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CBM Technique to Secure E-Banking Transaction.

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Abstract: Preserving the confidentiality of user details while doing any kind of financial or money based transaction is of most importance. Thus, this paper focuses to provide a means of protecting or securing the banking transaction of any financial institute, using the concept of CBM. CBM requires certain parameters to be calculated and implemented at the client's side irrespective of any platform. Mobile OTP generation concepts will also be used to generate time limited password for authentication of users. AES encryption algorithm will be used in modified version mainly called as Modifies-AES, where we will use 128-bit permutation instead of two 64-bit permutation operations. Consumers demand E-banking system must implement robust E-banking Identification and Authentication System (eIDAS). Thus, this paper also describes, a set of Challenges and Recommendations to be considered in any eIDAS.

Keywords: CBM (Confidential Building Matrix), OTP (One Time Password), eIDAS (E-banking Identification and Authentication System), Encryption, Modified AES (Advanced Encryption Standard), Cryptography.

I. INTRODUCTION

Every bank account user who is registered with the bank and is identified by the bank will be a legitimate user for online banking and transaction service. Thus, the customers of such a service assume that the transaction is most secure for successful completion. The biggest concern of online bank users is the confidentiality of their personal and banking details.

Thus, to maintain the security of this banking transaction, we will need a trusted third party who holds the identity certificate for authentication of a valid sender and receiver. Lack of security may result in serious damage and severe lost of capital for that particular institute [1]. Hackers have many different schemes that they apply to break and breach any system. Thus, a secured end-to-end transaction requires a secured protocol to communicate over untrusted channels [1]. In the systems, where there is no authentication check, file content read from the server are not authenticated in any secure manners. Consequently, the client does not have any mechanism to determine the bytes are indeed send by the true server and not the hacker [18].

They are various algorithms for encryption to determine the security of any online system or banking transaction. They are DES, RCA and AES. Most of them are conventional encryption hash algorithms to implement various security schemes. However, over a long period of time it is very difficult to ensure enough adequate security.

This paper refers to the technique of CBM along with mobile-OTP generation to secure transactions done from financial institutes. It will also reflect modified-AES as a means of encryption algorithm. This paper also discusses the challenges as well as recommendations on E-Banking systems.

This paper is organised as follows, Section II deals with the objective of research work. Section III, we have Challenges and recommendation that are periodically been faced by this E-Banking institutes while implementing security measures. Section IV, discusses the methodology of research which includes the proposed modules along with modified-AES encryption algorithm. Section V, has an overlook at the main concept of CBM followed by Mobile-OTP generation been explained in details in Section VI. The last Section VII, concludes this paper of research.

II. OBJECTIVE

Attackers have the capability to destroy and form any system needed using many ways and schemes. Thus, this research work enables you to create a robust system to protect and ensure the security of any E-Banking system or financial institute. Following are the objective of this research.

1) Create a system using CBM and Mobile-OTP to ensure secured financial transactions.
2) To ensure secure end – to – end transactions to be communicated over untrusted channels.
3) To make the customers realise the vulnerabilities of online transaction systems and thus educate effective methodologies and practises for the same.
4) Provide high level of security to banking and E-commerce to our financial institutes.

III. CHALLENGES AND RECOMMENDATIONS

This section of the paper focuses on the main challenges that are usually been found in an E-Banking institute and thus suggest a set of recommendations for the same.

A. Challenge

Promote adequacy of eIDAS to content.

1) Recommendation

a) It is always recommended that risk associated to the operation should be always proportional to the strength of any eIDAS.

b) For medium and high risk transaction, customers need to be identified and authenticated through a strong authentication mechanism.

c) It is also said that an Authentication system should be build on "something user **have**" and not only "something users **know**".

d) It is also suggested that that in case of medium and high risk operations, at least two eIDAS should be implemented using different communication channels or devices.

B. Challenge

To improve the knowledge and behaviour of the customers and professionals.

1) Recommendation

a) To improve perception between customers and professional the actual risk associated to E-banking transaction and eIDAS, continuous training of the customers and professional is needed, keeping in mind the latest threats and attacks methodologies of the criminals.

b) In order to make the customers feel comfortable with the eIDAS, the professional of this financial institute are responsible for training their customers in effective manner.

c) Taking into considerations actual threads to the Operating System and security issues, technology provided must guarantee security and user-friendly development of banking transactions and eIDAS application.

d) It is must for an E-banking institute to do the distribution of these applications through trusted channels and reputed websites, which guarantee that the applications have been tested for security.

