

The Algorithm Analysis of Electronic Payment Systems

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Abstract: *The buying and selling of products and services by businesses and consumers without using any paper documents , through an electronic medium is e-commerce. It also includes transactions over the internet that is through electronic measures. There are various types of electronic payment systems and its issues. E-payment system can be classified into four categories: electronic cash system, electronic cheque system, online credit card payment system and smart cards . There are few algorithms to analyze the security levels in these electronic payments systems, and makes the transactions for the user trust worthy.*

Keywords: electronic payment system, authentication factor

1. Introduction

Online Transactions through e-payment system is a process of online payment of products and services with the help of internet directly from bank using its features such that amount of money taken from a payer and money is given to payee . The two most important things we look for in e-payment systems are the order of information and the payment instructions . There are certain algorithms described in this paper that can be used to implement the security of online transactions.

2. Categories of Electronic Payment Systems

Electronic payment has revolutionized the business processing by reducing paper work, transaction costs, labour cost. Being user friendly and less time consuming than manual processing, helps business organization to expand its market reach / expansion. Some of the modes of electronic payments are following.

- Credit Card
- Debit Card
- Smart Card
- E-Money
- Electronic Fund Transfer (EFT)

2.1 Credit Card

Payment using credit card is one of most common mode of electronic payment. Credit card is small plastic card with a unique number attached with an account. It has also a magnetic strip embedded in it which is used to read credit card via card readers. When a customer purchases a product via credit card, credit card issuer bank pays on behalf of the customer and customer has a certain time period after which he/she can pay the credit card bill. It is usually credit card monthly payment cycle. Following are the actors in the credit card system.

- The card holder - Customer
- The merchant - seller of product who can accept credit card payments.
- The card issuer bank - card holder's bank

- The acquirer bank - the merchant's bank
- The card brand - for example , visa or master card.

Table 1: Credit card payment process

Step	Description
1.	Bank issues and activates a credit card to customer on his/her request.
2.	Customer presents credit card information to merchant site or to merchant from whom he/she want to purchase a product/service.
3.	Merchant validates customer's identity by asking for approval from card brand company.
4.	Card brand company authenticates the credit card and paid the transaction by credit. Merchant keeps the sales slip.
5.	Merchant submits the sales slip to acquirer banks and gets the service charges paid to him/her.
6.	Acquirer bank requests the card brand company to clear the credit amount and gets the payment.
7.	Now card brand company asks to clear amount from the issuer bank and amount gets transferred to card brand company.

2.2 Debit Card

Debit card, like credit card is a small plastic card with a unique number mapped with the bank account number. It is required to have a bank account before getting a debit card from the bank. The major difference between debit card and credit card is that in case of payment through debit card, amount gets deducted from card's bank account immediately and there should be sufficient balance in bank account for the transaction to get completed. Whereas in case of credit card there is no such compulsion.

Debit cards free customer to carry cash, cheques and even merchants accepts debit card more readily. Having restriction on amount being in bank account also helps customer to keep a check on his/her spendings.

2.3 Smart Card

Smart card is again similar to credit card and debit card in appearance but it has a small microprocessor chip embedded in it. It has the capacity to store customer work

related/personal information. Smart card is also used to store money which is reduced as per usage.

Smart card can be accessed only using a PIN of customer. Smart cards are secure as they store information in encrypted format and are less expensive/provide faster processing. Mondex and Visa Cash cards are examples of smart cards.

2.4 E-Money

E-Money transactions refer to a situation where payment is done over the network and the amount gets transferred from one financial body to another financial body without any involvement of a middleman. E-money transactions are faster, convenient and save a lot of time.

Online payments done via credit card, debit card or smart card are examples of e-money transactions. Another popular example is e-cash. In case of e-cash, both customer and issuer issue e-cash.

2.5 Electronic Fund Transfer (EFT)

It is a very popular electronic payment method to transfer money from one bank account to another bank account. Accounts can be in the same bank or different banks. Fund transfer can be done using ATM (Automated Teller Machine) or using a computer.

Nowadays, internet-based EFT is getting popularity. In this case, the customer uses the website provided by the bank. The customer logs in to the bank's website and registers another bank account. He/she then places a request to transfer a certain amount to that account. The customer's bank transfers the amount to the other account if it is in the same bank; otherwise, the transfer request is forwarded to ACH (Automated Clearing House) to transfer the amount to the other account and the amount is deducted from the customer's account. Once the amount is transferred to the other account, the customer is notified of the fund transfer by the bank.

3. Live Examples

3.1 PayPal

PayPal is a global e-commerce business allowing payments and money transfers to be made through the Internet. Online money transfers serve as electronic alternatives to paying with traditional paper methods, such as cheques and money orders. It is subject to the US economic sanction list and other rules and interventions required by US laws or government. PayPal is an acquirer, performing payment processing for online vendors, auction sites, and other commercial users, for which it charges a fee. It may also charge a fee for receiving money, proportional to the amount received. The fees depend on the currency used, the payment option used, the country of the sender, the country of the recipient, the amount sent and the recipient's account type. In addition, eBay purchases made by credit card through PayPal may incur extra fees if the buyer and seller use different currencies. On October 3, 2002, PayPal became a wholly owned subsidiary of eBay. Its corporate headquarters are in

San Jose, California, United States at eBay's North First Street satellite office campus. The company also has significant operations in Omaha, Scottsdale, Charlotte and Austin in the United States; Chennai in India; Dublin in Ireland; Berlin in Germany; and Tel Aviv. PayPal has operated across the European Union as a Luxembourg-based bank.

