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Automation of Nokia Flexi Multiradio-10 BTS in Idd-4ud Configuration

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Abstract— Flexi multiradio-10 Base Transceiver Station developed by Nokia Networks is a BTS capable of resource sharing by multiple operators, supporting 2G, 3G and LTE technologies either in concurrent mode or dedicated mode as well as is world's smallest high capacity BTS. Depending upon customer requirement, resource availability, environment of installation etc. its System module(s) and Radio Frequency module(s)can be configured in many possible ways. Intelligent Downlink Diversity is one of those configurability feature of FMR-10 that increases its gain by 5 dB. To check for functionalities supported by the BTS several test cases are designed which can be tested manually as well as by automation. Since manual execution can be time consuming, tedious and not efficient automation is preferred. RIDE is one such open source software that has easy-to-use tabular data syntax and open source libraries and tools to be used by user.

Keywords— Flexi Multiradio-10, Intelligent Downlink Diversity with 4-way Uplink Diversity, Robot Integrated Development Environment.

I. INTRODUCTION

Global System for mobile communication is a standard developed by European Telecommunications Standards Institute in initial years of 1990s to remove all other existing expensive standards by a single standard. The standard replaced first generation analog cellular networks by digital circuit-switched network capable of supporting full duplex communication. Over time it grew to support data communication first by circuit-switched transport then by packet data transport in GPRS (General Packet Radio Service) and EGPRS (Enhanced Rates for GSM Evolution) protocols. As of 2014, GSM shares over 90% market share[4]. To meet such growing traffic there had been continuous improvement in hardware of BTS provided by many companies such as Nokia Networks. Flexi multiradio-10 is the most recent BTS developed by Nokia Networks that aims at lowest cost, higher efficiency and a superior customer experience through an adaptable radio network ,which can be customised profitably. For the hardware to work, it requires a software package and certain test cases that can be executed iteratively. Such executions when automated becomes more quick, organised, efficient and saves human time and intervention to check for the stability of software package in different environment conditions. Finally test cases that cater to requirements of customers are designed using automation testing tools. One such tool is RIDE(Robot Integrated Development Environment) which is an open source software developed by Nokia Networks[6].

To describe the technical work Section I of the paper gives a basic understanding and background of the title, Section II will elaborate on the methodologies and hardware used along with the description of their advantages. Finally, to conclude all Section III is mentioned.

II. METHODOLOGY AND HARDWARE USED

II.I FMR-10 BASE TRANSCEIVER STATION

Nokia Flexi Multiradio-10 Base Transceiver Station is the world's smallest high capacity, software defined Base station which is based on Flexi multi-radio system module and multi-radio capable RF module/ Remote Radio Head variants [2][3]. The BTS supports GSM/EDGE, WCDMA, HSPA and HSPA EVOLUTION and LTE TDD/FDD radio access technologies in all needed frequency variations as well as its architecture supports all 3GPP functions and features in releases 3GPP 9 and beyond. To serve various radio access technologies the BTS can work in concurrent mode where functionality can include several radio access technologies and their combinations as well as in dedicated mode. It also supports several operators to share the resources of one BTS. The architecture of Flexi Mutltiradio-10 can be depicted by following figure:

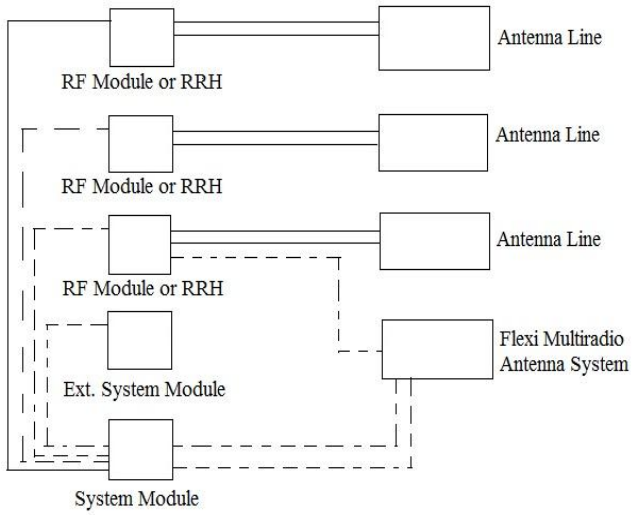

Figure 1:General Architecture of Flexi Multiradio-10 BTS

Some of the benefits and features of using Flexi Multiradio-10 BTS can be:

(i) cost-effective network building: the BTS is capable of using existing site equipment and can be installed at any legacy site for broadband data capability upgrade. Also the site rental cost is reduced

(ii) easy to install and simple and speedier to maintain due to module integration and automatic fault detection procedures

(iii) intelligent shut-down feature: different shutdown timers and priorities to BTS sectors and carriers can be given by the operator during commissioning of BTS[3]. So in the event of AC power failure an external alarm is raised that causes the BTS to operate at reduced power, where power comes from a battery backup unit, or no service offered as long as the AC power supply is restored back.

