iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 2 **Issue:** VIII **Month of publication:** August 2014

DOI:

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

ISSN: 2321-9653

INTERNATIONAL JOURNAL FOR RESEARCH IN APPLIED SCIENCE AN D ENGINEERING TECHNOLOGY (IJRASET)

Reengineering Library from Semi-Digital to Digital Library: A Case Study

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Abstract— An easy access to resources of library can make tasks fast and interesting for users (employee, students, etc.). This paper focuses on increasing the ease of utilizing library resources, by reengineering old, obsolete processes of an online library. It focuses on reducing time, cost and efforts of users while improving performance of the library system specially he digital services provided by a library. Unified Modeling Language is used to design the models of existing and reengineered library system. The study reveals the bottlenecks, scarcity of resources and unawareness among the users'. Procurement of resources and user's limited access to resources cause ineffectiveness in system. The proposed model attempts to maintain optimum level of inheritance, polymorphism, coupling and cohesion among classes which provides clean and user friendly functionalities. MOOD Matrices Suite is applied to calculate MHF, AHF, MIF, AIF, PF, and CF of both existing and proposed model. The net effects endeavors the improve efficiency , effectiveness and improved performance of system by providing more in less efforts by enabling the organization to earn an envious of a vibrant, dynamic and progressive status.

Index Terms— Reengineering, Digital Library, Library Management, Metrics, MOOD , UML

I. INTRODUCTION

In developing era, every organization is striving for latest productive and progressive techniques. Reengineering is a never-ending process of improvement in performance and it is applied in every walk of life. In an organization when processes are not user oriented, user then they prove costly and time consuming resulting inefficiency and dissatisfaction. This creates a desperate need to analyze and reengineer the old-fashioned, obsolete and lousy processes to improve performance.

This case study focuses improvement of Traditional Library system by identifying the bottlenecks n the day to day work processes. In a traditional library multiple functions include users' requests, information management, staff activities, database access by user, vendor and shipping company transactions etc. A new model is also suggested concentrating on digital library section. Existing model and proposed model is designed using UML class diagram in Rational Rose Software. UML is a commonly used Unified Modeling Language. It is most popular among Software designers. Further, the improvement is scrutinized using MOOD Metrics Suite.

II. LITERATURE REVIEW

"Reengineering is the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance such as cost, quality, and service and speed". According to Hammer and Champy Reengineering is about reinvention – not improvement or modification. It is similar to starting from scratch [1].

Business Process Reengineering is equally applied in libraries. Business mainly focuses on customers and library focuses on users (students, employees, patrons). Libraries also becoming interested in reducing process overheads and costs. Reengineering is not a new concept in the field of library and information services. [2-6]. It has been applied to collection development and acquisitions [7] , to user services [8],to e-resource acquisition [9],to technical services [10],to knowledge management [11],to cataloging and website [12],to

ISSN: 2321-9653

digital library [13],to library – vendor collaboration [14] ,and to customer services.[6,15].

MOOD Metrics was designed by Fernando Brito e Abreu in 1996[16]. It has been used in measuring performance of Java RMI classes [17] and various other object-oriented software [18,19].MOOD Metrics suit is applied to a number of object oriented software before actually implementing them to find the performance and quality among the various modules in Software Development Life Cycle. UML is used for designing the class diagrams of the existing and proposed model of library .The analysis and designing role of UML is widely recognized. Wamper stated that design and development methodologies have always needed a graphical notation to express the designs [18, 19].Unified Modeling Language uses standard notation. UML diagram is used in designing e-governance services [20, 21] and in various other reengineering projects in public and private sector.

III. "AS –IS" SCENARIO

Library Management System under consideration has following resources.

a. **Book section** includes General Books, Reference Books and Book- Banks. It has details related to title, author, holder and owner of the books.

b. **Person** includes author and reader. Reader section if further segregated into the three sections i.e. student, research scholar and employee.

c. **Library Online System** includes catalog and digital library.