C. Challenge

Risk Reduction

1) Recommendation

a) To reduce the risk in financial organisations, they must perform specific risk analysis, taking into consideration of the following points – actual loss, number of incidents, number and type of customers involved and vulnerabilities of authentication methods available.

b) Then based on the above parameters and analysis, institute should choose such an eIDAS that effectively reduces risk and loss of money.

c) Customer's authentication has to be implemented continuously and strategies such as customer's behaviour including log-in attempts, time-out, transaction history, browsing profile, transaction limits and destinations should be monitored for analysis.

d) It is also recommendation to register the devices, browsers and mobile application usually used by customers and also the Banking institutes.

IV. METHODOLOGY

The Methodology proposed in this research work is explained in this section. This section is divided into two parts, in the first part we will be looking at the modules of the system and in the second part, we will be looking at the proposed algorithm for encryption.

A. Proposed Modules

1) User Registration & Login: The user will be facilitated to register here based on his credit card details for net-banking and execute login operation based on credentials specified therein and by use of CBM analysis.

2) Machine Detection: The system will track the devices used for registration and each login executed by each user to include the following parameters MAC id, Time slot used for access, IP address of the machine as per CBM analysis.

3) OTP Authentication: After machine detection after login mechanism using CBM analysis, the system will generate validity status as valid or invalid. For invalid status the system will generate a random key for OTP verification which will transmitted on email or SMS (paid service) to ensure users authenticity.

4) *E-banking features:* This module will consist of banking features containing view of account details, view account balance, transfer amount to particular account no specified, mobile recharge using current balance, pay credit card bills
5) *Transaction Security:* This module will facilitate ensuring security of data of each transaction (account no and amount) with modified AES during storage in database.

B. Modified AES (Advanced Encryption Standard).

AES-128 makes use of 128 bit of cipher key and 128 bits of data block. It performs K rounds (K= 10 for 128 bit AES) of encryption before finally gives the cipher text. Four operations are performed while encryption namely as substitute byte, shift row, mix column and add round key. The key expansion unit generates ten keys of 128 bits each required by all the ten rounds. The decryption process is just the reversed method where the cipher text is fed as input to the system. After completing Nr rounds (Nr= 10 for 128 bit AES) of decryption the final plain text is generated. In the last round the Mix-column sub-process is bypassed. The decryption process also makes use of four sub processes, namely as inverse substitute byte, inverse shift row, inverse add round key and inverse mix column. The inverse mix-column sub-process is bypassed in the last round of decryption process.

It has been found that the mix-column in encryption and inverse mix-column in decryption are most computational and hence consumes large amount of clock period. The increased clock period reduces the throughput and it has been found that mix-column and inverse mix-column operations consume the highest dynamic power consumption. Hence we are suggesting a modified algorithm for AES, in which substitute byte, shift row will remain as in the original AES while mix column operation is replaced by 128 permutation operation followed by add round key operation. This permutation operation is similar to the one done in DES algorithm but with 128 bits instead of two 64 bit permutations. The 128 bit encryption will be done as shown in the Figure 1. The decryption will be done as shown in the Figure 2. The similarity in the encryption and decryption architecture is an added advantage while implementing on the any of the hardware platforms. The permutation box and inverse permutation box used in our algorithm are as shown in Figure 5.

