Tendency Analysis of Software Reliability Engineering

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Abstract—**Under the effects of integrated factors, such as IT technology, software engineering, user requirement etc, software reliability engineering has been gradually developed. With the continuous improvement of software engineering technology, the perfection of software reliability tools and the enhancement of user requirement for software reliability, and the research for software reliability are developing in a new manner. This paper simply reviews the basic contents and features of software reliability engineering, and then mainly introduces its development tendency. Finally, proposed some problems which need to be solved in the development of software reliability engineering.**

Keywords—**Software Reliability**; **Reliability engineering**; **software engineering**; **software testing**

I. INTRODUCTION

In the information society, the systems, based on the software, are more and more depended by the products. But for these systems, the ability which allows the failure occurrence is less and less and the requirements for the systems which have strong effects on the human life and property are more and more strict. For the users, the direct among all the software quality standards is software reliability. Therefore, the research for software reliability is gaining more and more importance. The argument of John. Musa in software reliability engineering and the presentation of IEEE in AR&MS Tutorial Nates "software AR&MS" in 2004, reliability is regarded as the most important among all the software quality attributes [1]. For the researchers, the number of software reliability engineering of IEEE ACM is from 40 in 1990 up to more than 1000 in 1996. The annual growth rate exceeds 70% [2]. At present, about hundreds of thousands of researchers in many institutions are working in this area. The research for hardware reliability has been more than for software reliability and the problems on software reliability are ever increasing [3]. This paper simply reviewed the basic contents and features of software reliability engineering, and then mainly introduced its development tendency. Finally, proposed some problems which need to be solved in the development of software reliability engineering.

II. SOFTWARE RELIABILITY ENGINEERING

A. The Conception of Software Reliability

Software reliability is one important software quality attribute. The software depends on the educational attainment, experience, habits of mind, cognitive ability, development environment and professional ethics and so on, so the failure is not avoided [4]. How to avoid the failure in engineering, how to measure these failures and how to find some methods to reduce failures are the problems which need to be solved.

The standard definition of software reliability [5] is the probability with no failures in specific natural unit or specific time intervals [1]. Two aspects in the definition need to be noted. (1) The time in the definition is natural unit or time intervals, not execution time of procedure. Although the execution time is more advance, the time value which unifies to general time is more meaningful. (2) Software failure is the deviation of the software running for user requirements. It is user oriented and different from software error which is development oriented.

B. The Content and Features of Software Reliability Engineering

At the beginning of the analysis of software features and user requirements, software reliability engineering (SRE) exits all the process of software life cycle. It contains three aspects:

- The specification must be given to satisfy the user requirement for software reliability.
- The measurement and analysis technique is the necessary condition for software reliability.
- A series of methods and techniques of assuring software development quality.

Software reliability engineering is an applied science to reduce the possibility of dissatisfying user requirement in software system running [1] which contains following contents:

- Software reliability analysis: confirm indicator,

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design process of software development, forecast, analysis the failure severity and so on.

- Software reliability measure: estimate or measure the software reliability by using the reliability models with failure data.

- Software reliability management: control and improve the development process by using reliability measure, and manage reusable software.

- Improvement of development process: confirm the factors of impacting software reliability, improvement of cost relationship.

The characteristic of software reliability engineering is listed below:

- Reliability engineering is interdisciplinary subject between inherent technology and management science which is high combined of management and technique. Reliability technique was compared to high combined of "immunology" and "pathology" in Japan.

- Only by integrated using the techniques of system engineering, human-computer engineering, environmental engineering, mathematical statistics and existed experience, can we resolve the reliability problem

- The evidence of predicting and preventing failure comes from information feedback in system design phase which is the basic characteristic of reliability management technique. The reliability can be raised by cycle technique which is composed of design, testing and manufacture.

III. DEVELOPMENT TENDENCY OF SOFTWARE RELIABILITY ENGINEERING

A. The Basic Issues of Software Reliability Engineering

The process of software engineering begins with the start of software engineering which corresponding with software engineering process. Generally speaking, software engineering can be divided into four stages: feasibility analysis and demand analysis, design, realize and testing. Correspondingly, software reliability engineering can also be divided into four stages: define needed reliability, provide operating profile, list test case, software testing and analysis of failure data [4].

In implementation process of software reliability engineering, the following problems should be resolved:

- The metrics of software reliability.

- Analysis and design of software reliability.

- Testing and verifiability of software reliability.

- Management of software reliability.

However, there are several techniques that can be analyzed through these problems, such as software failure mode and effect analysis (SFMEA), software fault tree analysis (SFTA), software sneak circuit analysis (SSCA), software Petri net analysis in reliability analysis technique, and fault-prevention design, fault-tolerant design, fault-detect design, error-correction design, failure-recover design, software reliability growth in software reliability design [6].

