Enhancement of Automation Test Framework for LTE systems

Prajwala M J[1] Dr K Nagamani[2]
[1]P.G. Student [2]Assistant Professor
[1,2]Department of Tele-Communication Engineering
[1,2]R V College of Engineering, Bengaluru

Abstract— A phenomenal growth in the wireless industry, both in terms of mobile technology and its subscribers, has been witnessed in last few years. There has been a clear shift from fixed to mobile cellular telephony, especially since the turn of the century. With all the technological advances, and the simultaneous existence of the 2G, 2.5G and 3G networks, the impact of services on network efficiency have become even more critical. Many more designing scenarios have developed with not only 2G networks but also with the evolution of 2G to 2.5G or even to 3G networks. LTE communication systems has different features like handover, carrier aggregation, and change in the transmission power etc. The LTE system which contains these features can be tested for different scenarios. Testing the different scenarios with respect to different features in the network will help indicate and improve the different problems present in the scenarios. Automation testing provides logs for every test scenario run quickly and efficiently when compared to the manual labor and time required to test each scenario manually. The automation framework supports automation test scripts which runs to generate logs for different test cases. The objective of the project is to enhance the Automation Test Framework that supports the automation scripts to obtain the results of the test cases in quick and user friendly manner. The automation test scripts run generates logs for each test case. The goal of the project is to reduce the manual activity required for analyzing the results of each test case every time by obtaining the results of all test cases in one space.

Key words: LTE, Networks

I. INTRODUCTION

LTE remains for Long Term Evolution and it was begun as undertaking in 2004 by telecom body known as the Third Generation Partnership Project (3GPP). The fundamental objective of LTE is to give a high information rate, low idleness and it is a packet optimized radio access technology. LTE supports data rate of 300Mbps in downlink data flow and 75Mbps peak data in uplink data flow. LTE uses Orthogonal Frequency Division Multiplexing (OFDM) which can reduce the frequency fading by using sub carrier technique to hold the bandwidth being transmitted. The subcarriers are used carry part of the bandwidth each [1].The LTE devices support the

Multiple Input and Multiple Output transmissions. The architecture supports the hard QOS which provides end to end quality of service. TDD, FDD techniques are supported. In the TDD technique there are sub channels considered, which are formed based on the time slots. In the TDD technique, the sub-channels are formed based on TTI (Transmission Time Interval) .Each TTI is composed of two slots which is of 0.5 ms each, which means that each TTI is 1 ms. Each slot consists of 6 or 7 symbols based on cyclic prefix (i.e.) 6 symbols for extended cyclic prefix and 7 symbols for normal cyclic prefix. The band is divided based on the time slots divided and sub channels are used to hold the traffic based on the varying traffic and the design that is used in the system [2].LTE supports various features and many scenarios can be developed using the features. Testing plays an important role in this aspect by detecting the defects present in the developed scenario. Automation testing is done to test the different scenarios developed. In automation testing, test mechanization is the utilization of exceptional programming (separate from the product being tried) to control the execution of tests and the correlation of real results with anticipated outcomes. Test automation can robotize some monotonous yet fundamental assignments in a formalized testing prepare as of now set up, or add extra testing that would be hard to perform physically. Test automation is basic for constant conveyance and nonstop testing. The manual methodology of testing may not generally be compelling in finding certain classes of imperfections. Test mechanization offers a plausibility to perform these sorts of testing viably. Once automation tests have been created, they can be run rapidly and repeatedly.

A Framework is thought to be a combination of set of conventions, principles, norms and rules that can be followed in order to exploit the advantages of the platform given by the Framework. A "Test Automation Framework" is platform that is laid to give an execution domain to the automation test scripts. The structure furnishes the user with different advantages that helps them to create, execute and report the automation test scripts proficiently. It is more like a framework that has been made particularly to automate our tests.

The automation test framework supports different frameworks like scalable framework which can span to different technologies, can be used in different projects and also expandable to catch different nodes or elements in test setup.

Modular Framework in which the system partitions the whole "Application under Test" into number of legitimate and confined modules. For every module a different test script is scripted. Consequently, when these test scripts taken together forms a bigger test script consisting to more than one modules.