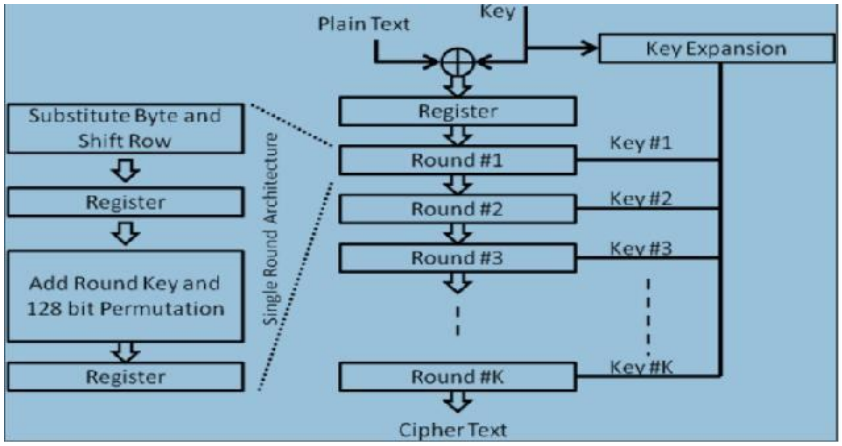

Figure 1. 128 bit AES Encryption

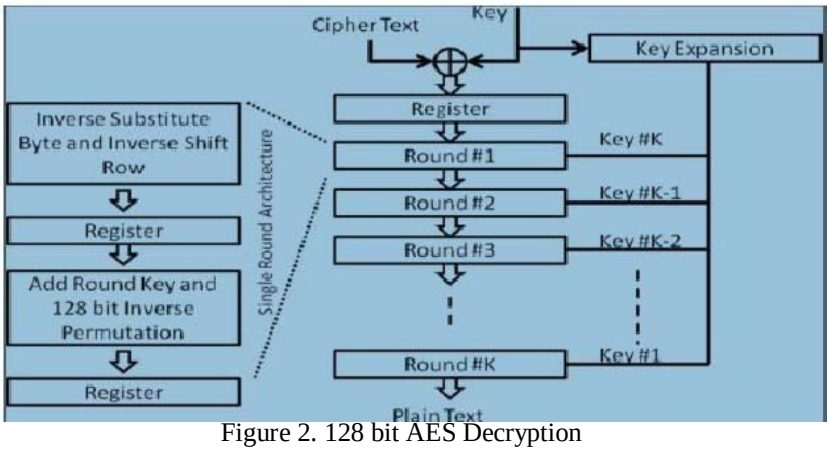

Figure 2. 128 bit AES Decryption

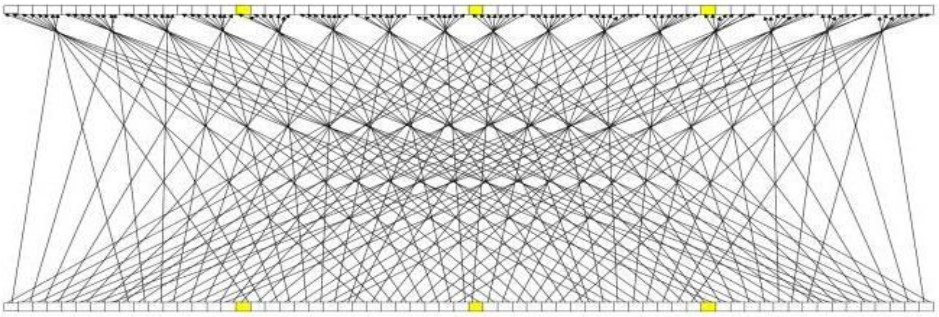

Figure 3. Permutation box implementation

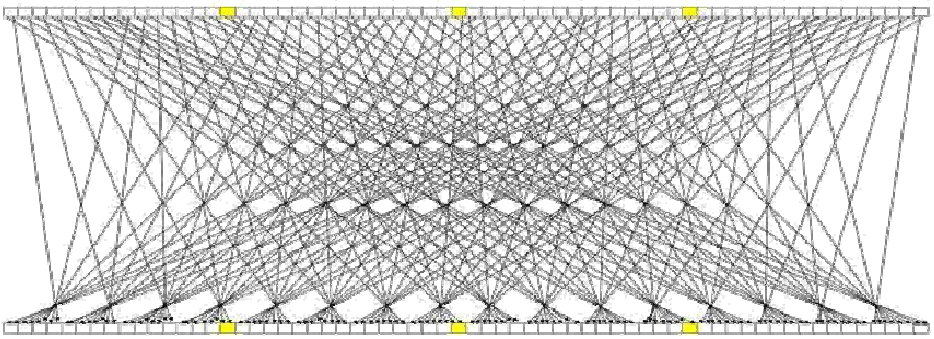

Figure 4. Inverse Permutation box implementation

114	98	82	66	50	34	18	2	116	100	84	68	52	36	20	4
118	102	86	70	54	38	22	6	120	104	88	72	56	40	24	8
122	106	90	74	58	42	26	10	124	108	92	76	60	44	28	12
126	110	94	78	62	46	30	14	128	112	96	80	64	48	32	16
113	97	81	65	49	33	17	1	115	99	83	67	51	35	19	3
117	101	85	69	53	37	21	5	119	103	87	71	55	39	23	7
121	105	89	73	57	41	25	9	123	107	91	75	59	43	27	11
125	109	93	77	61	45	29	13	127	111	95	79	63	47	31	15

