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Imperfect Debugging in Software Systems by SRGM with TEF

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Abstract: ***In the Proposed work we are going to assimilate two important process called TEF and imperfect debugging in software systems for analyzing FDP and FCP. By applying the tools called debuggers we are going to identify the failures and going to correct them in order to attain the high quality reliability. As we know, testing effort function is predicted during this time by allocating the resources which influences considerably only for the fault identification rate and also for the correction of such faults. Additionally, new faults may be included for evaluating as the feedback. In this technique, first it is proposed to demonstrate for the inclusion of TEF and fault introduction into FDP and later develop FCP as delayed FDP with a proper effort for correction. The FCP as well FCP as paired specific models which are extracted based on the basis of types of assumptions of introducing fault introduction as well as correction effort. In addition, the optimal policy of software release for different criteria with examples was also presented in this work.***
Keywords: FDP, FCP, TEF, Fault.

I. INTRODUCTION

New generation computers and advanced networking technologies are transformed human day to day life. They are responsible for so many things changing drastically in the field of electronics, telecommunication and computer networks and technological changes created revolution in many areas like automation of manufacturing sectors, hospital management, transportation and office automation as well. In addition, the role of computers are diversified into many applications namely, monitoring systems

1) In avionics for the control of air traffic
2) Nuclear plants
3) To get real time solutions in military
4) Used for measurement and control inprocess industries.
5) Used in Automotive industries forsafety assessments
6) Used in medical equipment for patient

In world's economy computer and computer networks play important and major roles in terms product manufacturing and services. In this regard, the operations and maintenance of becomes tedious and time consuming in this modern world. The critical applications and functionality of software size and their complexities also leads to several challenges for the users and manufactures. Hence, design and development of reliability software is an important issue for finding software systems faults.
It is the fact that, two major components are incorporated in computer system computer systems they are hardware and software components. As on today, there is a tremendous research work carried out on testing of hardware reliability but there is no much focus for the development of SRGMs even though increase of software applications. As per the expert's opinion, reliability of software is entirely different from reliability of hardware in terms design and usability etc. If the software flaws and design were incorporated in the software system itself, human will not experience any software failures.

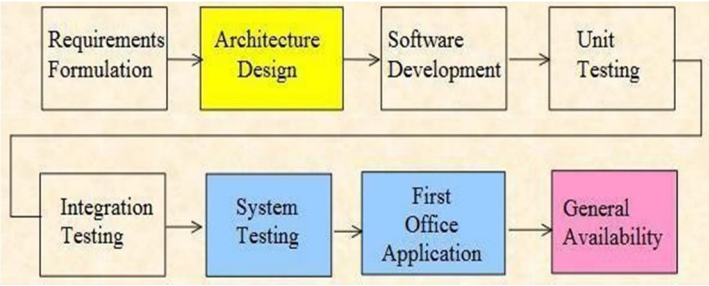

Figure 1.1 Architecture Based Reliability Models.

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It is observed that, conventional SRGMs are applied to system test dataset to get the software failure information that can be monitored in the field. Perfect debugging assumption is an acceptable assumption. Therefore, the below challenges are taken into account while designing the SRGMs.

Utilization of different profile compare to testing profile.

Removal of faults in the instantaneous environment.Providing quality data for software reliability.Commonly, software faults are more tediousand time consuming to identify the faults as compared to hardware or physicals faults. In principle, the software will be made available free from faults, unlike components of hardware systems. However, it is noticed that, all design failures were there during theinstallation of the software into the hardware system

[1] and [2]. For critical applications, computer programs vary between thousands and millions andthis will make the fault decision. The above circumstances and other similar events have made it inevitable to predict and evaluate the software reliability [3] and[4] before applying for different tasks.

