Transport Layer Security

TLS was released in response to the Int rnet community's demands for a standardized protocol. TLS (Transport Layer Security), defined in RFC 2246, is a protocol for establishing a secure connection between a client and a server. TLS (Transport Layer Security) is capable of authenticating both the client and the server and creating a encrypted connection between the two. Many protocols use TLS (Transport Layer Security) to establish secure connections, including HTTP, IMAP, POP3, and SMTP. The TLS Handshake Protocol first negotiates key exchange using an asymmetric algorithm such as RSA or Diffie-Hellman. The TLS Record Protocol then begins opens an encrypted channel using a symmetric algorithm such as RC4, IDEA, DES, or 3DES. The TLS Record Protocol is also responsible for ensuring that the communications are not altered in transit. Hashing algorithms such as MD5 and SHA are used for this purpose. RFC 2246 is very similar to SSLv3. There are some minor differences ranging from protocol version numbers to generation of key material.

Version Number: The TLS Record Format is the same as that of the SSL Record Format and the fields in the header have the same meanings. The one difference is in version values. For the current version of TLS, the Major Version is 3 and the Minor Version is 1.

Message Authentication Code: Two differences arise one being the actual algorithm and the other being scope of MAC calculation. TLS makes use of the HMAC algorithm defined in RFC 2104. SSLv3 uses the same algorithm, except that the padding bytes are concatenated with the secret key rather than being XORed with the secret key padded to the block length. For TLS, the MAC calculation encompasses the fields indicated in the following expression:

HMAC_hash(MAC_write_secret, seq_num || TLSCompressed.type ||
TLSCompressed.version || TLSCompressed.length ||
TLSCompressed.fragment)

The MAC calculation covers all of the fields covered by the SSLv3 calculation, plus the field TLSCompressed.version, which is the version of the protocol being employed. Pseudorandom Function: TLS makes use of a pseudorandom function referred to as PRF to expand secrets into blocks of data for purposes of key generation or validation. The PRF is based on the following data expansion function:

P_hash(secret, seed) = HMAC_hash(secret, A(1) || seed) ||
HMAC_hash(secret, A(2) || seed) ||
HMAC_hash(secret, A(3) || seed) || ...

where A() is defined as

A(0) = seed

A(i) = HMAC_hash (secret, A(i - 1))

The data expansion function makes use of the HMAC algorithm, with either MD5 or SHA-1 as the underlying hash function. As can be seen, P_hash can be iterated as many times as necessary to produce the required quantity of data. each iteration involves two executions of HMAC, each of which in turn involves two executions of the underlying hash algorithm.

Set (Secure Electronic Transaction)

SET is an open encryption and security specification designed to protect credit card transactions on the Internet. SET is not itself a payment system. Rather it is a set of security protocols and formats that enables users to employ the existing credit card payment infrastructure on an open network, such as the Internet, in a secure fashion. In essence, SET provides three services:

• Provides a secure communications channel among all parties involved in a transaction

• Provides trust by the use of X.509v3 digital certificates

• Ensures privacy because the information is only available to parties in a transaction when and where necessary

SET Requirements

- Provide confidentiality of payment and ordering information
- Ensure the integrity of all transmitted data
- Provide authentication that a cardholder is a legitimate user of credit card account
- Provide authentication that a merchant can accept credit card transactions through its relationship with a financial institution
- Ensure the use of the best security practices and system design techniques to protect all legitimate parties in an electronic commerce transaction
- Create a protocol that neither depends on transport security mechanisms nor prevents their use
- Facilitate and encourage interoperability among software nd network providers

SET Key Features

To meet the requirements, SET incorporates the following features:

- Confidentiality of information
- Integrity of data
- Cardholder account authentication
- Merchant authentication

SET Participants

- Cardholder: purchasers interact with merchants from personal computers over the Internet
- Merchant: a person or organization that has goods or services to sell to the cardholder
- Issuer: a financial institution, such as a bank, that provides the cardholder with the payment card.
- Acquirer: a financial institution that establishes an account with a merchant and processes payment card authorizations and payments
- Payment gateway: a function operated by the acquirer or a designated third party that processes merchant payment messages
- Certification authority (CA): an entity that is trusted to issue X.509v3 public-key certificates for cardholders, merchants, and payment gateways

Events in a transaction

1. The customer obtains a credit card account with a bank that supports electronic payment and SET
2. The customer receives a X.509v3 digital certificate signed by the bank.
3. Merchants have their own certificates
4. The customer places an order
5. The merchant sends a copy of its certificate so that the customer can verify that it's a valid store
6. The order and payment are sent
7. The merchant requests payment authorization
8. The merchant confirms the order
9. The merchant ships the goods or provides the service to the customer
10. The merchant requests payment

