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RELIABILITY METRICS IN COMPONENT BASED METHODS FOR A DISTRIBUTED SYSTEM

S. P. Angelin Claret[1,2] , M. Germanus Alex[3] , R. Yamini[4] and Arun Sahayadhas[5]
[1] Department of Computer Science, Bharathiar University, Coimbatore, India
[2]Department of Computer Applications, SRM University, Chennai, India
[3]Department of Computer Science, Kamarajar Govt. Arts & Science College, Tirunelveli, India
[4]Department of Computer Software Engineering, SRM University, Chennai, India
[5]Department of Computer Software Engineering, VELS University, Chennai, India
E-Mail: arun.se@velsuniv.ac.in

ABSTRACT

The distributed system is a paradigm in which the components can communicate by means of the interface connected between them. The interaction between the components takes place in order to achieve a common goal. The reliability metrics is used to evaluate the performance of the components which is connected by the distributed systems. The Mean Time Between Failure (MTBF), Mean Time to Repair (MTTR) and Mean Time to Failure (MTTF) are the standard reliability metrics used to measure the failure state occurred in the components. The reliability indices of a component based method in the distribution system can be performed its function in a specified period of time without any failure. The reliability metrics algorithm used here shows the reliability function for distributed system in a component based method at a specified time interval.

Keywords: reliability metrics, reliability indices, component based methods, distributed system.

1. INTRODUCTION

The software applications are increasing with more complicated and huge prominence on reuse. The component based methods are utilized to overcome the difficulties arises in the software applications. The software reliability is used to identify the probability of the regular operation of the software system with the specified period of time in the particular situations [1]. The reliability can be estimated by the some of the reliability metrics such as Mean Time Between Failure (MTBF), Mean Time to Repair (MTTR) and Mean Time to Failure (MTTF) [2]. The capability of the component or a system which is working for a long time without any hardware or software faults continuously can be represented for the MTTF [3].The objects can be communicated through components. The component based method is an open standard. It can be executed on any different platforms. The components are activated through interfaces. The client uses the any component based method to identify the server and the transmission can be takes place by the interfaces used [4].To develop large complex systems using component based methods the reliability measures has to be evaluated. The development process consists of interconnection of components together. Distributed systems require more services than the component based systems. The interface links are established between the sources to component based method to the destinations. From this point of view, the development of various distributed system is integrated by software components and resultant produce the component based software systems [13].

The analysis of reliability is essential to estimate the reliability of the individual components. The distributed systems are incremental in nature due to their complication. Therefore the subsystem components can be further decomposed into individual components to show their reliability. The reliability analysis of individual component and distributed complex systems is unpredictable [14].Measuring and predicting reliability to provide unavoidable fault system is measured by various reliability measures [15]. The estimation of system reliability based on the component based methods and architectures are expressed in [16].

This paper focuses on the reliability measures of the component based methods in distributed systems. The distributed systems can be connected from any source to destination through any standard principles. This system can be expressed by the component based methods. The component based method provide various typical procedures such as maintainability, flexibility, reusability, reliability etc., This work concentrates on the reliability methods of component based method. The reliability metrics and indices used here express the reliability of the distributed systems by component based method connected from source to the destination. Three different types of components are used to show reliability metrics individually.

Section 2 concentrates on the motivation of various reliability studies. Section 3 focuses on the reliability metrics used in the component based methods. Section 4 explains about various reliability indices and how this can be applied for component based methods. Section 5 focuses on the conclusion and future work of the present work.

2. MOTIVATION

Goseva-Popstojanova and Trivedi [17] present a examination on different reliability models. Most of the work are concentrated in the mathematical formaulations. Aleksandar Dimov and Sasikumar Punnekkat [16] explore the models for architectural description of reliability for component based method. It shows the ability to rectify

the noted issues in any architectural models. One of the model used by [18] is SaveCCM, which can analyze the applicability of reliability.

Wang and Dai Pan [18] introduced an architecture based model to estimate software reliability in any phase which does not require any test data using the Markov model.

Tyagi and Arun Sharma [19] propose a reliability model based on heuristic component dependency graph using ant colony optimization. This model uses the execution paths that are mostly used and thus estimates the reliability of the components followed in that path. Anurag and Pradeep Tomar [20] proposed a reliability model that uses path propagation probability and impact of the component. This model describes the effect of the components active during the path propagation and shows the component used more during execution have a great impact on the reliability of the system.

This work concentrates on the client and server that can be connected by the component based methods with the interface connected between them. The component based methods described here are C++, JAVA and CORBA. Figure-1. shows the overview of component based method for the distributed system. The principles of various components along with their features are expressed in Table-3. The source is denoted as client and destination is represented as server.