Figure 5 (a) Permutation box

72	8	80	16	88	24	96	32	104	40	112	48	120	56	128	64
71	7	79	15	87	23	95	31	103	39	111	47	119	55	127	63
70	6	78	14	86	22	94	30	102	38	110	46	118	54	126	62
69	5	77	13	85	21	93	29	101	37	109	45	117	53	125	61
68	4	76	12	84	20	92	28	100	36	108	44	116	52	124	60
67	3	75	11	83	19	91	27	99	35	107	43	115	51	123	59
66	2	74	10	82	18	90	26	98	34	106	42	114	50	122	58
65	1	73	9	81	17	89	25	97	33	105	41	113	49	121	57

Figure 5(b) Inverse Permutation box.

In our security algorithm, except the replacement of Mix-column with permutation operation and replacement of Inverse Mix-column with Inverse Permutation box as shown in Figure 4 and 5, where the data scrambling is between 128 bits rather than 64 bits, which increases the more resistance to attacks compared to 64 bit permutation boxes. The rest of the encryption and decryption process would remain similar to the original 128 bit AES, as shown in Figure 1 and Figure 2. Our modified algorithm has 10 rounds

of key expansion and 10 rounds of encryption. The decryption process requires the round key in the reverse order to that of encryption. The same round keys generated while encryption are used for decryption.

The implementation environment was as follows:

1) The Permutation box is of 128 bit instead of two 64 bit permutations. This reduced the computation time further and the inter bit delay differences achieved are very less.

2) The implementation was on a dedicated hardware designed for the algorithm on 180nm CMOS technology. Therefore, the over heads of the processor and OS performance were taken into consideration. The original AES implementation was done by authors on the same FPGA platform [17]. The highest throughput achieved was 1Gbps using rolled architecture of 128 bit data bus. Our implementation of modified AES using the rolled architecture of 128 bit data bus achieved a throughput of 2.087Gbps on Xilinx Vertex4 FPGA. The only drawback of our method is larger memory used for storing the 128bit permutation box.

The implementation results for our design are:

a) The design was successfully clocked at 163MHz.

b) Total gates required for encryption and decryption were: 107K gates (including memory in equivalent gate terms).

c) The throughput is 163MHz*128/10 = 2.087Gbps.

d) Power consumption is 23.84mw at 163Mz.

e) The scrambling of data bits with our permutation box has resulted into less inter-path delay differences.

We achieved a throughput of 2.087 Gbps which means 16.305M, 128 bit blocks per sec. OR 61.332ns for each block of 128 bit data. We have tested on Vertex 4 FPGA platform. The most important contribution of our implementation is that the inter bit delay differences are very less. The maximum delay between the most critical path and shortest data path from input to output is found to be 1.0118ns. This result has helped us in reducing the clock period, as the data arrival uncertainty was reduced. The table below summarizes the comparison among different AES designs [1].

V. CONFIDENTIAL BUILDING METRIC (CBM)

As mentioned in earlier sections, every account holder (client) registered and identified by the Bank will be able to use online banking and transaction services. Every transaction done by the client with the bank is encrypted using 128 bit modified AES described above. The primary concern in this part of the design is the key distribution. The key has to be renewed every time whenever the bank asks to change the access and transaction password of the client. This is normal practice with the banks to request or make it mandatory to the client to change the access and transaction passwords regularly. The passwords are expired after every certain period is passed. We additionally suggest another level of security using Confidence Building Metric (CBM). Such that, in order to increase the protection by still getting faster computation, we may use the concept of Confidence Building Metrics (CBMs) based on the certain parameters of access to the bank portal by the account holder. The CBM is mapped on a scale of 0 to 10. The value of CBM increments with the following list of events as mentioned below:

