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AUTOMATING THE PROCESS OF TESTING THE FUNCTIONALITIES OF COMPLEX COMMUNICATIONS SYSTEMS

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Abstract: *One very important part in a product or systems' life cycle is the testing, or better said, how we do it and how we interpret the results. One has to test while developing a product in order to assure its reliability and conformity with the handed requirements. Once you acquire a product or system, you have to test it to be sure you got what you wanted and to determine exactly its limitations. Forward on, while exploiting a product, you will have to test it periodically to prevent loss of functionalities or diminishing performance of some characteristics.Testing specific products, especially when speaking about electronic devices, had become more automated. In these particular cases, testing is much faster and more reliable. Complex communication systems are composed of a variety of products and, even if each one works perfectly independently, all kinds of problems may appear at system level. To avoid these difficulties we have to test the system and use the results in order to improve the system as a whole. In the first part of this paper we present a series of testing procedures, with an accent on military communications systems, presenting the difficulties we have encountered. From those, we have selected some procedures that are suitable for an automated process conducted by an application for software assisted testing. As a necessary step in introducing the software assisted testing, we presented the software requirements for this application. The following steps will conclude by presenting the improvements of testing procedures with regard to rapid and objective tests' results.*
Keywords: *Informatics, Testing-and-evaluation, Communications.*

Introduction

Testing is such a trivial activity. Everyone says it is important, the majority knows that they have to treat it very carefully but just a few actually do it right.

We consider very important to define the general approach to testing, as this will guide the entire process and maybe it will help us not to derail from the purpose. "Today, test methods for communication protocols assume, among other things, that the protocol design is specified as a single, monolithic finite state machine (FSM). From this specification, test suites that are capable of detecting output and/or transfer faults in the protocol implementation are derived. Limited applicability of these methods is mainly because of their specific assumptions, and due to the size of the derived test suite and the resulting test effort for realistic protocols."[2]

Objective

It would be very nice if the testing could be objective. We can do this regarding measurements and in some cases where a well-defined standard is in place. But, unfortunately, it is quite difficult to test the functionalities of a complex system or forward more a system of systems.

We know what the product / the system and so on has to do, but we just cannot know how to prove it and it is more difficult to provide tests which are reveling all systems' characteristics.

Even if the words before describe the general purpose of automating testing a communications system this paper will describe only some steps.

State-of-the-art

Communications systems being so widely spread in many fields and having so many and diversified components the preferred testing approach is to design personalized tests and procedures. This approach can bring the desired results but implies hard work in the planning phase and long and non-standard tests [1].

There are a lot of software tools, developed for specific systems:

- Elektrobit Testing Ltd. used MathWorks tools to develop the Propsound™ CS, a high-resolution multidimensional radio channel measurement system;

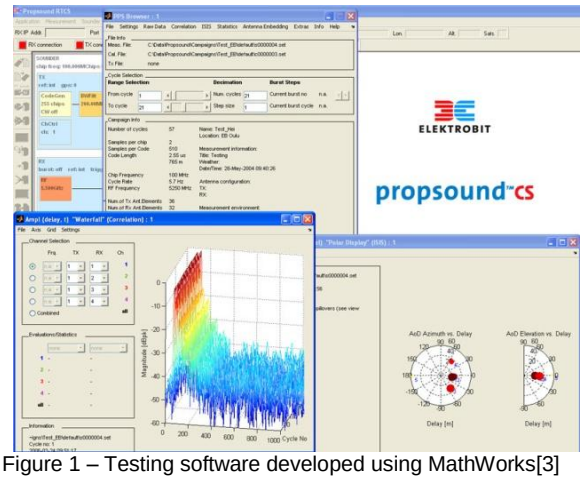


Figure 1 – Testing software developed using MathWorks[3]

The example described before is only a solution of getting tests results using an automated testing system.

To enforce the power of such examples we will present a more specific case of conducting evaluating procedures in a laboratory.

Testing in laboratory conditions

A very good example of our endeavor is the automated process of evaluating equipment, from TEMPEST point of view in this case. The first think is to get you familiarly with TEMPEST evaluation.

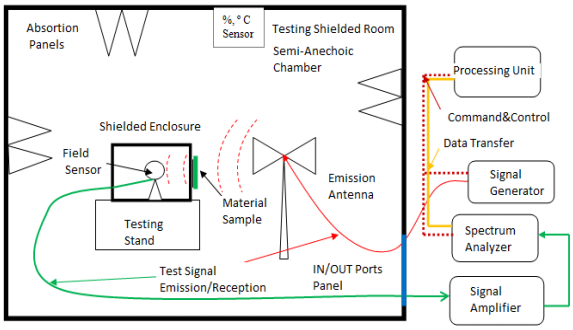
The problem is to verify the Electromagnetic undesired radiations from a Communications and Informatics System – CIS.