Fault $m_d(t) = aF(t).$ **Introduction using FDP and FCP Models**

$$\lambda_r(t) = \int_0^t \lambda_d(y) f(W(t) - W(y)) w(t) dy$$
$$= \int_0^{W*(t)} \lambda_d(W^{-1}(W(t) - x)) f(x) w(t) d(W^{-1}(W(t) - x))$$
$$= \int_0^{W*(t)} \lambda_d(W^{-1}(W(t) - x)) f(x) w(t) \frac{dx}{w(W^{-1}(W(t) - x))}$$

Number of failures predicted during the time t can be expressed by the function $a(t)$ which is known as fault function. This function is equal to sum initial failures number in the software and number of faults introduction at the interval $[0,t]$. In this case, $w(t)$=Testing effort rate which depends on time and also for the CTE (cumulative testing effort) consumed till time t.

Let$d(t)$= Mean value function for depiction of the predicted faults

Let d(t)= Mean value function for depiction of the predicted faults detected at time t.

Let λd(t)=dm(t) /dt= Fault Intensity function.

For, the time interval [t,t+ Δt) with testing effort function can be expressed as, λd (t) =dmd (t) / d(t) =b(t) w(t)(a(t) –md (t)

where,b(t)= Current fault detection rate per unit of testing effort at time t.

w(t)=Current testing effort expenditure attime t. Putmd(0)=0 in equation (1.1) we get, m d(t)= a(t)−exp{−∫ t(0)b(x)w(x)dx}

−exp{−∫ t(0)a 1(x) exp{∫x(0)b(y) w(y)dy} dxwhere, a '(x) =da(x). dx of a(t),b(t) and w(t). λd(t) can be obtained bysubstituting (1.2) into the equation (1.1).

λd(t)= dmd(t)= ab(t)w(t) exp{−∫ t(0)b(x)w(x)dx}(1+ t(0)−exp{−∫ t(0) a 1(x) exp{∫x(0)b(y)w(y)dy }dx(1.3)

Functions of the SRGMs were predicted in terms of these datasets. The value of mean function $mr(t)$ is applied to define the removal of faults which was expected till the interval t and λ

where, $r(t)=^{dmr(t)}$= Fault removal intensity function

[5] and [6].

In general, correcting various failures may need different quantity of investigating materials [7], [8]. Hence, the PDFand the CDF were used as random variables for correction effort.

$$m_r(t) = \int_0^t \lambda_d(y) F(W(t) - W(y)) dy \qquad (1.4)$$

here, $F(W(t)-W(y))$= Probability of fault identified at y is corrected before. Different $mr(t)$ will be calculated using $m_d(t)$ for different $f(x)$ respectively. Then these parameters can be expressed by the following equation.

(1.5)

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II. FDP AND FCP MULTI-RELEASE MODELING

The modeling method of FDP is single version software whereNHPP of SRGM is incorporated with the cumulative faults.
Let $N(t)$= De-tested faults and is assumed to follow a Poissondistribution and$md(t)$= MVF.

$$P\{N(t)=n\}=\frac{m_d^n(t)}{n!}e^{-m_d(t)}.$$

(1.6)

The, the Mean Value Function can be expressed by thefollowing equation.

$$\begin{cases}\frac{dm_d(t)}{dt}=\lambda_d(t)=\frac{F'(t)}{1-F(t)}[a-m_d(t)]\\ m_d(0)=0\end{cases}$$

here, $\lambda d(t)$= represents fault rate at the time of processtest and $F(t)$=CDF and by computing the equation (1.7), the MVF may be expressed as,

$$m_d(t)=a[1-\exp(-\gamma t)].$$

Assuming $F(t)$as an experiential distribution, it is

$$\lambda_c(t)=E[\lambda_c^*]=\int_0^t \lambda_d(t-x)\cdot g(x)dx$$

$$\lambda_c^*=\begin{cases}\lambda_d(t-\Delta t), & \Delta t\le t\\ 0, & \Delta t>t\end{cases}$$

considered as popular Goel model.

$$m_c^*=\begin{cases}m_d(t-\Delta t), & \Delta t\le t\\ 0, & \Delta t>t\end{cases}$$

Mean value function which is delayed (MVF) m^*c
can defined by the following expressions.