(iv) it offers outdoor modules that can be located close to antenna, which will then reduce antenna feeder losses

(v) receiver sensitivity and uplink performance are optimized due to better antenna system performance. Antenna's performance is improved by providing support to 3GPP like antenna tilting and master head amplifier support.

(vi) it does not require additional cabinet, cooling or shelter as the BTS perfectly suits for indoor as well as outdoor use.

These features make it, the most energy efficient base station on the market as it offers more flexibility, high efficiency, low costs and a superior customer experience [2].

III. INTELLIGENT DOWNLINK DIVERSITY WITH 4 WAY UPLINK DIVERSITY

RFM(s) of FMR-10 can be physically and via commissioning method be configured in various ways like Type-A, Type-B, Type-C , Type-H or Type-K(IDD4UD/IDD2UD). Which way the RFMs are to be configured depends upon test case or customer requirement. One such configuration is Type-K or Intelligent Downlink Diversity with four uplink diversity(IDD4UD).

Signal when sent gets reflected along multiple paths before being finally received. Such reflections can introduce phase shifts, time delays, attenuations, and distortions that can destructively interfere to reduce signal strength and quality at the receiver. Antenna diversity is one solution to overcome such losses. Spatial diversity, pattern diversity, polarization diversity, transmit/receive diversity and adaptive arrays are some methods to employ antenna diversity [5]. According to the environment and expected interference designers can use one or more of these methods to improve quality of signal. In spatial diversity antennas with almost same characteristics are used. The space between them can be of the order of wavelength. This will also cancel the interference produced by users who are occupying same the same frequency band and time slot[1]. This allows more user in the same bandwidth-in practice the number of users is limited by the number of antennas and the accuracy of digital signal processors used at the receiver. Since interference may come from users in other cells or other radio type or even other radiating devices, interference cancellation allows radio systems to operate in high interference environments. Example of spatial diversity is cellularization or sectorization scheme that is used by mobile communication industry. While if several co-located antennas with different radiation patterns are used they create Pattern diversity. In Polarization diversity a pair of antennas with orthogonal polarizations are employed whose signals when get reflected may undergo changes in polarization. This method is basically used to immunize a communication system from polarization mismatches that can cause signal fading.

In Flexi Multiradio-10 BTS arrangement Pattern diversity was used, where multiple antennas were installed to offer several observations of same signal, which finally gets overlapped onto one another upon reception and so receiver antenna is better capable of processing the signal. Intelligent downlink diversity is the term used to refer Pattern diversity, where Downlink diversity means that the downlink signal is sent via two separate transmitters at same frequency but with

some delay, which feed to separate receivers. The delay value depends upon modulation and coding scheme used. Thus, downlink signal is improved in two ways: signal power is doubled using two transmitters and effect of fast fading is decreased due to two strong uncorrelated signal paths. The improvement can be upto 5dB under optimum circumstances. While the term 4-way uplink diversity(4UD) means that four received signals are combined together at the receiver antenna by using Interference Rejection Combining and Maximal Ratio Combining techniques. To enable this feature in BTS two transmitters and four receivers are cabled together to form one sector as well as the same needs to be defined while commissioning the BTS from a GUI PC, which is a remote PC installed with GUI to manage the BTS.

IV. DEVELOPMENT OF SCRIPT USING ROBOT FRAMEWORK

Verification of basic functionalities of FMR-10 in IDD4UD configuration can be done either manually or by automation by test engineers. Manual execution is time consuming, tedious, inefficient, hectic and more prone to error . While test automation overcomes all these points by using software to control execution of tests and comparing actual outcomes with the expected outcomes. Additionally test automation can perform hard to do tasks, or tasks that are repetitive in nature or tasks that already exists but need some modifications. Some of the hardware requirements include hardware connection between System Module and Radio Frequency Module(s) by optical cables and RF cable, backhaul connectivity of System Module with Base Station Controller, log collecting PC and GUI PC. Transmitters of RFM(s) are then directly connected by RF cables to antenna of mobile phones. The mobile phones are enclosed within RF box that guards mobile from catching other adjacent cell's frequency. It acts as an isolation to the phones that are expected to be always latched to their cell's Location Area Code(LAC) and Cell Identity(CI). GUI is a PC that hosts a GUI to remotely interact and perform operations on BTS while Call Generator PC is used to remotely make Circuit switched(Half Rate/Full Rate), Packet Switched(GPRS/EGPRS) calls or Mobile Originating and Mobile Terminating (MO-MT) call or send SMS or run a combination of either of the calls. Controlling of GUI PC and CG PC is done by Master PC that hosts RIDE(Robot Integrated Development Environment) and contains automated scripts to make use of them. Connection of Master PC with GUI PC and CG PC is via ssh and telnet respectively as shown in following figure.