The problem comes when the intended CIS processes classified information. It is a well known fact that it is possible to reconstruct the information using the electromagnetic emissions generated as a side effect by parts of the CIS.

Some examples are the video cable from the graphic card of a computer or the emissions induced in the power cables.

In a laboratory that evaluates from TEMPEST point of view different CIS' there are well defined procedures that assure us that we test all frequencies capable to carry classified information. The process is somewhat reliable, as the tester is following the procedures to the letter and if he or she has a highly specialized training in this field. The downside is the duration of carrying on all the necessary measurements and the necessity of using all kinds of antennas and recalibrations of the measurement equipments.

Figure 2 presents a classical testing platform used in a TEMPEST laboratory and figure 3 is an illustrative example of the multitude of antennas necessary for different frequencies measurements.
As we can see there are a lot of equipments which need to be operated without mistake in order to obtain the intended results.



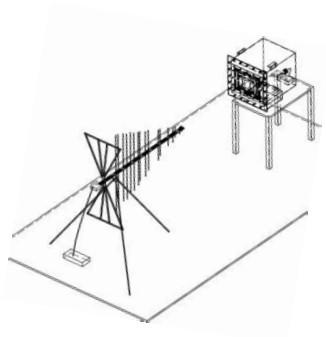


Figure 2 - Testing and evaluation HW-SW platform [4]

As a solution to eliminate the human error and to speed up the entire process we can conceive an automated systems which allows us to measure the necessary parameters without having to involve a human in the most part of the tests.

Figure 3 – Antennas used in TEMPEST measurements

Such a solution will allow us not only to speed up the process but also to prolong the life of different jacks and other types of connections.

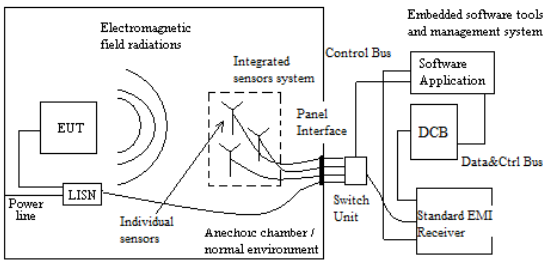


Figure 4 – Automated TEMPEST measurements platform

In the figure 4 it is presented a possible utilization scenario of an automated measurement system. As we can see it contains all technical hardware and software tools needed for standard TEMPEST measurements, but using an improved an automatic solution.
Both automated solutions presented work just fine and offer us all the advantages of such systems. Unfortunately neither of this solutions can be extended to a testing the functionalities of a complex communications system, but we can take parts of them to implement in our intended testing system.
From the example presented we will underline some ideas:

- A software computation system is necessary to be implemented in order to manage the entire procedure;
- The use of different hardware may be automated by creating an platform that allows us to connect to the system;
- "It is important to have a clear-cut methodology suitable for software implementation" [1].

Following those written before we will describe the procedure in place in military testing procedures, based on this procedure we will try to present a concept of an automated solution and finally we will get into details of implementation of such a solution.

Testing the military systems

Through time we had undertaken a lot of testing procedures, especially for military communications systems delivered and developed by civilian entities but not only.
First, we have to say a few words about testing approach in Romanian Ministry of National Defense. All this activities, including communications systems, are somewhat standardized by I.1004 document [5].
The objectives of the testing and evaluation process are as follows:

- The rapid generation of objective information, with a high degree of accuracy, needed for the decision authority in order to establish the efficiency and the readiness of a product regarding military use.
- The identification of problems and the proposal of solution for them in order to solve the eventual deficiencies.
- The establishment of the upgrade possibilities for a certain product or system.
- Minimizing the risks presented in different life cycle phases.

Of course, the testing can offer help with different other problems and it is possible to implement testing activities addressing some specific issues.
The testing plan is based on the product specifications. Talking about development testing the main concern is to identify if the product or system is complied with the specifications we had considered at the beginning of its design. The object of testing is somewhat changing with the lifecycle phase in which the product is at the time of the testing.
No matter the testing activity, development, operational, acceptance or other there are some steps we have to follow and some inputs and outputs that are necessary:

- The testing plan is based on specification
- The testing plan selects the requirements to test, the type of test and presents the proper procedure
- After the testing, on presents all the results in a report which analyzes the behavior of the system.

The concept of automated testing

Figure 5 presents the desired implementation of an automated testing system regarding the functionalities of a complex communications system.
The final product will be a software which allows us, not only to automate the gathering of the results of different tests, but also to control the execution of those tests.
The main component is the Testing and Evaluation Automat for Complex Communications Systems Software – TEACOM SW which will control different sensors – TEACOM Sensors. TEACOM Sensors may be software applications installed on the components or subsystems of the system to be tested or even hardware products interconnected with that system.

