TOOLS OF TEST GENERATION FOR SATELLITES CONTROL PROGRAMS

Andrey Tyugashev, Ekaterina Myasnikova, Elena Sopchenko

S.P. Korolyov Samara State Aerospace University (National Reseach University)

The paper presents a research in the field of test automation for testing spacecraft control programs. Means for generating a test is carried out to build a complete set of tests for the macro. Tests creating sequence diagrams in the language DIPOLE 6 in XML. Specialists use them to debug complex ground to verify the on-board software.

Well-timed information acquisition plays an important role in all sphere of human activity. One way of doing this is to use the information systems of satellite communications. Modern spacecraft are complex automated systems. Their functionality are expanded. Used systems become more complex. New onboard systems are introduced. Accordingly, the requirements for all production stages of new spacecraft is increasing.

One of the final production stage – the stage of complex electrical tests. The purpose of this step is to monitoring of spacecraft's functions as a whole and its individual systems. Missed software errors in the test phase could lead to faulty operation of the spacecraft, which in turn will lead to accidents and damage to expensive equipment. Therefore, this stage is very important.

Essence of complex tests is issue of control actions to unit under test (satellite, spacecraft) and analysis of parameters that characterize states and behavior of individual systems and spacecraft as a whole. It should be noted that the control spacecraft includes thousands of commands and the thousands of parameters can describe its state. Therefore, test automation is an urgent problem.

Because of high complexity of spacecraft systems and components, the current level of automation is characterized by a many of problems. They are related to the small efficiency of methods for developing tests. Programmers or designers of spacecraft systems write tests manually. With this approach, it is impossible to test all possible situations (combinations of commands and parameters) that may be on board.

In such a way, the actual problem is the research and develop new methods for testing of onboard control programs ('macro-programs'). The solution to this problem will improve the quality and efficiency of the test stage.

This work is carried out for "Information Satellite Systems named after M.F. Reshetnev" as part of the complex "Tools intellectual support for the design and verification of 'macro-program' integral control."

Programs that implement the logic of the satellite autonomous control. Programs written in a problem-oriented programming language. These programs are called integral control 'macro-programs'.

Macro-program are structured set of logical conditions and appropriate control actions. Composition of macro-programs, according to [1], is presented in the following list:

- a group of logic sequences;
- logical sequence;
- an array of possible conditions;
- control actions (commands).

Groups of logical sequences contains a list of logical sequences. In turn, logical sequence consist of a sequence of logical conditions and logical control actions.

Now, automated test stand is used for testing. This hardware and software complex provides the implementation of comprehensive electrical tests. Tests are carried out by issuing the control actions on the spacecraft and condition monitoring systems parameters of the spacecraft. Automated test stand consists of two levels. The upper level represents the part of the

program complex hardware- and software-independent from the tools of interaction with the unit under test (in particular provides an interface with the user). The lower level is device drivers [2].

Figure 1 represents a simplified diagram of the test automation software. Initial data for automated test stand is presented in the following list:

- algorithms for testing;
- set of control actions (database commands and arrays);
- set of parameters (database parameters).

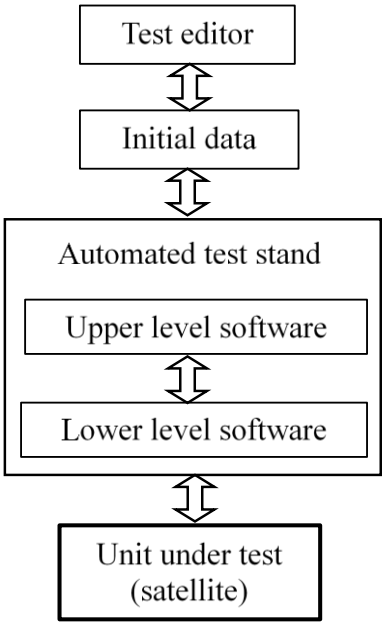

Fig. 1. Structure of test automation software

Let us formulate basic concepts of program testing.