Library Architecture Testing Framework in which the application under test is not separated into test scripts instead the applications are isolated into capacities or rather normal functions that can be utilized by alternate parts of the application also. A typical library constituting of basic functions for the application under test is created. In this manner, these libraries can be called inside of the test scripts at whatever point required. Data Driven testing framework is a Framework offers the user some assistance with segregating the test script rationale and the test information from one another. It gives the user a chance to store the test information into an outside database. The outside databases can be property documents, xml records, exceed expectations documents, content records, CSV documents,

ODBC vaults and so forth. The information is ordinarily put away in "Key-Value" sets [3]. Along these lines, the key can be utilized to get to and populate the information inside of the test scripts. Keyword Driven Testing Framework in which the system not just isolates the test information from the scripts, it keeps the specific arrangement of code in the test script into an external information document. These arrangement of code are known as Keywords and consequently the system is so named. These words are self-directing with reference to what activities should be performed on the application. Behavior Driven Development Framework in which the system permits automation of practical approvals in effectively meaningful and justifiable arrangement to Business Analysts, Developers, Testers, and so forth. Test Setup of Automation Test Framework

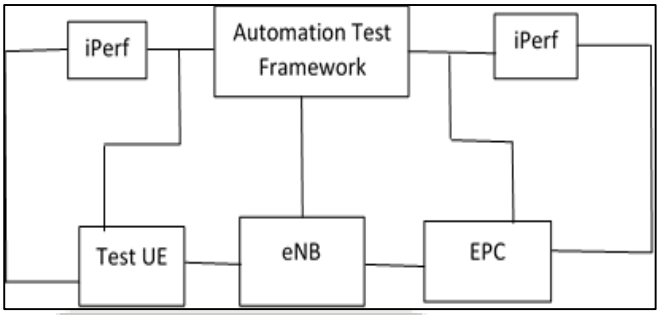

Fig. 1: Automation Test Framework Test Setup

The automation test framework setup is as shown in Fig 1.Automation test framework will run on Linux machine and it is connected to eNB. It is also connected to commercial UEs and EPC through serial port connection. It is also connected to the iPerf (client and server) using serial port. The UE is a device used by the end user to communicate. It can be a mobile or laptop with broadband adapter or dongle. The user equipment connects to the Base Station (eNB) to ensure communication. There is a radio interface between the UE and the eNB called the LTE-Uu interface. eNB refers to evolved Base Station. It controls the mobiles in one or more cells. The serving eNB is a base station that is communicating with a mobile. EPC is a framework for providing converged voice and data on a 4G Long-Term Evolution (LTE) network is called Evolved Packet Core.

II. LITERATURE SURVEY

A. Transformation from 1G to 4G

Wireless industry is on a path that promises a great innovation in the upcoming years. Manufacturers are advancing to meet the requirements of the customers by improving the speed of data transmission.1G relates to simple cell advances turned accessible in the 1980s.It has a speed up to 2.4kbps and allows voice calls. It supports analog signals. It is also referred as AMPS and was launched in USA. 2G signifies beginning of advanced frameworks, presenting administrations, for example, short and lower speed information. The speed supported is 64kbps.It enables services like picture messages and multimedia messages.2.5G is a technology between 2G and 3G, it is called as cellular technology. The speed ranges from 64-144kbps.3G necessities were indicated by the ITU as a major aspect of the International Mobile Telephone 2000 (IMT-2000) venture, for which computerized systems needed to give 144 kbps of throughput at portable rates, 384 kbps at walker paces, and 2 Mbps in indoor situations. It is called smart phones and features increased its bandwidth, supports web applications and audio video files. The development of new advances in the portable correspondence frameworks. Furthermore the constantly expanding development of client interest have activated specialists and businesses to think of an extensive sign of the up-coming fourth era (4G) versatile correspondence framework. 4G supports speed ranges from 100Mbps and 1Gbps.High Quality of Service and High security is assured. LTE-A (Advanced) which is also referred to as LTE-A is part of 3GPP 10 release has various primary features which propels it to achieve higher speed. OFDMA is used in LTE-A networks to achieve high throughput, the measure of amount of information can be processed by a system in a prescribed time, and spectral efficiency which indicates how efficiently the bandwidth is utilized for the users [4].Some features may be carrier aggregation where the component carriers are aggregated to form a cumulative bandwidth. It helps to utilize the spectrum efficiently [5]. Higher order MIMO is another feature in which MIMO increases the bit rate by using multiple transmitting and receiving antennas. Enhanced Inter Cell Interference Coordination which is used for heterogeneous networks to minimize the interference between different cells in the network. Different scenarios are developed based on the features, so testing plays an important role in recognizing the defects in the scenarios. Testing could be done manually or it can be automated

