A Study on Reliability of software metrics in Software products

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Abstract : The objective of this research paper is to study about the software reliability metrics. "Software Reliability is defined as the probability of failure-free software operation for a specified period of time in a specified environment". Software Reliability is different from Hardware reliability. Achieving Software reliability is hard because the complexity of software tends to be high. Software Reliability can be categorized into 3 parts : modeling, measurement & improvement. Various approaches can be used to improve the reliability of the software, however, it is hard to balance development time and budget with software reliability. But the best approach to assure software reliability is develop a reliability metrics. This article article provides an overview of Software Reliability measurement techniques.

Keywords.

Software, Software Reliability, Reliability Metrics.

Software Reliability is the key task for achieving the high reliability of any software industry. It applies the attributes that are helpful for achieving the reliability and if focus on metrics. IEEE defines reliability as "The ability of a system or component to perform its required functions under stated conditions for a specified period of time"

Software reliability is comprised of three activities :

1. Error prevention
2. Fault detection and removal.
3. Measurements to maximize reliability, specifically measures that support the first two activities.

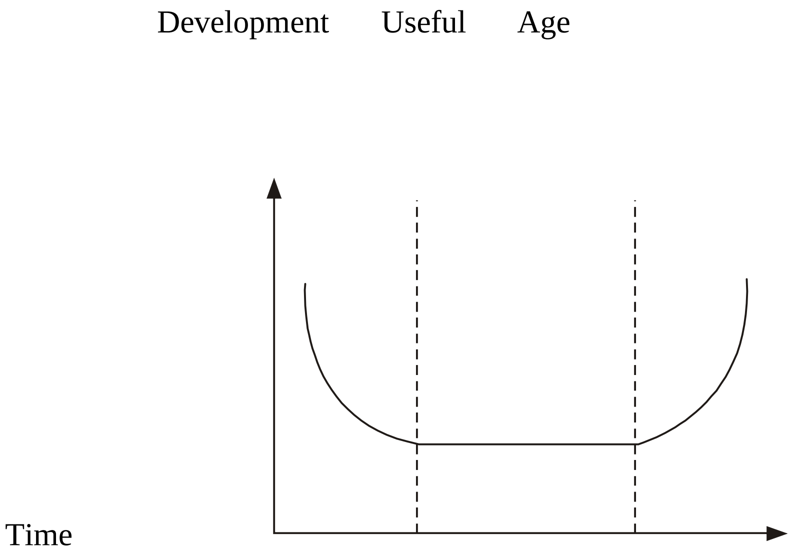
There has been extensive work in measuring reliability using mean time between failure and mean time to failure metrics. Software Reliability is an important factor that effects system reliability. It differs from hardware reliability as it reflects the design perfection, not manufacturing perfection. This paper tries to give general idea for software reliability and the metrics used to measure the software reliability.

2. SOFTWARE RELIABILITY

Reliability may be defined as the probability or an item to perform a required function under stated conditions for a specified period of time. Software Reliability is defined as the probability of the failure free software operation for a specified period of time in a specified environment. Unreliability of any product comes due to the failures or presence of faults in the system. The unreliability of software is primarily due to bugs or design faults in the software. It occurs only when system is in use and not preceded by warnings.

3. BATHTUB CURVE FOR HARDWARE RELIABILITY & SOFTWARE RELIABILITY

Software errors have ranged from poorly designed user interface to direct programming errors. Software does not rust, age, wear-out, or deform. Unlike mechanical parts, software will stay as is unless there are problems in design or in hardware Software will not change over time unless intentionally changed or upgraded. Software failures may be due to errors, ambiguities or misinterpretation of the specification that the software is supposed to satisfy, carelessness or incompetence in writing code, inadequate testing, incorrect or unexpected usage of software or other unforeseen problems Over time, hardware exhibits the failure characteristics as shown in Figure Known as bathtub curve.



"Figure 1" Bathtub curve for hardware Reliability

4. BASIC RELIABIITY METRICS

Reliability metrics are used to quantitatively express the reliability of the software product. The choice of which metric is to be used depends upon the type of system to which it applies & the requirements of the application domain.

Measuring the software reliability is a difficult problem because we don’t have a good understanding about the nature of software. It is difficult to find a suitable way to measure software reliability, and most of the aspects related to software reliability. Even the software sizes have no uniform definition. If we cannot measure the reliability directly, something can be measured that reflects the characteristics related to reliability.

Some reliability metrics which can be used to quantify the reliability of the software product are discussed below :-

4.`1 MEAN TIME TO FAILURE (MTTF)

MTTF is defined as the time interval between the successive failures. An MTTF of 200 means that one failure can be expected every 200 time units. The time units are totally dependent on the system & it can even be specified in the number of transaction. MTTF is relevant for systems with long transaction.