   3.1 **Catalog** provides OPAC (Online Public Access Catalog) and archives facility. Archive has previous details and data of books, authors, publishers, suppliers and vendors. OPAC provide access to user for online resources.

   3.2 **Digital Library** provides four main services i.e. Access, Journals, E-facilities and Government facilities.

d. **Other** facility provided by traditional library consists of vendor, supplier, database etc.

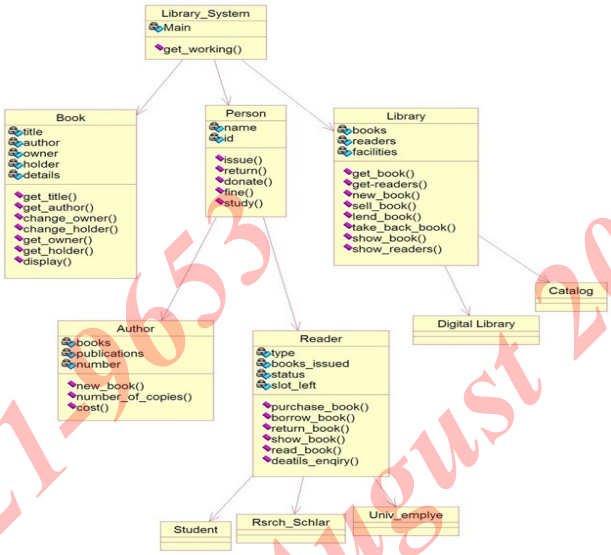

Fig-1. Class Diagram for Existing Library System

DRAWBACKS OF EXISTING SYSTEM

- Access to users is limited.
- E-journals are available in read only format.
- Process of Digitization is slow.
- Access to Government facilities is limited.
- Online Catalog is not accessible all users.
- Under utilization of library resources due to lack of knowledge among users.
- Lack of training programs for students and employees.
- Inadequate communication regarding conference alerts, seminars, training, workshop etc.

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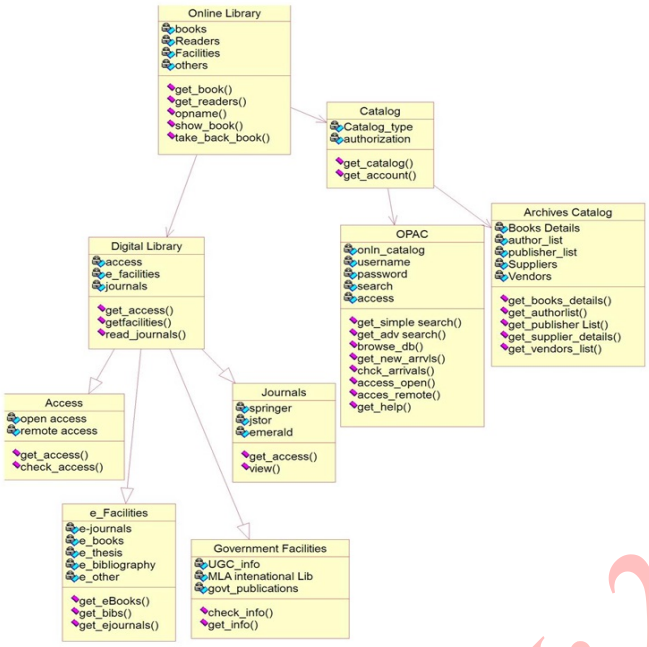

Fig-2. Class Diagram of Online Library in "As-Is" Scenario.

IV. "TO BE" MODEL

METRICS

The metrics set defined by MOOD, includes basic structural related metrics attributes like encapsulation (MHF and AHF), inheritance (MIF and AIF), polymorphism factor (PF), message passing (CF) in reference of object oriented paradigm [22]. MOOD metrics can be summarized as,

1. Encapsulation

- Method Hiding Factor (MHF): It is used to measure the information hiding attribute and can be represented as a ratio of the sum of the invisibilities of all methods defined in all classes to the total number of methods defined in the system.

