is a crucial task. Agile development has an increasing requirement of regression testing to be done after every release in the sprint and time has always been one of constraint in such agile environment. From this study about regression testing, we can see that there are many approaches and methods which are optimized for selecting regression test suites and the process itself. Automation has added another level efficiency in Regression testing of these embedded devices and has brought a great factor of improvement in the field. It has helped the tester and developers to quickly identify the failures in the releases with no or very less errors.

There is a lot of scope in automating the process of regression testing in the future. Further studies has to be made in standardizing the frameworks for hardware and software regression testing which would provide the developers some ground work or base to add and customize the framework according to their use case.

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