1) Automated Testing over Manual Testing

Manual testing refers to testing different scenarios for defect manually. It involves a tester who plays the role of an end user. The tester uses already defined test plan to test different cases. Manual testing requires more resources and time to complete the testing process. It is not consistent, one tester may approach and perform a certain scenario differently when compared to the other. It does not scale well, as the complexity of the scenario increases the complexity of testing the problem also grows exponentially. Each test case can be run only once or twice. It requires more time because it's run manually every time. In the automation testing the same operation is performed each time. It is useful in executing the set of test cases frequently [6]. The existing system uses end to end automation testing to obtain the logs of the different scenarios tested. End-to-end testing is a technique used to test whether the flow of an application right from start to finish is behaving as expected. The purpose of performing this testing is to identify system dependencies and to ensure that the data integrity is maintained between various system components and systems. The entire application is tested for critical functionalities such as communicating with the other systems, interfaces, database, network, and other applications. The flow of the existing system is as shown in Fig 2,

The test procedure for each scenario is as follows:

1) The EPC machine(MME,HSS,PGW) is connected to the eNB and the Tshark logs are collected
2) Tshark (terminal shark) is a network protocol analyzer. It captures the packet data from a live network

3) The S1-AP log collection is done in the T shark which shows the interface between EPC and eNB
4) All the connected UEs are detached and the UE release messages are collected on the Tshark.
5) eNB reboot takes place, the board is rebooted and the EPC nodes are ready to start the services
6) Attach procedure is carried out for all the connected UEs.
7) Once Attach procedure completes, IP address of the attached UE is obtained.
8) Tshark log collection step will collect all the S1AP logs.
9) The same IP address will used for data transfer step
10) For data transfer test step, based on data type and number of UEs
11) Various logs folder are present to collect the logs with time stamp

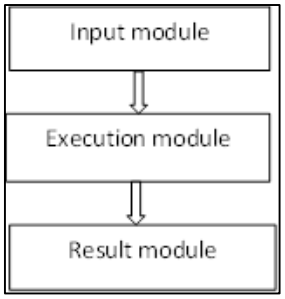

Fig. 2: Execution flow of Automation testing

It consists of three modules:

1) Input module: The scripts or excel sheets act as input, if excel sheet is the input user required parameters will be passed for execution. The input may include the test case number, number of UEs attached, uplink or downlink datatype, number of resource blocks, Cell id etc.
2) Execution module: Interface of different nodes and Operation carried out on the nodes. The operation may be carried out between EPC and eNB and produces the S1-AP logs or it could be the transport and control plane logs generated
3) Result module: Obtaining log modules (eg: TP log, CP log) and verification of the modules. This module focuses on obtaining the results for each test case. It obtains the files which hold the details of number of UEs attached, the IP address of the UEs attached, the uplink and downlink data received and transmitted.

III. PROPOSED SYSTEM

A. Automation Framework Enhancement

The end to end automation testing of different scenarios, produces different logs for each test case. The logs for each test case is saved in a test folder for the particular test case. Each test case folder will have certain files as follows:

1) Capture file:It holds the data of initial UE request and responses if the UE is attached else the UE is not attached
2) The number of UEs attached, the downlink and uplink data expected is present in one file.
3) Result file: holds the Uplink and Downlink data received
4) UeIPaddress_Filter file:It holds the IP address of the UEs attached

Each test case has these files and has to be viewed every time to know if attach is complete and if it is complete the UE IP and the number of UEs. The downlink and uplink data transmitted and the expected downlink and uplink data for each test case should be viewed. Excel sheet using python script is generated which holds the following:

1) Name of each test case
2) The number of UEs
3) UEs are attached or not
4) If UEs are attached the IP addresses related to all UEs
5) The expected downlink and uplink data transmission
6) The actual downlink and uplink data being transmitted
7) Comparison of the expected transmission data with the actual transmission data being observed
8) The comparison data reflects pass if the data transmitted is equal to data expected else reflect fail in the excel sheet
9) The excel sheet will hold the test cases and the information related to each test case making it more convenient for the user to conclude if the test case has passed or failed.