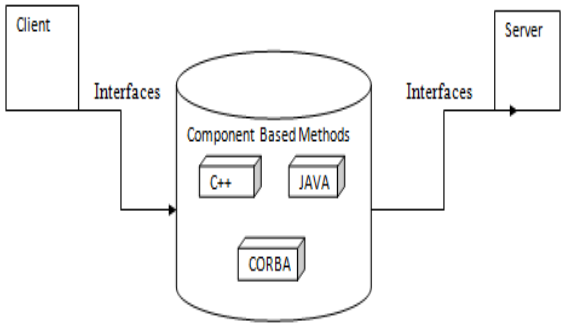

Figure-1. Overview of component based methods for the distributed system.

3. RELIABILITY METRICS

The reliability metrics of the three components can be measured by the following reliability metrics algorithm.

Let A,B,C represent three different types of components such as Component 1 ,component 2 and component 3 respectively.

Assume X_{ij} i=1,2,…….N , the duration of time taken from source(client) to the components

j=1,2……..N, the duration of time taken from components to the destination (server)

Let X denotes the reliability of the components from source to destination

Let T_{ij}= failure time from source to destination at time t.

F_{Tij} (t) = Probability density function of failure time

Reliability function, R_{ij} (t) = probability that system will work properly at time t

Failure distribution function, F_{ij} (t) = probability that a system will fail by time t

$$\mathbf{F_{Tij}\ (t) = \sum R_{ij}\ (t) - \sum F_{ij}\ (t)} \quad (1)$$

From (1) the failure distribution function of a system at time t can be evaluated.

$$\mathbf{X= F_{Tij}\ (t)} \quad (2)$$

$$\mathbf{Y= A +B +C} \quad (3)$$

From (2) and (3)

$$\mathbf{R_{ij}(t)= X-Y} \quad (4)$$

From (4) ,the reliability function from source to destination can be estimated

a) Mean time to failure

The expected time to failure of a particular system is expressed as mean time to failure. Basically it is used to measure the reliability of the non repairable systems. Also it is used to measure the mean for a huge range of time. Evaluate the meantime to failure from source to each of the component and from the components to the destination. There by the average usage of the particular system can be identified. From here the reliability of the components from source to destination is evaluated with the below mentioned formula

$$\mathbf{MTTF = \int_0^\infty tf\ (t)\ dt = \int_0^\infty R\ (t)\ dt} \quad (5)$$

tf(t)dt is the average functional time from the source to the destination.

R(t)dt is the reliability of each component from source to destination in a particular time.

b) **Mean time to repair**

It is measured by the variations occurred between the total down time and the number of breaks.

Mean time to repair = (Total down time) / (number of breaks) (6)

The variations occurred from the each of the components from source to the destinations is estimated to identify the total down time of the system in terms of the ideal states.

c) Mean time between failure

The average time intended to measure the execution time of a system. The MTBF value is equivalent to the working hours of the particular before going to the

failed state. It is measured by the total up time and the number of breaks.

Mean time between failures = (Total up time) / (number of breaks) (7)

The variations occurred from the each of the components from source to the destinations is estimated to identify the total execution time of the system along with its ideal states.

From (5), (6) and (7) the exact reliability metrics of the component based method can be estimated at time t as shown in Table-1 and Figure-2.

Table-1. The reliability metrics of various components.

Metrics	Component 1	Component 2	Component 3
MTTF	0.003	0.002	0.003
MTBF	1.032	1.121	1.024
MTTR	18.23	18.10	17.15

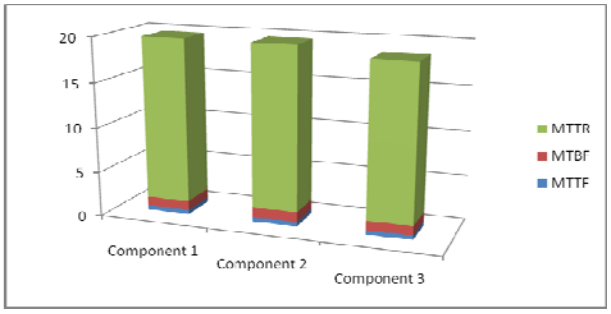

Figure-2. Reliability metrics of various component.

From Figure-2 it can be clearly stated that the failure state is very minimum when compared to MTBF and MTTR . This represents the reliability function of component based methods from source to destination.The calculation of reliability metrics from source to the individual components and from the components to the destination through the interface is shown in Figure-3.