- Attribute Hiding Factor (AHF): AHF can be defined as a ratio of the sum of the invisibilities of all the attributes defined in all classes to the total number of attributes defined in the system. It is also helpful to determine the information hiding complexity in any object oriented system.

The Method Hiding Factor (MHF) and Attribute Hiding Factor (AHF) metrics were proposed jointly as measures of encapsulation [23]. MHF is defined formally as:

$$\frac{\sum_{i=1}^{TC}\sum_{m=1}^{M_d(C_i)}\left(1 - V(M_{mi})\right)}{\sum_{i=1}^{TC} M_d(C_i)}$$

Where Md (Ci) is the number of methods declared in a class,

$$V(M_{mi}) = \frac{\sum_{j=1}^{TC} is\_visible(M_{mi}, C_j)}{TC - 1}$$

and

Where TC is the total number of classes, and

$$is\_visible(M_{mi}, C_j) = \begin{cases} 1 & iff \quad j \neq i \wedge C_j \text{ may call } M_{mi} \\ 0 & otherwise \end{cases}$$

Thus, for all classes, C1, C2... Cn, a method counts as 0 if it can be used by another class and 1 if it cannot. The total for the system is divided by the total number of methods defined in the system, to give the percentage of hidden methods in the system [24].

2. Inheritance

- Method Inheritance Factor (MIF): It is a ratio of the sum of the inherited methods in all classes to the total number of available methods. MIF has a strong capability to measure the complexity related to message passing dependencies among various methods of different classes.

- Attribute Inheritance Factor (AIF): AIF can be represented as the ratio of the sum of inherited attributes in all classes of the system to the total number of available attributes for all classes. This explores the possibilities of attribute accessibility of different attributed from different classes

- The Method Inheritance Factor (MIF) and Attribute Inheritance Factor (AIF) metrics can be defined as follows:

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$$\frac{\sum_{i=1}^{TC} M_i(C_i)}{\sum_{i=1}^{TC} M_a(C_i)}$$

where

$$M_a(C_i) = M_d(C_i) + M_i(C_i)$$

And

Md (Ci) = the number of methods declared in a class,

Ma (Ci) = the number of methods that can be invoked in association with Ci,

Mi (Ci) = the number of methods inherited (and not overridden) in Ci. For MIF, for each class C1, C2... Cn, a method counts as 0 if it has not been inherited and 1 if it has been inherited. The total for the system is divided by the total number of methods, including any which have been inherited (i.e., methods which are inherited are counted as belonging to their base class as well as to all inheriting subclasses) [25].

3. Coupling

Coupling Factor (CF): It denotes the ratio of the maximum possible number of couplings in the system to the actual number of couplings not imputable to inheritance. CF has been defined formally as:

$$\frac{\sum_{i=1}^{TC}\left[\sum_{j=1}^{TC} is\_client(C_i, C_j)\right]}{TC^2 - TC}$$

Where

$$is\_client(C_c, C_s) = \begin{cases} 1 & iff \quad C_c \Rightarrow C_s \wedge C_c \neq C_s \\ 0 & otherwise \end{cases}$$

And $C_c \Rightarrow C_s$

represents the relationship between a client class, Cc, and a supplier class, Cs.

CF is calculated by considering all possible pair wise sets of classes, and asking whether the classes in the pair are related, either by message passing or by semantic association links (reference by one class to an attribute or method of another class). These relationships are considered to be equivalent as far as coupling is concerned [26], [27].