A. Code coverage

Requirements applicable to onboard software called critical very high, so it is important ensure an adequate level of code coverage. Statement coverage is not enough for function tests, because we ignore the logical conditions. Decision coverage is not enough, because we ignore possible function calls that are part of conditions. Multiple condition coverage is very complex and redundant.

We will use modified condition/decision coverage [3]. According to this coverage for testing conditions with three components, we need only four test cases – one basic and three cases, which show an independent effect of each component on the condition. This coverage will provide an adequate level of code coverage, because it will show effect of each condition's component on program and will allow test all branch of logical conditions.

B. Program description

Each test must be accompanied by a description of expected results (in our work it is the time sequence of the control actions).

C. Right and wrong data

Tests should be selected not only for correct input data, but also for incorrect data. There are two types of elements of conditions which in various combinations can be included in a logical sequence. Types of conditions: "value in the range", "boolean" and "function call". For each type of conditions must be created template that simulates different sets of input data.

D. The program as a whole and its parts

It is necessary to test not only the program as a whole, but also its individual parts: group

and logical sequence.

E. Implementation of the concept

Now, we have developed program for generation tests that allows:

– connect to existing databases with description of satellite's 'integrated macro control' software;

– find all possible values for program parameters;

– generate covering tests for 'macro-program' or for only groups;

– visualize the time sequence of test.

The example of developed tool's screenshot with generated test is presented in Fig. 2.

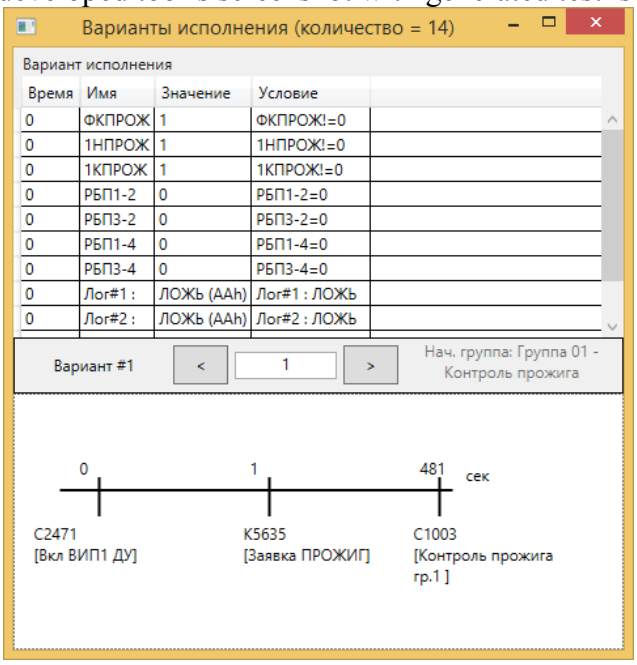

Fig. 2. Generated test with parameters and time sequence of control actions

Fig. 3.

As the result of this work, we will have a software product that allows analyzing parameters accuracy and its accordance with macro-program, generating tests for automated test stand. This program is to improve the quality of the tests by optimizing the organization, control and information processing. Efficiency of testing should be increased by reducing the required human and time resources.

References

1. Kochura, E.V. Razrabotka makroprogramm integral'nogo upravleniya kosmicheskimi apparatami [Development of integral control macro-program]. Vestnik SibGAU [Herald of Siberian SAU], 2011, vol. 1, pp. 105-107. (in Russian).

2. Esyunin, V.V. Osnovnye printsipy postroeniya ispytatel'nogo stenda bortovogo kompleksa upravleniya dlya perspektivnykh izdelii OAO «ISS» [Basic principles of construction the test stand for onboard control complex]. Vestnik SibGAU [Herald of Siberian SAU], 2010, vol. 2, pp. 93-96. (in Russian).

3. Pokrytie programmnogo koda [Code coverage]. http://www.intuit.ru/studies/courses/1040/209/lecture/5410. (in Russian)