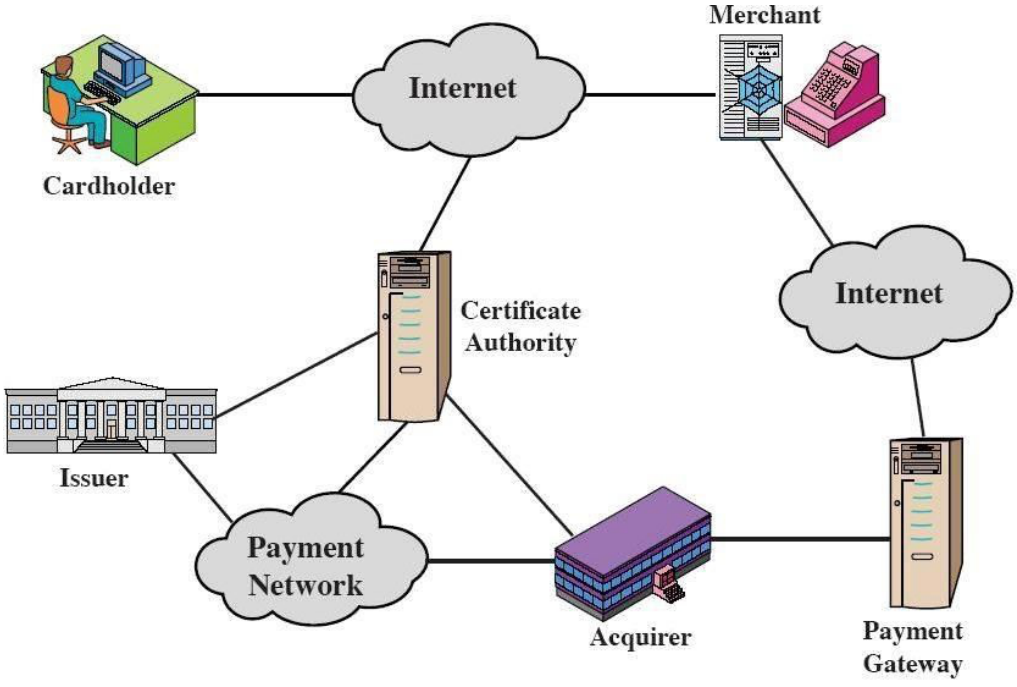
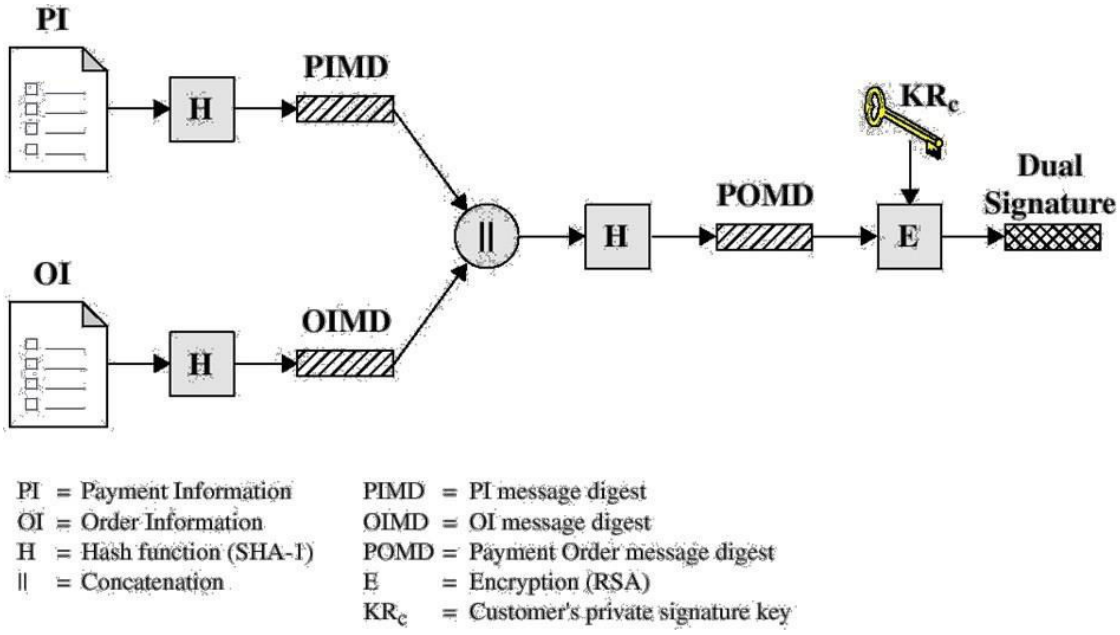


Figure 17.8 Secure Electronic Commerce Components

DUAL SIGNATURE

The purpose of the dual signature is to link two messages that are intended for two different recipients. The customer wants 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's order. The customer is afforded extra protection in terms of privacy by keeping these two items separate. The two items must be linked and the link is needed so that the customer can prove that this payment is intended for this order and not for some other goods or service.



