

## 12. SECURE ELECTRONIC TRANSACTION

SET is an open encryption and security specification designed to protect credit card transaction on the Internet. The current version, SETv1, emerged from a call for security standards by MasterCard and Visa in February 1996. A wide range of companies were involved in developing the initial specification, including IBM, Microsoft, Netscape, RSA, VeriSign, and Visa. Beginning in 1996, there have been numerous tests of the concept, and by 1998 the first wave of SET – compliant products was available.

- Provides a secure communications channel among all parties involved in a transaction
- Provides privacy because the information is only available to parties in a transaction when and where necessary
- Provides trust by the use of X.509v3 digital certificates

### 12. 1. Requirements:

◆ **provide confidentiality of payment and ordering information:** It is necessary to assure cardholders that this information is safe and accessible only to the intended recipient. Confidentiality also reduces the risk of fraud by either party to the transaction or by malicious third parties. SET uses encryption to provide confidentiality.

◆ **ensure the integrity of all transmitted data:** That is, ensure that no changes in content occur during transmission of SET messages. Digital signatures are used to provide integrity.

◆ **provide authentication that a cardholder is a legitimate user of a credit card account:** A mechanism that links a cardholder to a specific account number reduces the incidence of fraud and the overall cost of payment processing. Digital signatures and certificates are used to verify that a cardholder is a legitimate user of a valid account.

◆ **provide authentication that a merchant can accept credit card transactions through its relationship with a financial institution:** This is the complement to the preceding requirement. Cardholders need to be able to identify merchants with whom they can conduct secure transactions. Again, digital signatures and certificates are used.

◆ **Ensure the use of the best security practices and system design techniques to protect all legitimate parties in an electronic commerce transaction:** SET is a well-tested specification based on highly secure cryptographic algorithms and protocols.

◆ **Create a protocol that neither depends on transport security mechanisms nor prevents their use:** SET can securely operate over a ‘raw’ TCP/IP stack. However, SET does not interfere with the use of other security mechanisms, such as IPSec and SSL/TLS.

◆ **Facilitate and encourage interoperability among software and network providers:** The SET protocols and formats are independent of hardware platform, operating system, and web software.