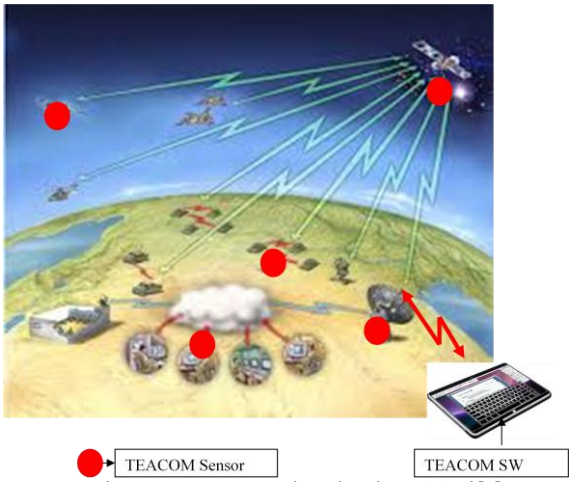


Figure 5 – Automated testing (TEACOM)[1]

Figure 6 lets us describe the functionalities of TEACOM. Filed with green color are presented the inputs for our system. Those inputs are quite usual for any testing and evaluation process.
The yellow boxes represent system's components (TEACOM SW, TEACOM Sensors, Procedures database) and the output of the system (Testing procedure, testing report and even testing plan if possible).

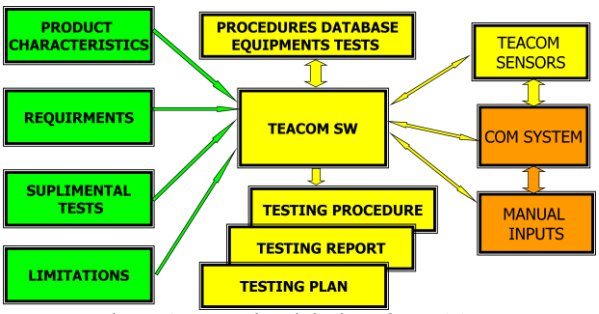


Figure 6 – Functional design of TEACOM

Considering our goal, as we have described before we must define some stages of our project designed to lead us to the final system of testing.

- First stage is to gather all necessary documentation, divided into military and commercial approaches. This will allow us not only to analyze the testing and evaluation procedures and processes used but also to compare the two systems and to identify the differences and to commonalities.
- The natural follow up of the first stage is to elaborate a clear-cut, "software friendly" methodology which will guide us to the final stage.
- The third stage is to develop a software to manage our testing, when is possible, without human assistance.

Apart of defining a "software friendly" methodology based on "lessons learned" we are trying to make the first step in creating that "software aid" we mentioned, intended to help us conduct a faster and more reliable testing procedure.

The concept is pretty simply: we created a web server, using free applications such Apache WEB Server, installed on a tablet or computer.
Using a router we can create a wireless network to access the web server. This allows us to access the testing plan and procedures store on the server from anywhere in the wireless network with just a common internet browser.
The clients, each tester, will log into the server and choose the test to be undertaken at that moment. The server will offer through the browser's interface the procedure to follow for the specified test and the tester has just to respect each step and to upload into the server the results obtained.
The software will compare the results with those expected and will generate a testing report.
In this stage we need to supervise the report and the way the software decides if a test is passed or failed and we have to repair a number of errors generated for example by two clients choosing the some test or by undertaking tests related to each other, or using the same system and so on.

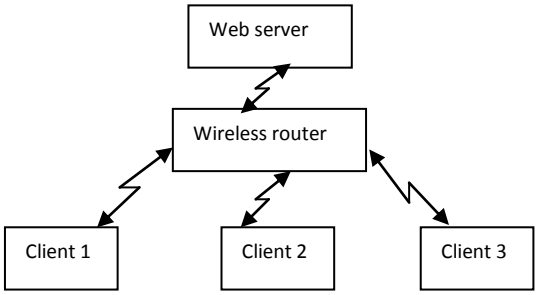


Figure 7 – Functional design of testing software aid

Even in this simple implementation the system proves several advantages especially when talking about planning and undertaking the testing. The more complex the system, the larger the testing team, the more difficult to organize the testing and to gather the results and to verify them. We do not have to forget the time needed by such activities.

Conclusion

The automation of the testing process regarding the functionalities of a complex communications systems has, no doubt, its benefits but we have to overcome some difficulties and it is possible not to be able to automate the entire process.
At this stage we consider that even an incipient intervention of the computer helps the testing process become faster and more objective.

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