IV. RESULT AND DISCUSSION

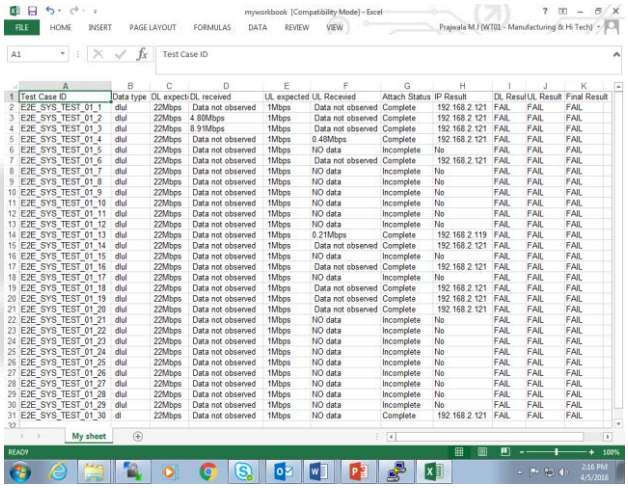

Fig. 3.Result for single UE attach

The excel sheet shown in Fig 3 represents the single UE attach procedure. The excel sheet represents the number of each test case detailed with the information related to it. The expected data in uplink/downlink is compared with the received data in uplink/downlink and the result is obtained as pass if it's equal else fail is printed in the excel sheet.

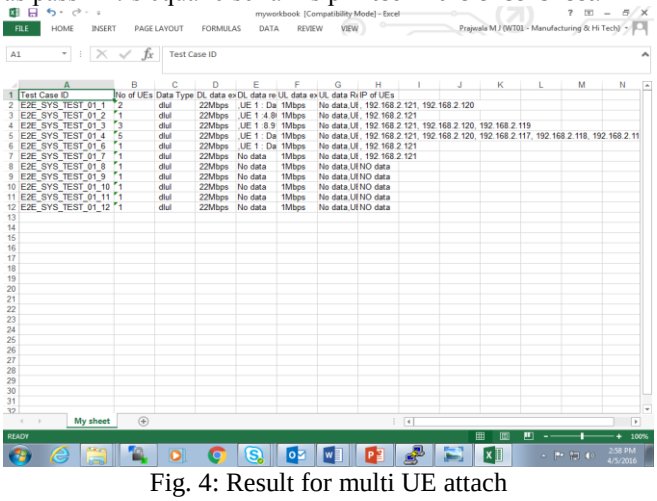

Fig. 4: Result for multi UE attach

The excel sheet for multi UE attach is represented in Fig 4.The data type, number of UEs attached, the IP addresses of the multi UEs attached are seen for different test cases.

The excel sheets are easy to read, the detailed information of each test case is present, the manual effort of going through the results of each test case is brought down. The result of each test case is present in terms of pass or fail, so the user can easily see the success rate of the test cases.

V. CONCLUSION

In this project, the automation framework used for testing the different scenarios is enhanced. The drawbacks in the previous 3G, 3.5G are overcome in LTE. The results obtained from end to end automation testing is analyzed every time by the developer to know the success and failure of the scenario run. The enhancement of the automation framework holds the results of all the test scenarios which are run in one excel sheet. The results obtained are easy to analyze and consume less time of the developer, as the results of many test cases are present in one sheet. Thus the entire work of obtaining the results of different scenarios is automated.

VI. FUTURE WORK

The future aspects of this project includes attaching up to 50 UEs [connecting more users at once]. The automation test framework which is currently used in this project is for Release-10 3GPP. Later, it can be improved so that it will be used for new 3GPP Releases. The upcoming releases of 3GPP point to 5G requirements and preparation. So, in future, this automation framework can be enhanced to support the new technologies such as 5G.

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