Secure Electronic Commerce Components are given in Fig. 12. 1

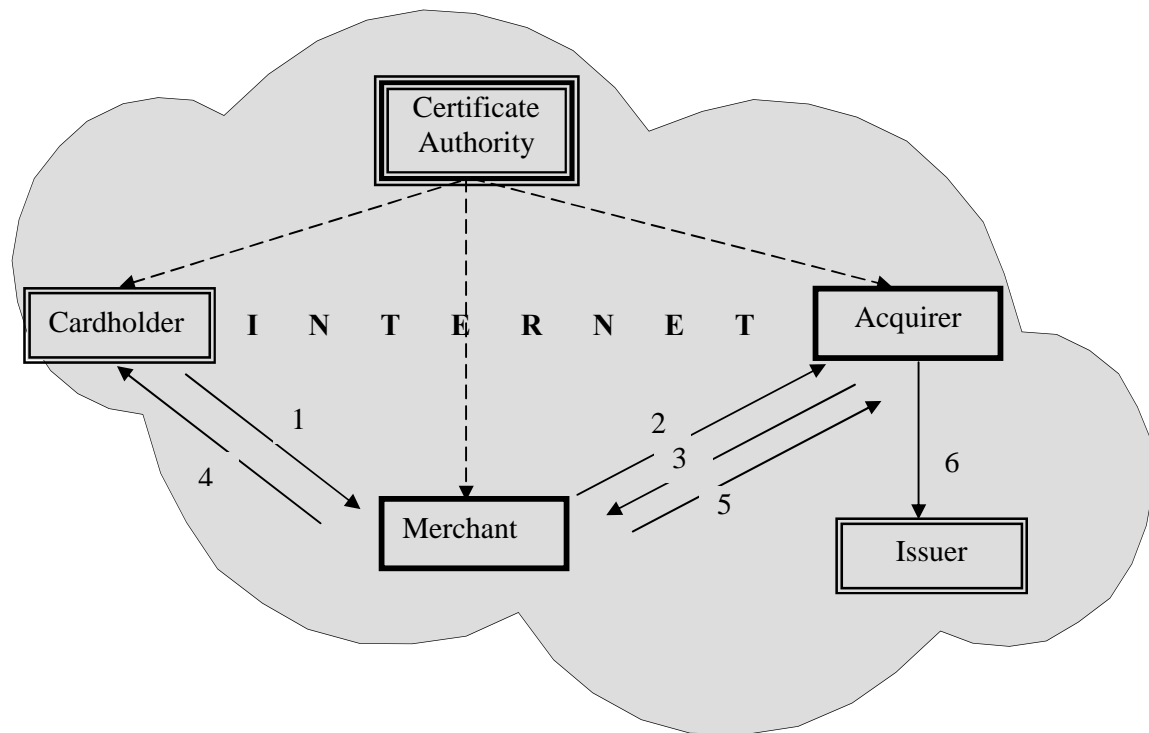


Fig. 12. 1

## 12.2. Key Features of SET:

◆ **Confidentiality of information:** cardholder account and payment information is secured as it travels across the network. An interesting and important feature of SET is that it prevents the merchant from learning the cardholder's credit card number; this is only provided to the issuing bank. Conventional encryption by DES is used to provide confidentiality.

◆ **Integrity of data:** payment information sent from cardholders to merchants includes order information, personal data, and payment instructions. SET guarantees that these message contents are not altered in transit. RSA digital signatures, using SHA-1 hash codes, provide message integrity. Certain messages are also protected by HMAC using SHA-1.

◆ **Cardholder account authentication:** SET enables merchants to verify that a cardholder is a legitimate user of a valid card account number. SET uses X.509v3 digital certificates with RSA signatures for this purpose.

◆ **Merchant authentication:** SET enables cardholders to verify that a merchant has a relationship with a financial institution allowing it to accept payment cards. SET uses X.509v3 digital certificates with RSA signatures for this purpose.

## 12. 3. SET Participants

Indicates the participants in the SET system, which include the following:

♦ **Cardholder:** In the electronic environment, consumers and corporate purchasers interact with merchants from personal computers over the Internet. A cardholder is an authorized holder of a payment card that has been issued by an issuer.

♦ **Merchant:** A merchant is a person or organization that has goods and services to sell to the cardholder. Typically, these goods and services are offered via a Web site or by electronic mail. A merchant that accepts payment cards must have a relationship with an acquirer.

♦ **Issuer:** This is a financial institution, such as a bank, that provides the cardholder with the payment card.

♦ **Acquirer:** This is a financial institution that establishes an account with a merchant and processes payment card authorizations and payments. Merchants will usually accept more than one credit card brand but do not want to deal with multiple bankcard associations or with multiple individual issuers. The acquirer provides authorization to the merchant that a given card account is active and that the proposed purchase does not exceed the credit limit. The acquirer also provides electronic transfer of payments to the merchant's account.

♦ **Certification Authority (CA):** This is an entity that is trusted to issue X509v3 public-key certificates for cardholders, merchants, and payment gateways. The success of SET will depend on the existence of a CA infrastructure available for this purpose.

1. **The customer opens an account.** The customer obtains a credit card account, such as MasterCard or Visa, with a bank that supports electronic payment and SET.
2. **The customer receives a certificate.** After suitable verification of identity, the customer receives an X.509v3 digital certificate, which is signed by the bank. The certificate verifies the customer's RSA public key and its expiration date. It also establishes a relationship, guaranteed by the bank, between the customer's key pair and his or her credit card.
3. **Merchants have their own certificates.** A merchant who accepts a certain brand of card must be in possession of two certificates for two public keys owned by the merchant: one for signing messages, and one for key exchange. The merchant also needs a copy of the payment gateway's public-key certificate.
4. **The customer places an order.** This is a process that may involve the customer first browsing through the merchant's Web site to select items and determine the price. The customer then sends a list of the items to be purchased to the merchant, who returns an order form containing the list of items, their price, a total price, and an order number.
5. **The merchant is verified.** In addition to the order form, the merchant sends a copy of its certificate, so that the customer can verify that he or she is dealing with a valid store.
6. **The order and payment is verified.** The customer sends both order and payment information to the merchant, along with the customer's certificate. The order confirms the purchase of the items in the order form. The payment contains credit card details. The payment information is encrypted in such a way that it cannot be read by the merchant. The customer's certificate enables the merchant to verify the customer.

7. **The merchant requests payment authorization.** The merchant sends the payment information to the payment gateway, requesting authorization that the customer's available credit is sufficient for this purchase.
8. **The merchant confirm the order.** The merchant sends confirmation of the order to the customer.
9. **The merchant provides the goods or service.** The merchant ships the goods or provides the service to the customer.
10. **The merchant request payment.** This request is sent to the payment gateway, which handles all of the payment processing.