B. Development Tendency of Software Reliability Engineering

1) Software Reliability Metrics.

As shown in figure 1, there are several methods of software reliability metrics. Furthermore, there are lots of research results in selecting parameters and forecasting reliability. Recently, the development of this field is shown as follows:

- The effect of environment analysis and research for software reliability.

- Qualitative evaluation method of software reliability.

- Software reliability assessment method based on gray-box testing.

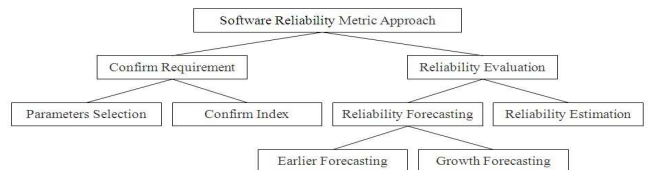- Software reliability assessment method based on accelerated test.

Figure 1. Diagram of Software Reliability Metric Approach

2) Software Reliability Analysis and Design.

The main software reliability analysis technique contains: software failure mode and effect analysis (SFMEA), software fault tree analysis (SFTA), software sneak circuit analysis (SSCA), software Petri net analysis. Although, some of techniques come from traditional hardware reliability analysis techniques, most of methods are not fully applied into engineering [7]. With the development of software engineering, this field has the following development tendency:

- With the development of software development based on UML, how to conduct SFMEA and SFTA has been becoming a research hot point of software reliability analysis technique by using UML to describe software requirement and design. Especially, the transformation method between UML code and FTA code, automatic building method and automatic analysis method of software fault tree are becoming the core areas of research fields.

- Although SFMEA method and AFAT method play an important role in improving the software

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reliability, both methods are associated with some inherent drawbacks such as, SFMEA has weak computing power and less visual in describing software reliability than SFTA, and SFTA is not quite complete. Therefore, we should take full advantage of positive sides and combine with each other in software reliability analysis.

- In embedded software reliability analysis field, the analysis methods are not integrated. Therefore, failure classification method and SFMEA comprehensive analytical method of embedded software will become an important part of investigation.

3) Software Testing and Verifiability.

Software testing method aims to detect and correct defects of software and improve software reliability, in order to satisfy reliability requirement of users. Figure 1.2 depicts the Software testing process.

The research of software Testing mainly focuses on the following respects:

- The construct method of operating profile and testing case for software.

- Automatic generation of reliability testing data and test scripts technique.

- Development technique of software reliability testing environment.

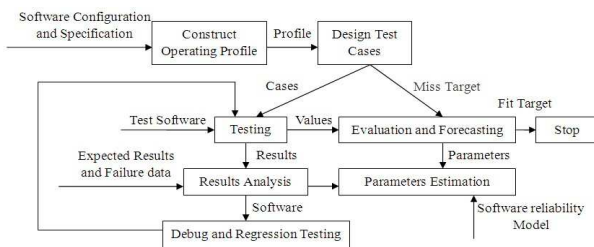- Software reliability accelerates testing technique.

Figure 2. Flow Diagram of Software Reliability Testing

4) Software Reliability Management.

Software reliability management is used to control and improve development process by using reliability measure and other information, manage the purchasing and reusing software, confirm factors of affecting software reliability, and improving relationship between cost and benefit. Recently, software development has developed to structure, middleware and formal methods step by step. Therefore, how to adapt to the changes of these development methods is a primary research area in reliability management.

IV. THE NEEDED RESOLVED PROBLEMS IN SOFTWARE RELIABILITY ENGINEERING DEVELOPMENT

With more than 20 years of the development in software reliability, the researchers transform few researchers into large team in China. Our national fundamental research approximates to foreign, but there is a large distance in engineering application. Therefore, we need to resolve the following problem:

- Software reliability engineering theory should be advertised, so that more and more technical and managerial personnel understand the importance of software reliability, and more and more software designers know the basic method of software reliability.

- Present reliability requirement of key component of important product, and produce high quality product.

- Combining with the actual project, integrated software reliability engineering method can be proposed by using standardized approach.

- The research and collection of failure data for software system modules provides a theoretical basis and actual analysis method for forecasting and designing of software reliability.

- Reliability theory methods, software safety design and analysis methods should be researched further.

V. CONCLUSION

Due to historical appearance, few technical and managerial personnel are well aware in software reliability technique [8]. Therefore, our products are uncompetitive, because the reliability analysis and management technique cannot be introduced into the production design, especially civil products. Obviously, these weaknesses restrict development of software reliability engineering. To sum up, the competition of production comes down to competition of reliability in 21st century. Only by enforcing these measures, can we develop rapidly in software reliability engineering.

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