4. Polymorphism

Polymorphism Factor is a ratio of the actual number of possible different polymorphic situation for a class to the maximum number of possible distinct polymorphic situations for the same class. This factor is helpful to measure the level of polymorphism exhibit by a particular class. It has been defined formally as follows [9]:

$$\frac{\sum_{i=1}^{TC} M_o(C_i)}{\sum_{i=1}^{TC} [M_n(C_i) \times DC(C_i)]}$$

Where

$$M_d(C_i) = M_n(C_i) + M_o(C_i)$$

Mn (Ci) = the number of new methods,

Mo(Ci) = the number of overriding methods,

DC (Ci) = the descendants count (the number of classes descending from Ci).

PF is the number of methods that redefine inherited methods, divided by the maximum number of possible distinct polymorphic situations [28].

"TO BE" MODEL

A Reengineered model for online library is proposed to overcome the drawbacks in existing system. Online Library is divided into three sections i.e. Collection Development, Online Catalog and Digital Library.

1. **Collection Development** provides details about collection of resources to the employees.

2. **Online Catalog** maintains OPAC, Existing Catalog and Networking fields. OPAC provides proper access to all users. Existing Catalog works similar to earlier system. Networking includes Internet, Extranet and Intranet related facilities.

ISSN: 2321-9653

3. **Digital Library** includes eGranthalaya, Digitization, Government facilities and Document Delivery.

3.1 **E-Granthalaya** is shown in Fig-4. It has mainly four sections i.e. eAccess , eResources ,eLearning and eDatabases.

3.1.1 **E-Access** provides remote access, private access, IP address based access, single window access to users. This access provides E-Thesis, conference Alerts and eBooks to the users. E-Thesis gives access to PhD thesis. Conference Alerts are sent to students via email as registered in the online database.

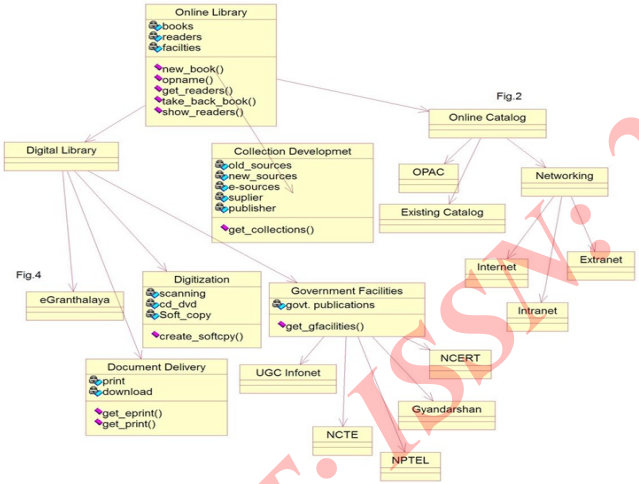

Fig-3. Class Diagram of Proposed model for Online Library

3.1.2 **EResources** include reference books, articles, papers are now available to view, read and print. It also provides access to scan-copy of books, articles, journals.

3.1.3 **ELearning section** gives facility of training, tutorials, e-Tutorials, workshops to staff, students and remote users. It helps to create awareness about facilities of library among users.

3.1.4 **EDatabases** consists of Online Databases of student, employee, books, journals, vendor, supplier, author etc. This database can be accessed by concerned user with user authentication.

EDatabases mainly include three databases i.e. eJournals, eBibliogrpahy and eReferences. EJournals gives access to purchased journals and free journals. EReferences gives details of reference articles and reference book. EBibliogrpahy contains national and international bibliographies which are now accessible to all users.