#### 11. 4. Dual Signature

The purpose of the dual signature is to link two messages that are intended for two different recipients. In this case, the customer want to send the order information (OI) to the merchant and the payment information (PI) to the bank. The merchant does not need to know the customer's credit card number, and the bank does not need to know the details of the customer' order.

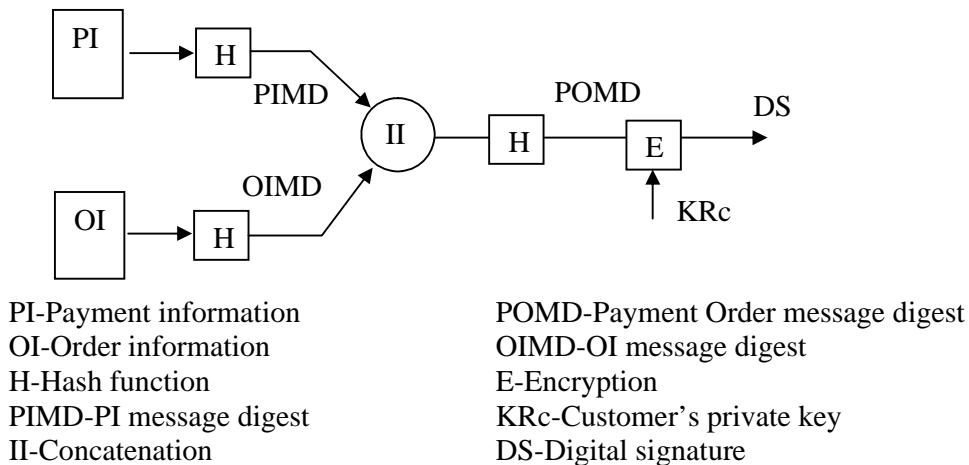


Fig. 12. 2

To see the need for the link, suppose that the customer sends the merchant two messages- a signed OI and a signed OI and a signed PI- and the merchant passes the PI on to the bank. If the merchant can capture another OI from this customer, the merchant could claim that this OI goes with the PI rather than original OI. The linkage prevents this.

Figure shows the use of a dual signature to meet the requirement of the preceding paragraph. The customer takes the hash (using SHA-1) of the PI and the hash of the OI. These two hashes are then concatenated and the hash of the result is taken. Finally, the customer encrypts the final hash with his or her private signature key, creating the dual signature. The operation can be summarized as follows:

$$DS = E_{KR_c}[H(H(PI) \parallel H(OI))] ]$$

Where  $KR_c$  is the customer's private signature key. Now suppose that the merchant is in possession of the dual signature (DS), the OI, and the message digest for the PI (PIMD). The merchant also has the public key of the customer, taken from the customer's certificate. Then the merchant can compute the following two quantities:

$$H(PIMD \parallel H(OI)) \text{ and } D_{KU_c}[DS]$$

Where  $KU_c$  is the customer's public signature key. If these two quantities are equal, then the merchant has verified the signature. Similarly, if the bank is in possession of DS, PI, the message digest for OI (OIMD), and the customer's public key, then the bank can compute the following:

$$H(H(PI) \parallel OIMD) \text{ and } D_{KU_c}[DS]$$

Again, if these two quantities are equal, then the bank has verified the signature. In summary,

1. The merchant has received OI and verified the signature.
2. The bank has received PI and verified the signature.
3. the customer has linked the OI and PI and can prove the linkage.

For example, suppose the merchant wishes to substitute another OI in this transaction, to its advantage. It would then have to find another OI whose hash matches the existing OIMD. With SHA-1, this is deemed not to be feasible. Thus, the merchant cannot link another OI with this PI.

## Payment Processing

- purchase request
- payment authorization
- payment capture

### 11.5. Purchase request

Before the purchase request exchange begins, the cardholder has completed browsing, selecting, and ordering. The end of this preliminary phase occurs when the merchant sends a completed order from to the customer. All of the preceding occurs without the use of SET. The purchase request exchange consists of four messages: initiate Request, Initiate Response, Purchase Response.

