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Enhancing Software Quality in Web Applications using Fault Tree Algorithm (FTA)

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Abstract*—In the recent times the WWW(World Wide Web) has transformed from static collection of HTML data to a dynamic system that offered a platform for cloud technologies and distributed information systems.Quality cannot be sprinkled onto a software just before it is delivered to clients.It must be maintained and evaluated in every stage of the Software Development Life Cycle (SDLC) from requirement analysis to the final retirement stage.In this paper we are going to discuss on enhancing the software quality in web applications using fault tree analysis.

***Keywords*—quality;web applications;fault tree algorithm;**

I. INTRODUCTION

In earlier days World Wide Web(WWW) was used as a platform to showcase the information in static pages,typically using Hyper Text Markup Language (HTML).These simple web pages consists of text documents and images interconnected through hyperlinks.

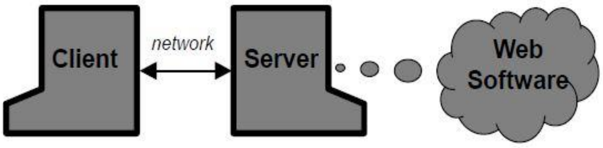

Figure1 Traditional Web Applications

But Now a days the use of web applications has changed dramatically.We are now using web applications in most of our day to day activities like shopping at e-commerce sites,travel ticket booking,mobile recharges,movie ticket booking and banking related applications etc...

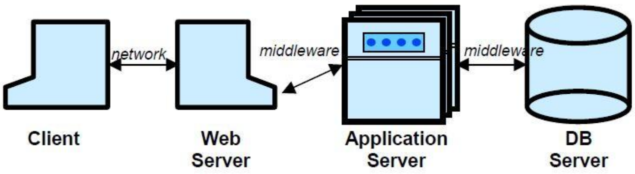

Figure2 Modern Web Applications

Websites are now fully functional software applications.Instead of referring to visitors to the website,we are now using the term users,which implies there is large interaction with the system.

II. COMPLEXITY IN WEB APPLICATIONS

Web applications are now powered by distributed software's that are implemented in many languages and styles and are developed with cutting edge technologies and interacts with users,databases,and other websites.These are all aspects of the software that involve diversity.

There is an increase in complexity of web applications because of increased functionality in modern websites,resulting in a need for complex software development,systems integration,design strategies and development processes.

One of the main reasons web software applications to become more complex is because of the way the software components are integrated together.The source is not available for most components and the executable may be hosted on remote servers at remote data centers.Thus web applications are loosely coupled components.

To ensure high quality we need novel techniques to integrate the components in a proper manner.

III. QUALITY ATTRIBUTES OF WEB APPLICATIONS

The following are the important quality criteria for the success of web applications:

A. Reliability

Highly reliable software is necessary for applications that are safety critical,such as banking,robotics,aerospace, and medical devices etc...

Web software, however, is critical to the commercial success of many businesses and if the software cannot work reliably, the businesses cannot succeed.

B. Usability

Many web applications do not meet the usability requirements that most of us expect. This, coupled with the fact that users exhibit little site loyalty,which implies that web sites that are not usable will not be used. Customers will quickly switch to more usable web sites as soon as they are put online.

Customers expect to be able to use web sites with no proper training. Thus, the software must flow according to the users' expectations, offer only needed information, and when needed, and provide navigation controls that are clear, simple and obvious.

C. Security

The Information and System Security was once a mathematical problem, then a networking problem, next a database problem, but now it is a software problem.

D. Availability

On the Web, customers not only expect availability 24-7 they expect the web site to be functional every day of the year 24-7-365.

Availability means more than just being up and running 24-7-365, availability also means that the web application must be available when accessed by diverse browsers.

To be available means, web sites must adapt their presentations to work with all the browsers, which requires significantly more knowledge and effort on the part of the web developers.