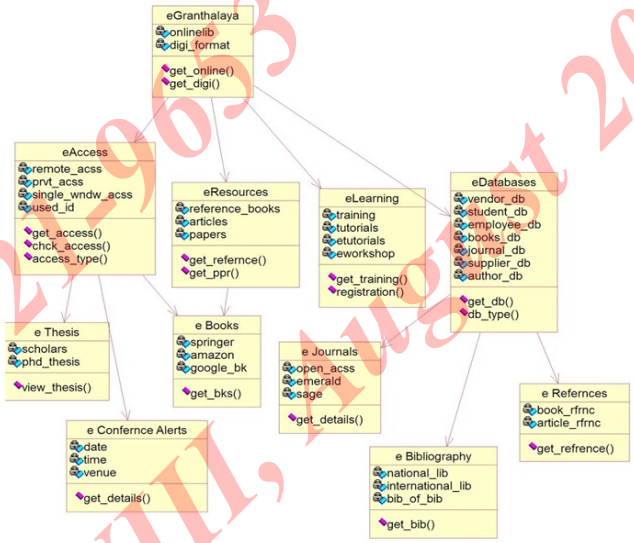

Fig-4. Class Diagram for e-Granthalaya

V. RESULTS AND CALCULATIONS

Results are shown with the help of a table and a bar-graph describing the change in the values of parameters of MOOD Metrics Suite.

Metrics	As-Is Model Values	To-Be Scenario
MHF	0.94	0.75
AHF	0.85	0.63
MIF	1.5	0.75
AIF	0.5	0.35
PF	0.2	0.45
CF	0.1	0.23

Table-1. Comparison table between As-Is Scenario and To-be Scenario of Digital Library.

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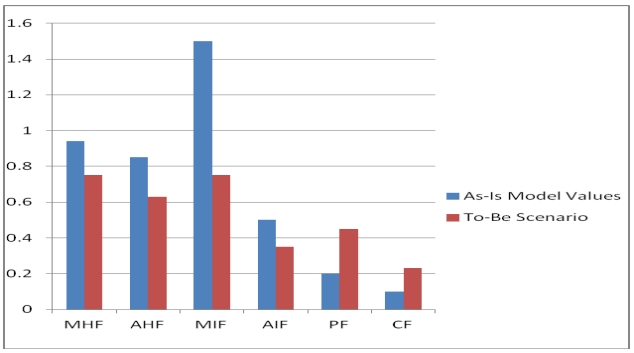

Graph-1.Comparison Graph

Inheritance: - MIF /AIF are the measure of inheritance which shows relations of generalization and specialization. Increased AIF/MIF creates low understandability and testability of the state. 1.5 MIF is reduced to almost half by using optimum levels in inheritance. AIF is also reduced substantially. 1.5 value of existing system shows that it is less specialized as method are inherited and functionalities are reused. In existing system, MIF value 1.5 and 0.5 AIF shows that reuse of functionality is higher than reuse of information data.

Encapsulation: - MHF shows measure for hiding factor. Increased MHF show little functionality. Existing model of digital library shows 0.94 MHF which shows low functionality. The value of MHF in proposed model is 0.75, which increases functionality. Data hiding or designing of attributes is shown by AHF. 0.63 AHF in new system instead of 0.85 AHF means that using class methods data can be accessed more conveniently.

Polymorphism: - 0.2 PF value in existing system shows that system uses less polymorphism. Increased 0.45 PF in proposed system explains increased level of polymorphism.

Coupling: - CF is responsible for message-passing and coupling among modules, which is increased in the proposed model from 0.1 to 0.2 (i.e. 10% to 20 %). New model is more communicative and user-friendly.

VI. CONCLUSION

The proposed model of e-granthalaya is better than existing model. MOOD Metrics suite applied for reengineering the library system yields that new model has better values of AIF,MIF,AHF,MHF,PF and CF. The proposed reengineered model attempts to reduce encapsulation (MHF,AHF) , Reduces Inheritance (MIF,AIF) and increases polymorphism and coupling among modules.

VII. FUTURE SCOPE

Reengineering is a continuous effort to improve the productivity of system while reducing the cost, time and effort. Focus of this paper is reengineering of online library of a University in India. The whole system of library including website and catalog, database, digitization, supply management, knowledge management, computing system, authentication process, collections, vendor management, automation etc. must be reengineered. Reengineering is iterative and mistakes will occur but we must be flexible enough to keep what works and to abandon the rest [29].