4.2 MEAN TIME BETWEEN FAILURE (MTBF)

We can combine MTTF & MTTR metrics to get the MTBF metric.

MTBF = MTTF + MTTR

4.3 RATE OF OCCURRENCE OF FAILURE (ROCOF)

Thus, an MTBF of 300 indicates, that once the failure occurs, the next failure is expected to occur only after 300 hours. In this case the time measurements are real time & not the execution time as in MTTF.

5 SOFTWARE RELIABILITY MEASUREMENT TECHNIQUES

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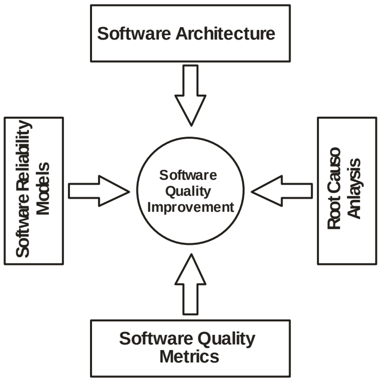

Fig 1 : Software Quality Improvement Factors

5.1 PRODUCT METRICS

Product metrics are those which are used to build the artifacts i.e. requirement specification documents, system design documents etc. These metrics help in assessment if the product is good enough through reports on attributes like usability, reliability, maintainability & portability. In this measurements are taken from the actual body of the source code.

- Software size is thought to be reflective of complexity, development effort and reliability. Lines of Code (LOC), or LOC in thousands (KLOC), is an intuitive initial approach to measuring software size. The basis of LOC is that program length can be used as a predictor of program characteristics such as effort & ease of maintenance. It is a measure of the functional complexity of the program and is independent of the programming language.

- Function point metric is a method to measure the functionality of a

Proposed software development based on the count of inputs, outputs, master files, in quires, and interfaces.

- Test coverage metric estimate fault and reliability by performing tests on software products, assuming that software reliability is a function of the portion of software that is successfully verified or tested.

5.3 PROCESS METRICS

Process metrics quantify useful attributes of the software development process & its environment. The goal of process metric is to do the right job on first time through the process. So process metrics can be used to estimate, monitor and improve the reliability and quality of software. Process metrics describe the effectiveness and quality of the processes that produce the software product. Examples are :

- Effort required in the process
- Time to produce the product
- Effectiveness of defect removal dring development
- Number of defect found during testing
- Maturity of the process

5.4 FAULT & FAILURE METRICS

A fault is a defect in a program which arises when programmer makes an error and causes failure when executed under particular conditions. These metrics are used to determine the failure - free execution software.

To achieve this goal, number of faults found during testing and the failures or other problems which are reported by the user after delivery are collected, summarized and analyzed.. Failure metrics are based upon customer information regarding failures found after release of the software. The failure data collected is therefore used to calculate failure density, Mean Time Between Failures (MTBF) or other parameters to measure or predict software reliability.

6 SOFTWARE METRICS FOR RELIABILITY

The Metrics are used to improve the reliability of the system by identifying the areas of requirements. The different types of software metrics that are used are :-

6.1 REQUIREMENT RELIABILITY METRIC

Requirements indicate what features the software must contain. It specify the functionality that must be included in the software. The requirements must be written such that is no misunderstanding between the developer & the client. The requirements must contain valid structure to avoid the loss of valuable information. Requirement Reliability metrics evaluates the above said quality factors of the required document.

6.2 DESIGN & CODE RELIABILITY METRIC

The quality factors that exists in design and coding plan are complexity, size and modularity. Complex modules are difficult to understand & there is high probability of occurring errors. The reliability will decrease if modules have a combination of high complexity and large size or high complexity and small size. These metrics are also applicable to object oriented code.

6.3 TESTING RELIABILITY METRIC

These metrics use two approaches to evaluate the reliability. First it ensures that the system is equipped with the functions that are specified in the requirements. Because of this, the errors due to the lack of functionality decreases.

Second approach is evaluating the code, finding the errors & fixing them. To ensure that the system contains the functionality specified, test plans are written that contain multiple test cases. Each test case is based on one system state and tests some functions that are based on a related set of requirements The objective of an effective verification program is to ensure that every requirement is tested, the implication being that if the system passes the test, the requirement's functionality in included in the delivered system.

7 CONCLUSION

Software reliability is an important research area and software reliability is key part of software quality. Software reliability metrics can be used to assess current reliability and forecast future. For any software industry achieving software reliability is the key task. Achieving Software reliability is hard because the complexity of the software tends to be high.

These metrics measures software reliability in requirements, design and coding, and testing phase. The scope of this paper is the measurement knowledge and metrics that are necessary to ensure the reliability of software agile process. So, using various software measurement techniques mentioned in this paper we can remove any error or fault from the software process, thus improving the reliability of the software product.

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