E. Scalability

The need for scalability has been a driver for most of the technology innovations of the past years. The industry has developed new software languages, new design strategies and techniques, and new data communication and transfer protocols, in part to allow web sites to grow as needed. Scalability also directly influences other attributes.

F. Maintainability

The web applications has a much faster update rate. Maintenance updates can be installed and be made available to customers instantly through the web site. Thus, even small individual change (such as changing the label on a button) can be installed immediately.

One result of this is that instead of maintenance cycles of months or years, web sites can have maintenance cycles of days or even hours.

G. Performance and Time to Market

The performance is important, but it is more important to note that performance is dominated by the internet traffic, often at the user's end.

The time-to-market has always been a key business driver, and is still important for web software.The requirement for patience can impact the process and management of web software products. Thus, the overall success for web application software depends on software engineering.

IV. FAULT TREE ANALYSIS

The fault tree analysis (FTA) produces a fault tree.The fault tree is the logical model of the relationship of the undesired event to more basic events.

The top event of the fault tree is the undesired event.The middle events are intermediate events.The bottom of the fault tree is the causal basic events or primary events.

The logical relationships of the events are shown by logical symbols or gates.

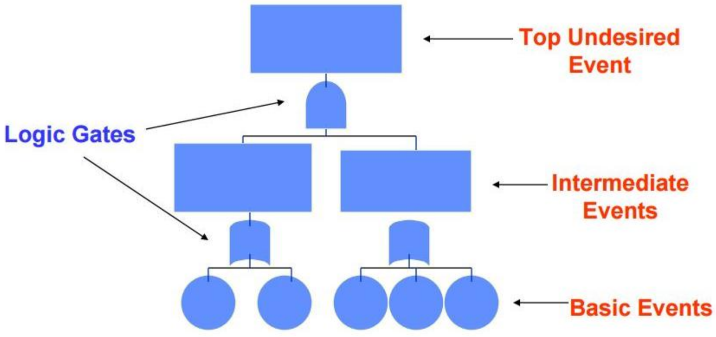

Figure3 Structure of Fault Tree Analysis

In fault tree analysis, we use Boolean logic to describe the combinations of events that may cause the failure in the software project. It takes a single failure and analyze with possible all causes for that failure in a detailed manner.

FTA finds the opportunities to identify the causes of specific failure and prevent those causes to happen. FTA is a top-down failure analysis used to find the root causes of failures or potential failures. It uses Boolean logic to combine a series of lower-level events. The symbols used in a single FTA Logic Diagram are called Logic Gates and are similar to the symbols used by circuit designers in electrical and electronics applications.

V. FTA ALGORITHM

Step1: Define the undesired event to be analyzed .(Focus)

Step2: Define the boundary of the system .(Scope)

Step3: Define the casual event to be considered.(Resolution)

Step4: Define the initial state of the system.(Refine)

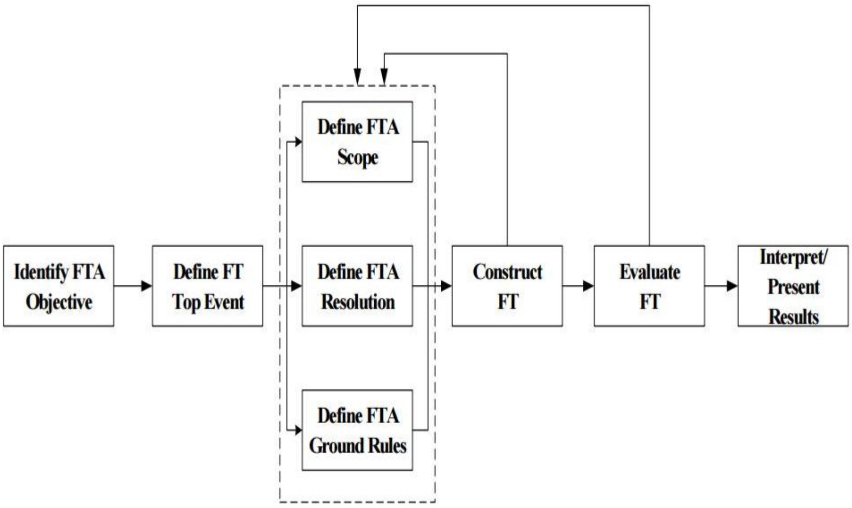

Figure4 Control Flow in Fault Tree Analysis

VI. EVENTS AND LOGICAL GATES IN FTA

Fault Tree consists of set of events both related and unrelated according to the context and also some logic gates used for representation purposes.