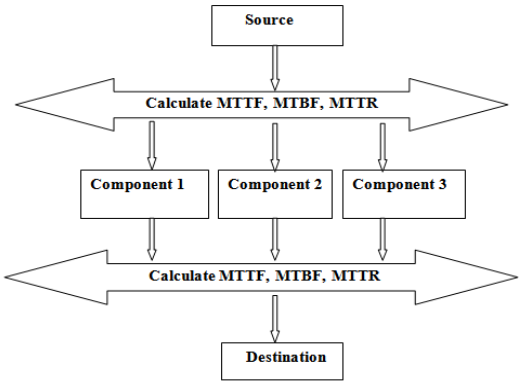

Figure-3. Evaluation of reliability metrics from source to destination.

4. RELIABILITY INDICES

The reliability metrics can be measured by the following methods.

- The average interruption duration index of the consumer is measured by[5]

$$CAIDI = \frac{\text{Total Duration in hours}}{\text{Number of customers affected}}$$

- The average service availability index of the service is measured by

$$ASAI = \frac{\text{Consumer hours service availability}}{\text{Consumer hours service demand}}$$

- The average service unavailability index of the service is measured by

$$ASUI = \frac{\text{Duration of outages in hours}}{\text{Total hours demanded}}$$

- The system average interruption duration index is measured by

$$SAIDI = \frac{\text{Total duration in hours}}{\text{Number of customers supplied}}$$

- The system average interruption frequency index

$$SAIFI = \frac{\text{Frequency of outages}}{\text{Number of customers supplied}}$$

Table-2. Reliability indices of various component.

Indices	Component 1 (hours)	Component 2(hours)	Component 3 (hours)
CAIDI	1.7	1.6	1.6
SAIFI	5.26	5.26	5.26
SAIDI	6.1	5.3	5.4
ASAI	5.26	4.15	3.41

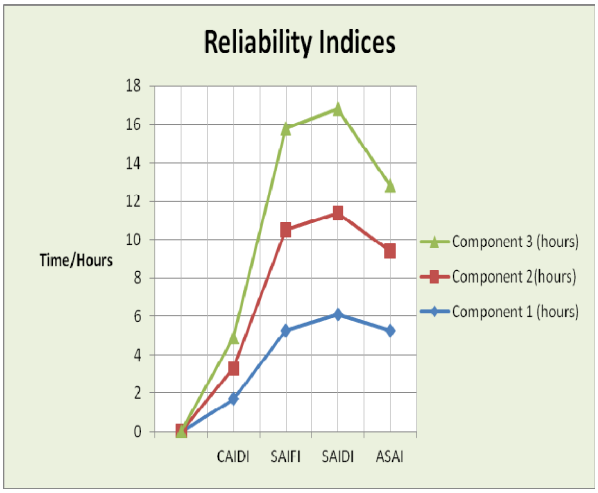

Figure-4. Reliability indices of various components.

The Figure-4 shows that at time t ,the component 1 utilizes a very good reliability when compared to the other two components. Component 3 takes the maximum time interval to show its interruption,availability and non availability of the services. Component 2 express the minimum reliability at time t. The Table-2 shows the reliability indices of various components in terms of time t.

a) Assessment of reliability

The reliability of components based method in any distribution system can be performed its function in a specified period of time without any failure [6]. Various observations of reliability metrics aimed to the development of abstract representation of the system [7]. The reliability measures can improve the occurrence of internal failures of metrics in a distributed systems [8].

b) The Principles of component based methods

The component based methods are the basic building blocks of any software components that encapsulate into any distributed/software sytem [9, 10, 11]. The distributed system can be connected by the composition of the interfaces from the source to the destination [12]. The Table .3 explains the principles of individual components such JAVA, EJB and CORBA along with their dependency, services, maintenance, flexibility, environment and reliability.

Table-3. Comparison of JAVA,EJB and CORBA components.

Principles		JAVA	EJB	CORBA
Dependency	Language	Independent	Dependent	Independent
	Platform	Independent	Independent	Independent
Services		Consistent	Not Consistent	Consistent
Maintenance		Need more interfaces	Less Interfaces	Need more interfaces
Flexibility		More	Less	More
Performance		Good	Average	Good
Environment	Development	Highly Developed	Moderate	Immature
	Binary Standards	YES	Moderate	NO
Reliability		High, Low Latency	Moderate	High

5. CONCLUSIONS

The reliability metrics for component based methods in a distributed system is estimated. The reliability metrics algorithm expresses the reliability function for a distributed system in a specified time interval for the component based methods. The need of component based methods has discussed to reliability function in an distributed system. The source and destination represents as client and server to show the application of distributed system. The components used here are JAVA, EJB and CORBA. It shows the principles in terms of its reliability along with their dependency, services, maintenance, flexibility, performance and environment. The reliability metrics and indices are also used to express the reliability of component based methods in distributed systems. Further this can be extended to find reusability and reliability measures for distributed networks.

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