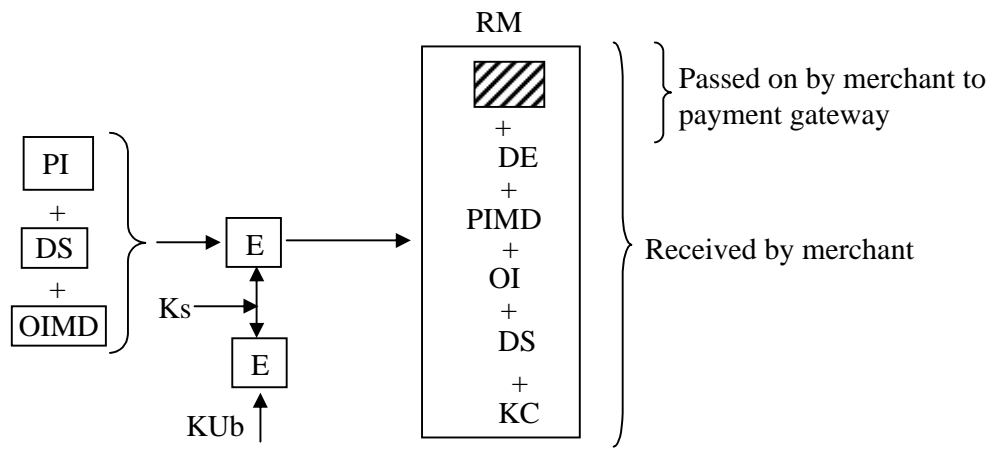
In order sent SET messages to the merchant, the cardholder must have a copy of the certificates of the merchant and the payment gateway. The customer requests the certificates in the **Initiate Request** message, sent to the merchant. This message includes the brand of the credit card that the customer is using. The message also includes an ID assigned to this request/ response pair by the customer and a nonce used to ensure timeliness.

The cardholder verifies the merchant and gateway certificates by means of their respective CA signatures and then creates the OI and PI. The transaction ID assigned by the merchant is placed in both the OI and PI. The OI does not contain explicit order data such as the number and price of items. Rather, it contains an order reference generated in the

exchange between merchant and customer during the shopping phase before the first SET message. Next, the cardholder prepares the **Purchase Request** message. For this purpose, the cardholder generates a one-time symmetric encryption key,  $K_s$ . the message includes the following:

**1. Purchase- related information.** Cardholder's Purchase Request will be forwarded to the payment gateway by the merchant consisting of

- the PI
- the dual signature, calculated over the PI and OI, signed with the customer's private signature key
- the OI message digest (OIMD)



$K_s$ - Temporary symmetric key;  $KU_b$ -Bank's public key exchange;  
 $DE$ -Digital envelope;  $KC$ -Cardholder's certificate;  $RM$ -Request message

Fig. 12. 3

The OIMD is needed for the payment gateway to verify the dual signature, as explained previously. All of these items are encrypted with  $K_s$ . the final item is

- The digital envelope. This is formed by encrypting  $K_s$  with the payment gateway's public key-exchange key. It is called a digital envelope because this envelope must be opened (decrypted) before the other items listed previously can be read.

The value of  $K_s$  is not made available to the merchant. Therefore, the merchant cannot read any of this payment-related information.

**2. Order-Related information.** This information is needed by the merchant and consist of

- The OI
- The dual signature, calculated over the PI and OI, signed with the customer's private signature key
- The PI message digest (PIMD)

The PIMD is needed for the merchant to verify the dual signature. Note that the OI s sent in the clear.

**3. Cardholder certificate.** This contains the cardholder’s public signature key. It is needed by the merchant and by the payment gateway.

When the merchant receives the Purchase Request message, it verifies Customer Purchase Request by the following action:

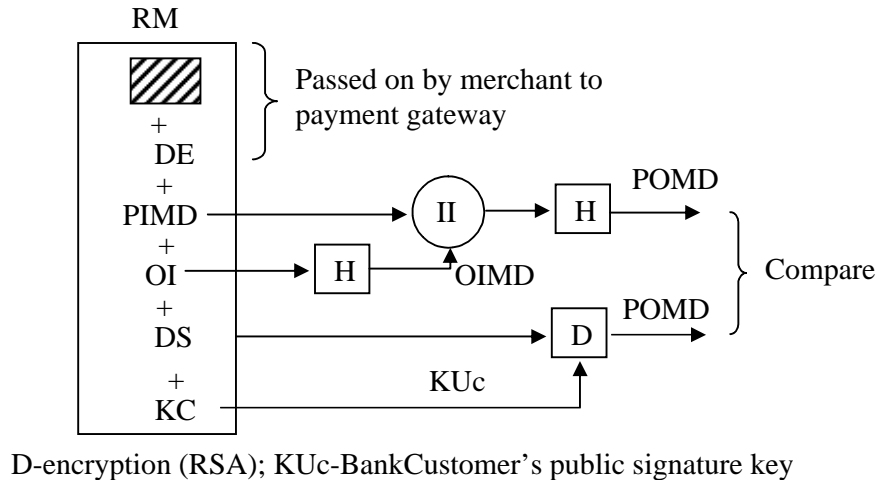


Fig. 12. 4 Merchant Verifies Customer Purchase Request

1. Verifies the cardholder certificates by means of its CA signatures.
2. Verifies the dual signature using the customer’s public signature key. This ensures that the order has not been tampered with in transit and that it was signed using the cardholder’s private signature key.
3. Processes the order and forwards the payment gateway for authorization (described later).
4. Sends a purchase response to the cardholder.

The **Purchase Response** message includes a response block that acknowledges the order and references the corresponding transaction number. This block is signed by the merchant using its private signature key. The block and its signature are sent to the customer, along with the merchant’s signature certificate.

When the cardholder software receives the purchase response message, it verifies the signature on the response block. Finally, it takes some action based on the response, such as displaying a message to the user or updating a database with the status of the order.

## 12. 5. Payment Authorization

During the processing of an order from a cardholder, the merchant authorizes the transaction with the payment gateway. The payment authorization ensures that the transaction was approved by the issuer. This authorization guarantees that the merchant will receive payment; the merchant can therefore provide the services or goods to the customer. The payment authorization exchange consists of two messages: Authorization Request and Authorization response.

The merchant sends an **Authorization Request** message to the payment gateway consisting of

1. **Purchase-Related information.** This information was obtained from the customer and consists of:
  - The PI
  - The dual signature, calculated over the PI and OI, signed with the customer's private signature key
  - The OI message digest (OIMD)
  - The digital envelope
2. **Authorization-related information.** This information is generated by the merchant and consists of
  - An authorization block that includes the transaction ID, signed with the merchant's private signature key and encrypted with a one-time symmetric key generated by the merchant
  - Digital envelope. This is formed by encrypting the one-time key with the payment gateway's public key-exchange key.
3. **Certificates.** The merchant includes the cardholder's signature key certificate (used to verify the dual signature), the merchant's signature key certificate (needed in the payment gateway's response).

The payment gateway performs the following tasks:

1. Verifies all certificates
2. Decrypts the digital
3. Verifies the merchant's signature on the authorization block
4. Decrypts the digital envelope of the payment block to obtain the symmetric key and then decrypts the payment block
5. Verifies the dual signature on the payment block
6. Verifies that the transaction ID received from the merchant matches that in the PI received (indirectly) from the customer
7. Requests and receives an authorization from the issuer

Having obtained authorization from the issuer, the payment gateway returns an **Authorization Response** message to the merchant. It includes the following elements:

1. **Authorization-related information.** Includes an authorization block, signed with the gateway's private signature key and encrypted with a one-time symmetric key generated by the gateway. Also includes a digital envelope that contains one-time key encrypted with the merchant public key-exchange key.
2. **Capture token information.** This information will be used to effect payment later. This block is of the same form as (1)-namely, assigned, encrypted capture token together with a digital envelope. This token is not processed by the merchant. Rather, it must be returned, as is, with a payment request.
3. **Certificate.** The gateway's signature key certificate.



With the authorization from the gateway, the merchant can provide the goods or service to the customer.

## **Payment Capture**

To obtain payment, the merchant engages the payment gateway in a payment capture transaction, consisting of a capture request and a capture response message.

For the **Capture Request** message, the merchant generates, signs, and encrypts a capture request block, which includes the payment amount and the transaction ID. The message also includes the encrypted capture token received earlier for this transaction, as well as the merchant's signature key and key-exchange key certificates.

When the payment gateway receives the capture request message, it decrypts and verifies the capture request block and decrypts and verifies the capture token block. It then checks for consistency between the capture request and capture token. It then creates a clearing request that is sent to the issuer over the private payment network. This request causes funds to be transferred to the merchant's account.

The gateway then notifies the merchant of payment in a **Capture Response** message. The message includes a capture response block that the gateway signs and encrypts. The message also includes the gateway's signature key certificate. The merchant software stores the capture response to be used for reconciliation with payment received from the acquirer.