1) MAC id of the computer regularly used

2) Time slot in day or night whichever is used often or regularly

3) IP address of the machine regularly used for transaction

4) Use of virtual keyboard used every time the transactions made

5) Amount of transaction within a certain limit pre-declared by the client

Each of these parameters or events mentioned above increments the CBM by certain value. The distribution of these values can be a design consideration of the bank. Similarly the CBM also decrements whenever certain events do occur as mentioned below:

6) New MAC id used other than the regularly one

7) Transactions being done at odd hours others than the regular ones

8) Different IP address of the machine or device other than the regular one

9) Virtual keyboard not used

10) Amount of transaction exceeds the pre-declared limit. New access and transaction password set.

The banks will maintain a set of security questions already configured or registered by the client. The banks may make the registration of security questions and their answers mandatory. Whenever the CBM decrements than the previous value an additionally security question is asked to the client from the set on random basis. And whenever the CBM increments no security questions are asked and the transaction can be done based on the access and transaction passwords while encryption is compulsorily

done for every data transfer. This makes a three tier system of verification and validation of the genuine client requesting the transaction. This three tier system is as shown in Figure 6.

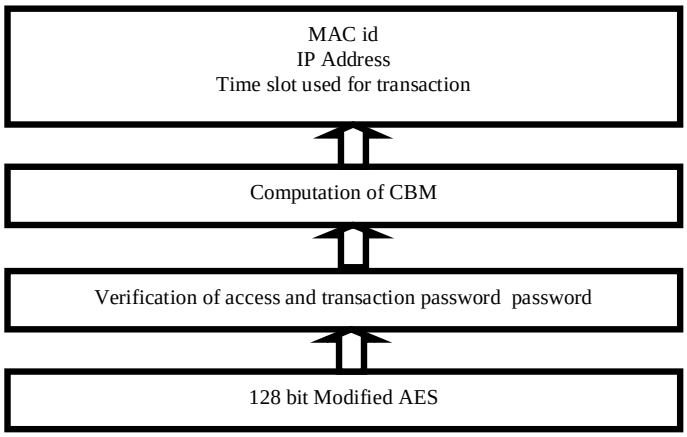

Figure 6. Tier structure of security system

The advantage of the above system is that it can be implemented on any platform at the client side including even the mobile phones with any OS [1].

VI. MOBILE - OTP GENERATION.

An OTP is a generated password which only valid once. The user is given a device that can generate an OTP using an algorithm and cryptographic keys. On the server side, an authentication server can check the validity of the password by sharing the same algorithm and keys.

Several software or devices can be used to generate the OTP, for example personal digital assistants, mobile phones, dedicated hardware tokens as it the most secure smart cards is devices among all the OTP generator provide tamper-resistant two-factor authentication: a PIN to unlock the OTP generator (something you know), and the OTP smart card itself (something you have). Figure 7 illustrates the three steps that required to generate an OTP: the collection of some external data, such as the time for synchronous OTP or a challenge for an asynchronous OTP, a ciphering algorithm with secret keys shared by the device and the authentication server, and finally a formatting step that sets the size of the OTP to typically six to eight digits[8].

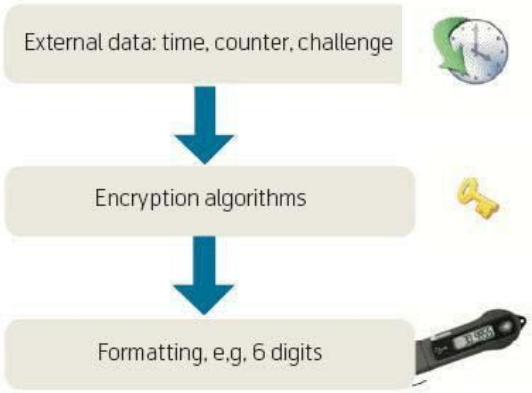

Figure 7. The generation of One-Time passwords

Until recently, OTP solutions were based on proprietary and often patented time-based or event-based algorithms. In 2005, OATH-HOTP [16] was defined as an open standard by major actors in the industry. This open standard allows multi-sourcing of the OTP

generating devices and authentication servers from different vendors. The HOTP algorithm is based on a secret key and a counter shared by the device and the server, and uses standard algorithms such as SHA-1 and HMAC.