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 ha h of the result is taken. Finally, the customer encrypts the final hash with his or her rivate signature key, creating the dual signature. The operation can be summarized as

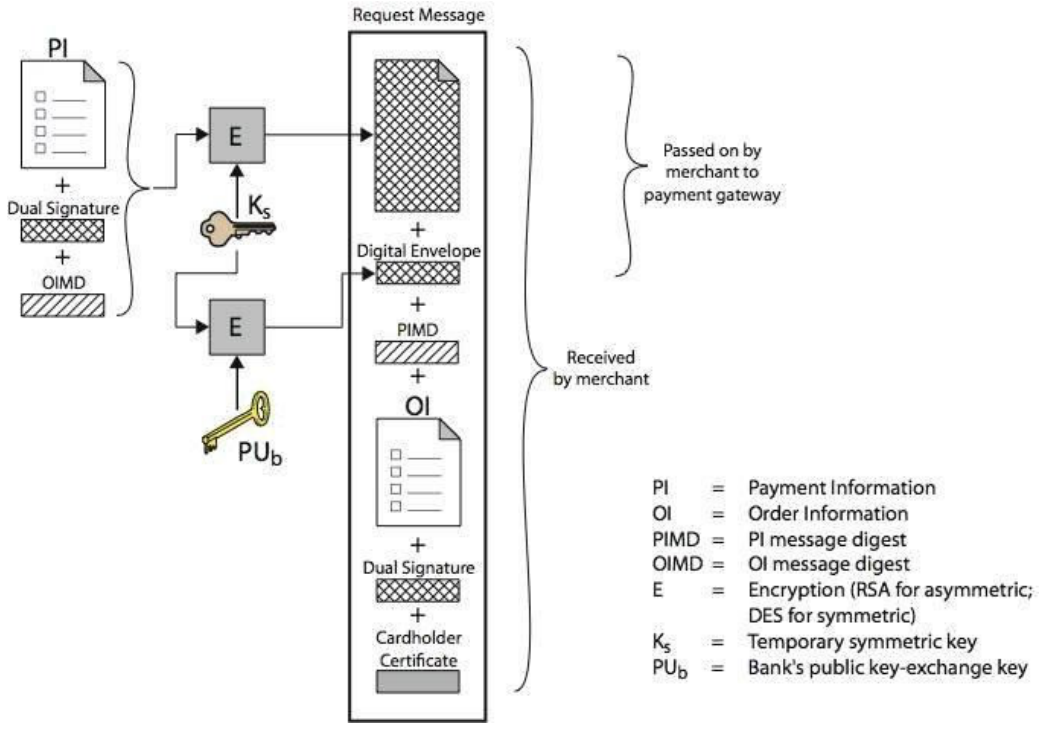
$$DS = E_{KR_c}[H(H(PI) \| \mathrm{H(OI)})]$$

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 quantities H(PIMS||H[OI]) and D_{KUc}(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 H(H[OI]||OIMD) and D_{KUc}(DS). Again, if these two quantities are equal, then the bank has verified the signature. To summarize:

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

For a merchant to substitute another OI, he has to find another OI whose hash exactly matches OIMD, which is deemed impossible. So, the OI cannot be linked with another PI.

Purchase Request



The message includes the following:

1. Purchase-related information, which will be forwarded to the payment gateway by the merchant and consists of: PI, dual signature & OI message digest (OIMD). These are encrypted using Ks. A digital envelope is also present which is formed by encrypting Ks with the payment gateway's public key-exchange key.
2. Order-related information, needed by the merchant and consists of: OI, dual signature, PI message digest (PIMD). OI is sent in the clear.
3. Cardholder certificate. This contains the cardholder's public signature key. It is needed by the merchant and payment gateway.

Merchant receives the Purchase Request message, the following actions are done:

1. verifies cardholder certificates using CA sigs
2. verifies dual signature using customer's public signature key to ensure order has not been tampered with in transit & that it was signed using cardholder's private signature key
3. processes order and forwards the payment information to the payment gateway for authorization
4. sends a purchase response to cardholder