$$m_c(t)=\int_0^t \lambda_c(\tau)d\tau=\int_0^t\int_0^\tau \lambda_d(\tau-x)\cdot g(x)dx\,d\tau$$
$$=\int_0^t\int_x^t \lambda_d(\tau-x)\cdot g(x)d\tau\,dx$$
$$=\int_0^t m_d(t-x)\cdot f(x)dx=E[m_c^*].$$

$$\lambda_c(t)=E[\lambda_c^*]=\int_0^t \lambda_d(t-x)\cdot g(x)dx$$

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Dai et al. [12], expressed the approach as expectation of thedelayed failure rate. Accordingly, $\lambda c(t)$ can be written as,

It has been justified that, $mc(t)=E[m*c]$ .Commonlyapplied TEF are discussed in following paragraph.

Constant TEF: In this case,$W(t)$ assumed to be constantvalue and defined as,

$$w(t)= w \quad (1.15)$$

$$W(t)=wt \quad (1.16)$$

It is observed that, the overall testing effort utilized to be the positive infinity, when time t reaches to positive infinity. If TEF is valued then it is awarded as w(t)=1 .

TEF in Weibull: Well fit most data will be studied which are often used in SRGM is called Weibull TEF. They are very flexible and TEF W(t) with cumulative value is defined by the following equation.

$W(t)=N(1-\exp\{-\beta t^m\})$

It must be noticed that, there is finite consumption of CTE and tends to N when t reaches positive infinity. Equation (1.17) is differentiated we get,

$$w(t)= N\beta mt\, m-1\exp\{-\beta t\, m\} \quad (1.18)$$

$$W(t)=N \quad (1.19)$$

$$1+A\exp\{-\eta t\}$$

TEF Logistic: As an alternative Rayleigh curve or Logistic curve was first studied by Parr et al. [13]. This TEF logistics gives similar characteristics as Rayleigh curve, other than project initial step. The logistic cumulative TEF $W(t)$ can be defined by the following equation.

here, A = Constant value and η =rate ofconsumption for the expenditure of testing effort.

Identical as Weibull case, there is finite consumption of CTE consumed resulting in N when t reaches to the value of positive infinity. Applying derivatives to the equation (1.19) we get,

$$w(t)= \frac{NA\eta}{\exp\{\frac{\eta}{2}t\}+A\exp\{-\frac{\eta}{2}t\}} \quad (1.20)$$

when, t=ln A/η when w(t) gets its highest value.

III. RESULTS AND DISCUSSION

The proposed SRGM uses dataset from the system T1 data of the RADC[14] This work analyses various TEF software dependent FCP and FDP with imperfect debugging.It is noticed that, during software testing stage, the resources were not allocated.

Table I illustrate the values of faults identification and faults corrected for 1st 21weeks during the first week of cumulative numbers. For the entire time span, totally 302.1CPU hours are utilized.

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Table.I Data Set.

Weeks	CPU time in Hours	Number of cumulative faults detected	Number of cumulative faults corrected
1	4.10	2.0	1.0
2	4.31	2.0	2.0
3	2.01	2.0	2.0
4	0.61	3.0	3.0
5	2.31	4.0	4.0
6	1.30	6.0	4.0
7	1.81	7.0	5.0
8	14.71	16.0	8.0
9	25.20	29.0	24.0
10	4.6	31.0	18.0
11	9.6	42.0	19.0
12	8.6	44.0	32.0
13	29.6	55.0	38.0
14	22.2	69.0	56.0
15	39.7	87.0	75.0
16	26.02	99.0	86.0
17	25	111.0	98.0
18	31.3	126.0	118.0
19	30.01	132.0	129
20	12.67	135.0	133.0
21	5.02	136.0	137.0

Table II. Comparative analysis of experimental results for different TEF with estimated parameters.