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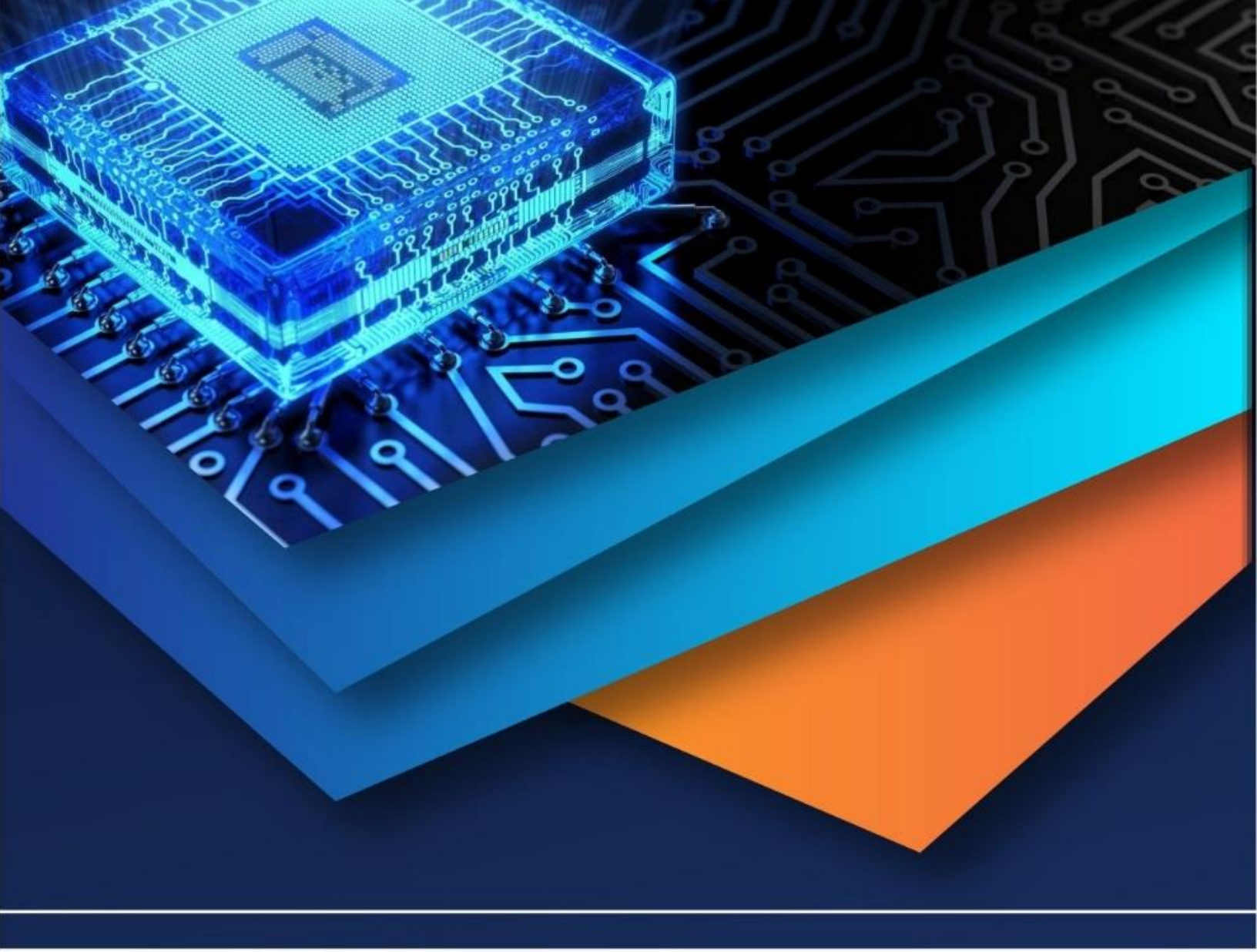

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