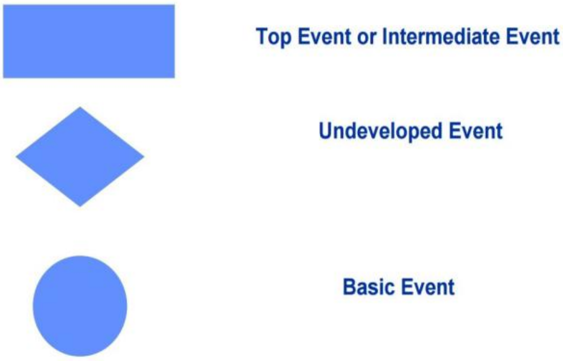

Figure5 Events in Fault Tree Analysis

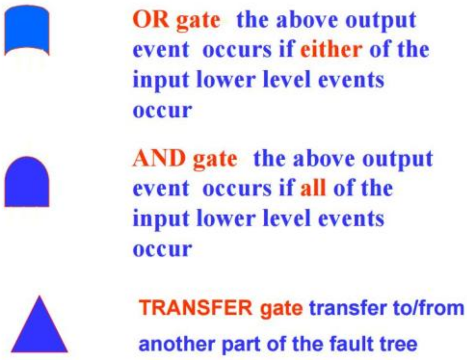
OR gate the above output event occurs if either of the input lower level events occur
AND gate the above output event occurs if all of the input lower level events occur
TRANSFER gate transfer to/from another part of the fault tree

Figure6 Logic Gates in Fault Tree Analysis

VII. REAL TIME EXAMPLE OF FTA

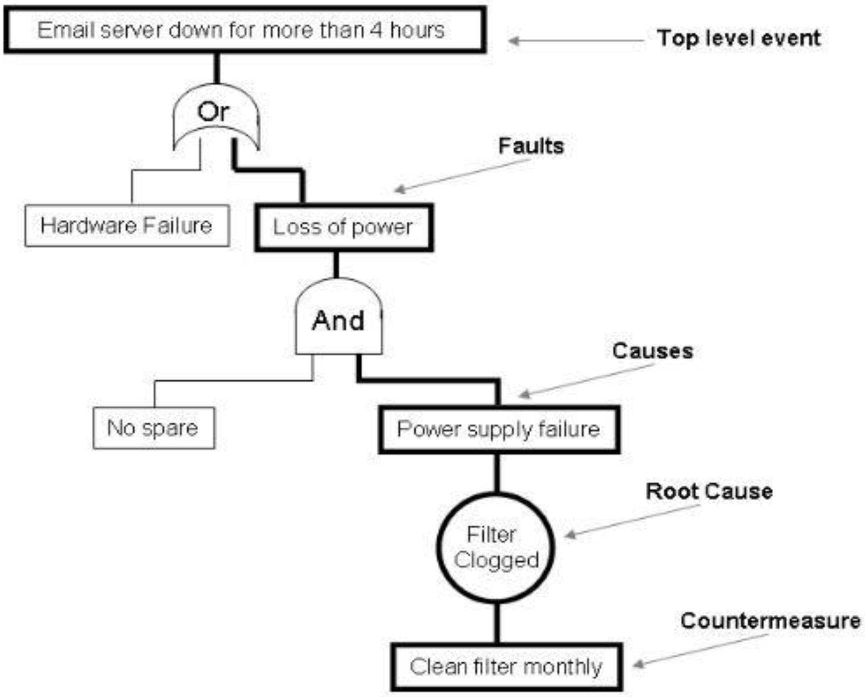

Figure7 Email Fault Tree Analysis Example

VIII. COMPARISON BETWEEN FTA AND OTHER APPROACHES

1)FTA is not a Fishbone analysis which is a more informal depiction of event causes. (informal deductive)
2)FTA is not Event Tree Analysis which assesses the consequences of given initiating events. (inductive)
3)FTA is not an FMEA which assesses different effects of single basic causes. (inductive)
4)FTA is a formal approach for resolving the basic causes of a given undesired event. (formal deductive)