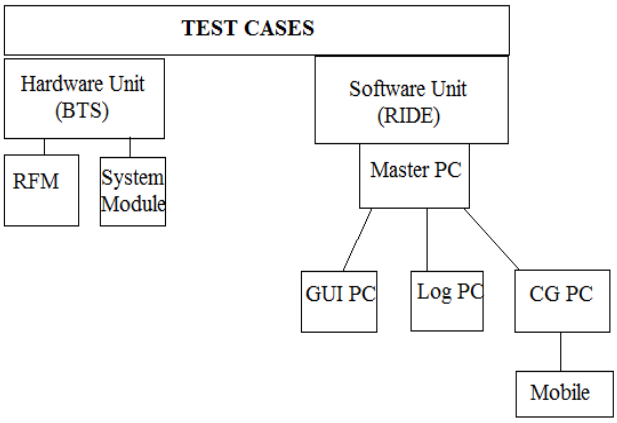

Figure 2: Automation Framework

As shown in figure, the software package compatible to the BTS is released, which is installed in GUI PC and then the designed test scripts are run on top of it. All this can be done by Master PC that starts execution of test case and make use of GUI PC along with CG PC at times. Log PC is required to collect all messages that are exchanged between BTS and BSC so that at times of fault occurrence, these log files can be checked to find any irregularity. If any test case fails it is either give a re-run or the captured logs are analyzed to check whether it is any occasional problem or hardware problem or fault in software package for the BTS. If it is any software package problem the build is modified and tested back for the same test suite. The test case are designed in RIDE, which is an open source software developed at Nokia Networks[6]. The software is independent of application and operating system, so the scripts designed are portable and can be run on any machine. Its core framework is implemented using Python which can also run on Jython (JVM) and IronPython (.NET). Test cases are written in tabular format with arguments against each keyword. The tables can be written in plain text, HTML, tab-separated values(TSV) or reStructuredText(reST) format files in any text editor or using RIDE[8][9]. One example of how to use RIDE is shown in following table:

Keyword/ Variable	Argument/ Keyword	Argument	Argument
${total}=	Add	20	30
Log	Total= ${total}		

Table 1: RIDE test case usage

User can use already available keywords from its various libraries or can develop their own keywords and thus use them to design test cases. Some of the test cases developed involved duplicating real life situations. For example BTS may be installed in a lightly populated remote site and due to weather condition it may become faulty. At such point it is expected to raise alarm to its remote engineer and meanwhile should take some steps to minimize the loss. Some of the times even power supply to BTS may be abrupted or discontinued, so Battery Backup Unit is expected to come up on its own to supply the power to BTS. While during daytime voice traffic is more, at night it decreases. In such situation transmitting signals at full power and from all transmitters is unnecessary and waste. Instead the BTS should be configured such that some of its transmitters/receivers should shutdown to save power and should come up again when the traffic increases back above the defined threshold. In real life mobile phone users are on the move, so does mobile phone. To check for certain features during mobility when the distance between mobile equipment and BTS is continuously changing can also be a testing scenario for engineer. All such kind of real life requirements and scenarios are to be duplicated in lab which shall consist of BTS, BSC, MSC and an insulated box containing mobile phones.

V. RESULTS AND CONCUSION

Flexi multiradio-10 BTS has proved to be one of the best BTS over last ten years as same hardware can be used across several radio technologies. This has resulted in compact BTS size, reduced rental cost and better site creation due to MIMO capability with fewer boxes. RF module and system module can be easily reconfigured by software to utilize six pipes of RF module that can be chained further to cater more traffic. All such hardware configuration when done along with IDD4UD feature, will then provide an additional gain of 4 to 5 dB. The setup is automated using RIDE which is a rich source of libraries and already existing keywords. As shown in figure if any test case fails it will generate test result which indicates total elapsed time, number of cases failed and passed and current keyword in execution. A log.html file is also created simultaneously that can be analysed if the test case fails to find at what step failure occurred and why it occurred.

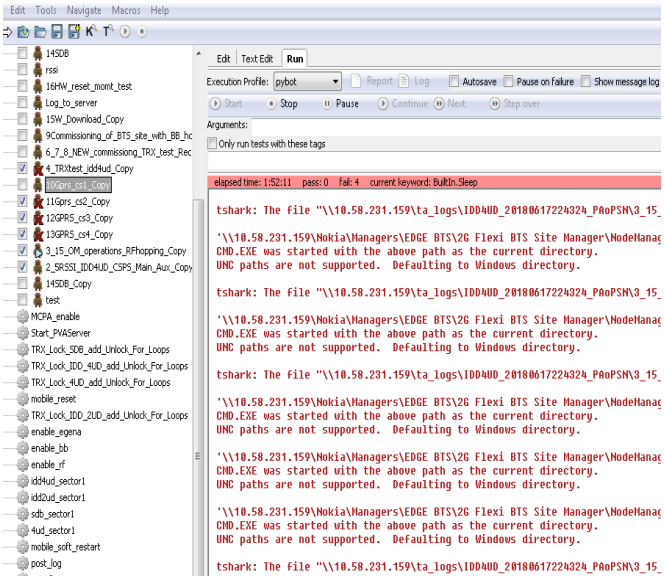

Figure 3: RIDE test result

After the BTS build is tested properly using automated scripts, it can be used for further testing like regressional , functional, performance etc. Finally it is released to the customer. Else the cause of failure of any test case is found, analysed and then debugged. If it is an issue with the BTS software the modifications are done and the changes are repackaged with the BTS software under new version.

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