3.2 Mobile Money Wallets

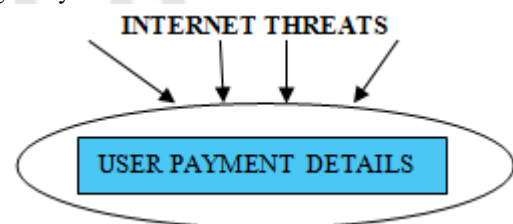
In undeveloped countries, the banked population is very less, especially in tier II and tier III cities. Taking the example of India, there are more mobile phone users than there are people with active bank accounts. Telecom operators, in such geographies, have started offering mobile money wallets which allow adding funds easily through their existing mobile subscription number, by visiting physical recharge points close to their homes and offices and converting their cash into mobile wallet currency. This can be used for online transactions and e-commerce purchases. Many payment options such as Airtel Money and M-Pesa in Kenya, ATW are being accepted as alternate payment options on various e-commerce websites. In Israel, from July 2007

4. Analysis of Authentication Mechanism of E-Payment System

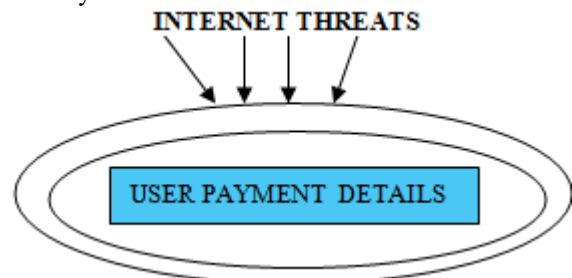
Authenticity of data plays a very important role in terms of security in e-payment systems. User payment details are the main information that must be kept authenticated and hidden from being revealed in any online transactions. There are various methods for authenticating the user details by multiple layers of protection. Greater the number of layers of protection, greater is the authenticity. The different security credentials in these layers are PIN, cryptographic key, digital signature, biometrics such as fingerprint etc.

The different layers of authentication can be easily understood by the diagrams in figure 1.

I. Single Layer Authentication Mechanism



II. Dual Layer Authentication Mechanism



III. Triple Layer Authentication Mechanism

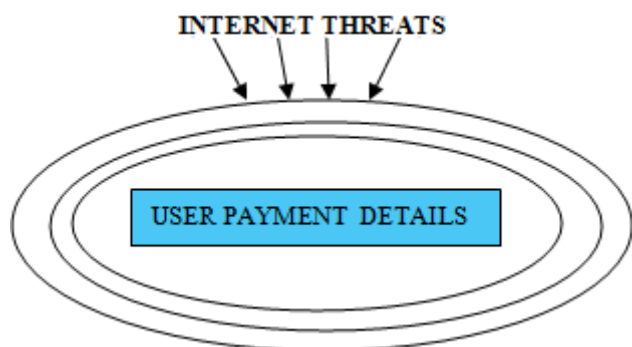


Figure 1: Layers of Authentication factor mechanism

The different electronic payment systems illustrated so far exhibit different levels of authentication factors. The authentication-factor determines the extent to which an electronic payment system is secured. A single-factor authentication mechanism uses or requires a user to prove his or her identity with an item of data only. This means that the electronic payment system is easily compromised if this single authentication-factor fails. A two-factor authentication presents two independent pieces of information in two coherent and dependent steps of just one single process whereas, A three-factor authentication presents three independent pieces of information in three coherent and dependent steps of just one single process. Authentication by multiple independent factors seeks to decrease the success that the requester is presenting false evidence of its identity in multiple independent, but coherent processes. The number and independency of factors is important, since more independent factors imply higher probabilities that the bearer of the identity evidence indeed holds that identity in another realm. Table 2 shows the categories of electronic payment systems with their number of authentication-factor and authentication types.

Table 1: Electronic Payment Systems with their authentication factors and types

Type of e-payment System	Authentication Factor	Authentication Type
Credit Card	2	PIN, Digital Signature
Debit Card	2	PIN, Digital Signature
Smart Card	3	PIN, Digital Signature , Biometric (Finger print)
E-Money	1	Token Encryption
EFT	2	PIN, Digital Signature

5. Conclusion

This paper describes the electronic payment systems in online transactions. It is briefly explained in the paper the categories of electronic payment systems and its working . The paper also demonstrates the analysis of the authentication mechanisms in these payment systems . Finally the analysis reveals that more the number of authentication factors in the payment system, more secured the system is.

Future work, will contain more description of the above authentication analysis. Further, we will show different cryptographic algorithms which can be applied in these

electronic payment systems such as user anonymity, payer anonymity, payment transaction untraceability, confidentiality of transaction data etc .

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