IX. SUCCESS SPACE AND FAILURE SPACE

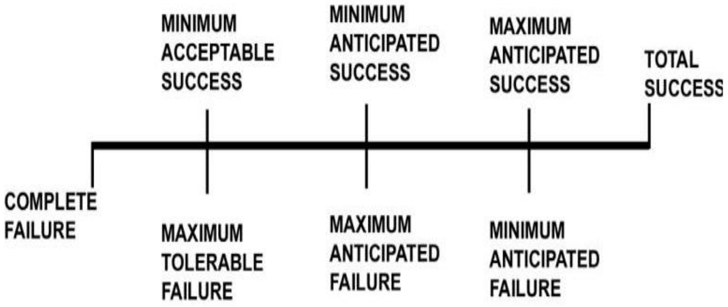
MINIMUM ACCEPTABLE SUCCESS
MINIMUM ANTICIPATED SUCCESS
MAXIMUM ANTICIPATED SUCCESS
TOTAL SUCCESS
COMPLETE FAILURE
MAXIMUM TOLERABLE FAILURE
MAXIMUM ANTICIPATED FAILURE
MINIMUM ANTICIPATED FAILURE

Figure7 Modes in Success Space and Failure Space

X. OPERATION OF FTA IN FAILURE SPACE

The designers design for success.The safety analysts analyze for failure.There can be various degrees of success. Thresholds for failure are identifiable.Failure events can be more readily discretized.Failure quantification's are simpler .The “failure mindset” probes for weaknesses and gaps.

A failure mode is the failure state of the system or component.Examples of failure modes are fail to start, fail to open, fail to shutdown.In contrast, failure mechanisms are the processes by which failures occur.A failure mechanism is only included in the failure mode definition when detailed mechanisms are modeled.

XI. NEED FOR FAULT TREE ANALYSIS

1)To exhaustively identify the causes of a failure
2)To identify weaknesses in a system
3)To assess a proposed design for its reliability or safety
4)To identify effects of human errors
5)To prioritize contributors to failure
6)To identify effective upgrades to a system
7)To quantify the failure probability and contributors
8)To optimize tests and maintenance activities

XII. FTA IN RISK ASSESSMENT AND SAFETY ANALYSIS

FTA is used to resolve the causes of system failure.It is is used to quantify system failure probability.FTA is used to evaluate potential upgrades to a system.It is used to optimize resources in assuring system safety.FTA is used to resolve causes of an incident.It is used to model system failures in risk assessments.

XIII. BENEFITS OF PROPOSED METHOD

The fault tree explicitly shows all the different relationships that are necessary to result in the top event.In constructing the fault tree, a thorough understanding is obtained of the logic and basic causes leading to the top event.
The fault tree is a tangible record of the systematic analysis of the logic and basic causes leading to the top event.The fault tree provides a framework for thorough qualitative and quantitative evaluation of the top event.

XIV. CONCLUSION AND FUTURE WORK

Fault Tree Analysis is backward looking approach.The end result is the analysis starting point.The end result is then traced back one step at a time to its immediate causes.The relationships of the causes, or events, are shown with logic symbols.This backward tracing process continues until the basic causes are identified.FTA systematizes and codifies the process.

Hence in this paper we illustrated how FTA can be used in web applications to enhance its quality.This can also be extended to embedded systems by researching about the uniqueness of embedded systems from the general software system applications accordingly.

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