OTP has carried more advantages over PKI as it does not require the deployment of smart card readers, drivers and PC software. However in terms of features, OTP only provides identification and authentication, whereas PKI provides addition encryption and signature. OTP being a password-based authentication is also vulnerable to man-in-the-middle attacks, such as phishing scams. Since there is no mutual authentication of the PC and the internet service provider server, an attacker can intercept an OTP using a mock-up site, and impersonate the user to the real internet web site.

The proposed authentication system performed the user authentication and digital signatures using authorized certificates in the same way as the existing authentication. To recognize and convert the code, we generate the mobile OTP code into a two-dimensional barcode using user's transfer information (TI), requested transfer time (T) and the hashed serial number (SN) of user's mobile device instead of security card. The authentication process of proposed system is shown below the Fig. 8.

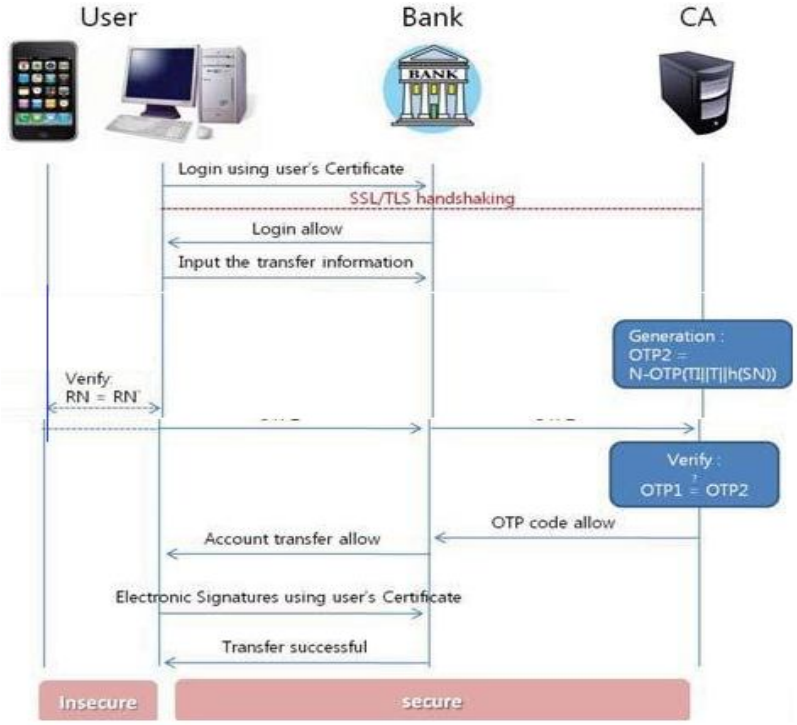

Figure 8. A propose Authentication System

1) When user execute the generated OTP, mobile device generate the OTP by reads the transfer information (TI), perceived value of time (T) and hashed serial number (SN) of user's mobile device are shared with the certification authority (CA). And output the generated OTP on the screen of mobile devices.
2) User input the generated OTP code from mobile device on the screen.
3) Server (Bank) sent OTP to certification authority (CA) to received OTP from user.
4) Certification authority (CA) compared by received OTP code (OTP1) and generated the OTP code (OTP2), sent to server (Bank) to for OTP code approval.
5) When the server (Bank) received approve of OTP from certification authority (CA), it will verify the entered OTP code with user consistent value and user digital signature. If the approve of OTP value does not receive, the transfer will be canceled.
6) Authorized user signed his certificates to complete the transfer.
7) Server (Bank) to verify the digital signature and final approve of transfer.

VII. CONCLUSION

E-banking is a form of banking where money is transferred through an exchange of electronic signals between financial institutions. The security of data record transaction has brought many concerns from different perspectives: government, businesses, banks, individuals and technology. Financial institutions are achieving the security of e-Banking data record transaction by methods of

cryptography, which deals with encryption of data. Here we have proposed a new encryption algorithm that is based on AES using open source symmetric key encryption algorithm. This modified AES algorithm provides better security for the e-banking services and overcomes the problem of computational overhead by reducing the calculation time of the algorithm Comparative study with traditional encryption algorithms is shown the superiority of the modified algorithm. A new innovated E-Banking Security Tier using Confidence Building Metric (CBM) and Modified AES was presented to be another level of protection. The CBMs are computed based on certain parameters and can be implemented on any platform at the client side. Some improvements on the deployment of our modified AES will be considered as a future work taking into consideration on the importance1 level of each e-banking transaction record.