TEF	Parameters	Bias	RMSE	RMSPE	Variance
Constant	W = 14.29	0.00048	12.11	12.11	12.11
	N = 407.0830				
Weibull	β = 2.064E-4	7.86	7.86	7.86	7.76
	M=2.923				
	N = 321.482				
Logistic	η = 0.3826	6.7838	6.7828	6.7818	6.7570
	A=423.788				

In the testing process, total of 136 faults are identified and corrected all of them. If more amount of of testing effort is consumed, debuggers may influence for the introduction of more faults because of the software code has experienced more changes. The TEF and the fault introduction effect can be incorporatedsimultaneously on both FDP and FCP to get the influences of testing resource allocation. On the basis different assumptions on correction effort as well as fault introduction various paired FCP and FDP models are obtained.

It is also observed that, the proposed SRGM model is quite common and it is very flexible. Parameters of various types of TEF were computed and predicted by using LSE which is defined in the previous section in order select a TEF that best fits this.

.

The reliability for the exposure time will be defined withrespect to the following parameters.
Time of calendarTime of Clock

Execution time of CPU

Number of test runs

Different types of TEF with estimated parameters werecompared and recorded in Table II.

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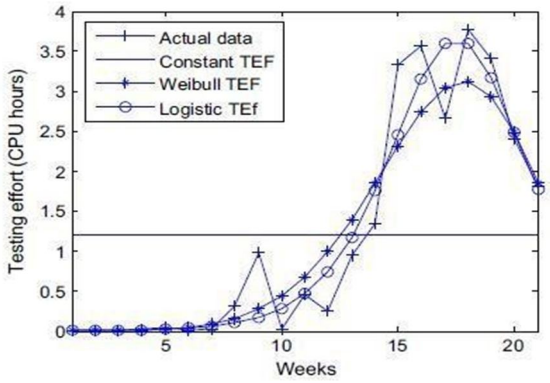

Figure 1.2 Graphical Demonstration of differentTEF

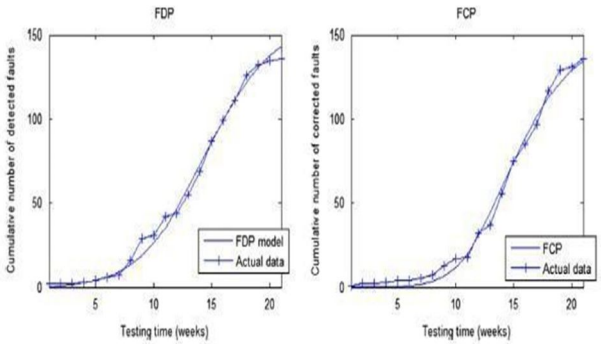

Figure 1.3 Paired model fitted against real database.

The fig. 1.2 shows graphical demonstration of differentTEF. According to the predicted values, about 101.93 failure values at the starting of the experiment.

Total values of faults for time duration t reaches to 197.08. Figure 1.3 is plotted for graphical demonstration of the proposed model. In order to obtain influences for the allocation of resources for testing as well as for the introduction of faults on both FCP and FDP. The release time for optimal software T = 39.626. Figure 1.4 plotted for software release policy versus total reliability cost for graphical demonstration.

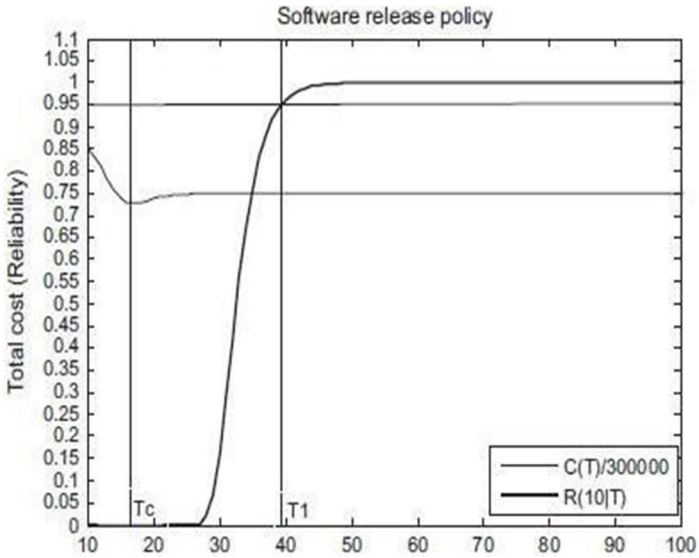

Figure 1.4 plotted for software release policy versus total reliabilitycost for graphical demonstration.