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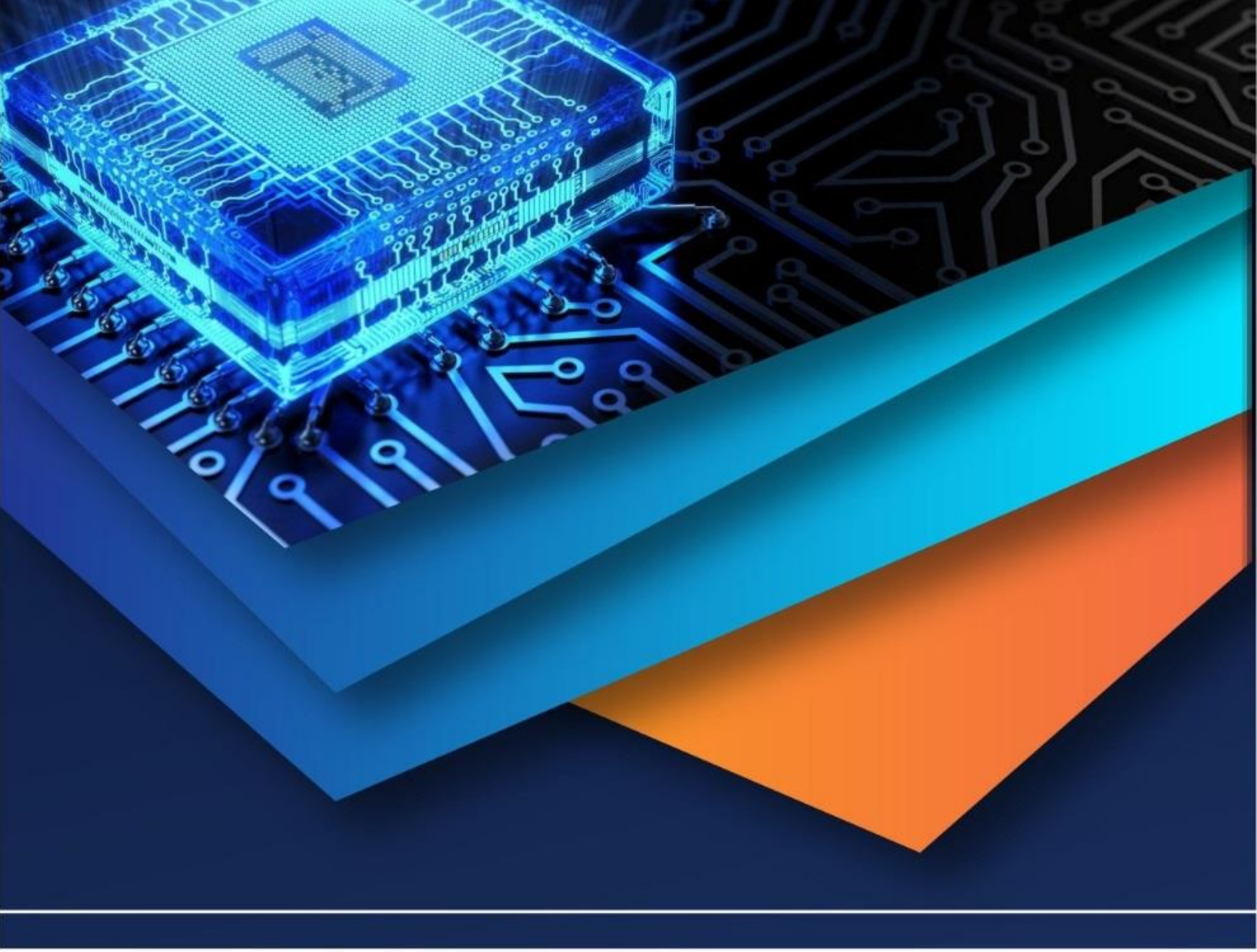

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