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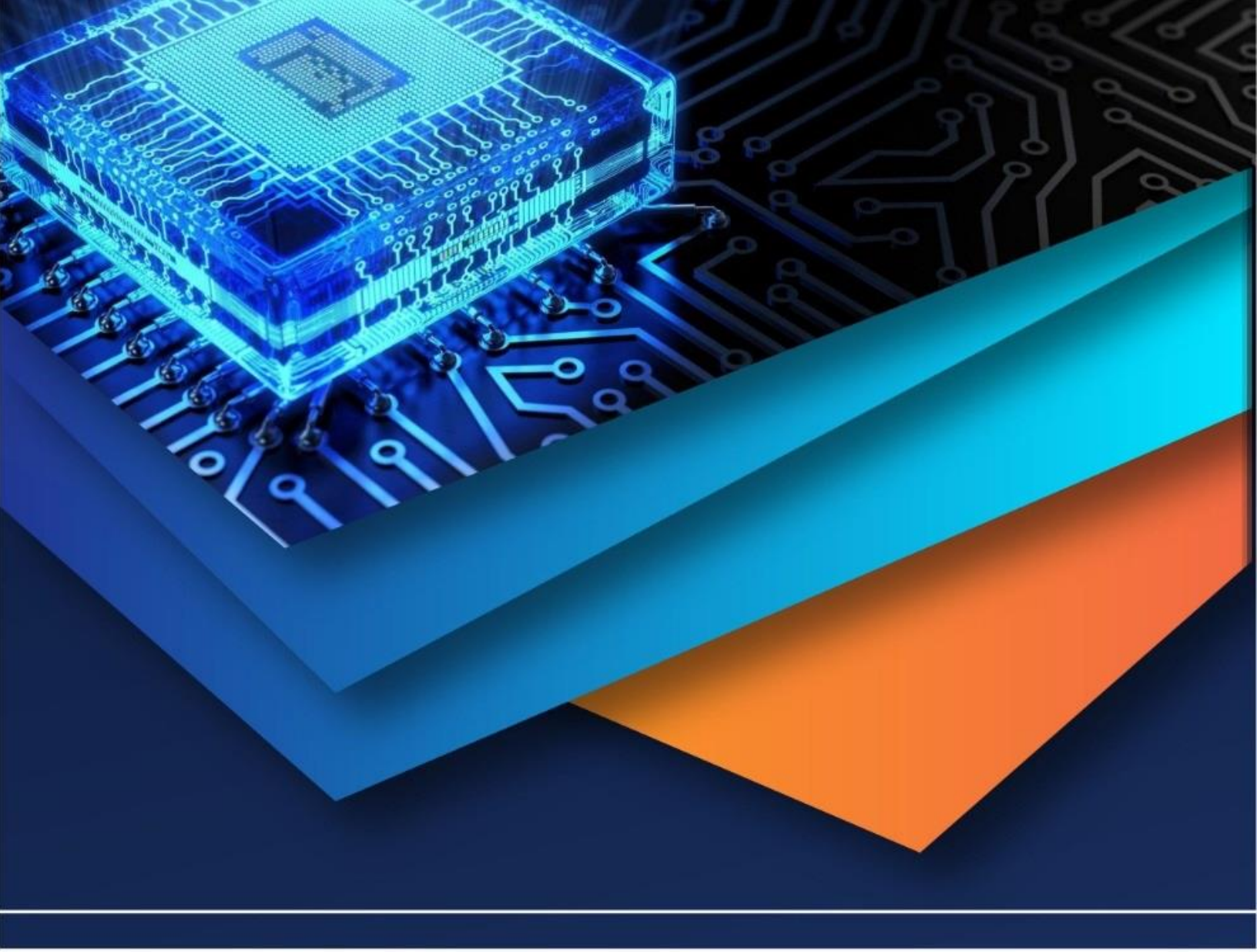

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