Secure Electronic Transaction

(SET)

Credit Cards on the Internet

- Problem: communicate credit card and purchasing data securely to gain consumer trust
  - Authentication of buyer and merchant
  - Confidential transmissions
- Systems vary by
  - Type of public-key encryption
  - Type of symmetric encryption
  - Message digest algorithm
  - Number of parties having private keys
  - Number of parties having certificates

Credit Card Protocols

- SSL 1 or 2 parties have private keys
- TLS (Transport Layer Security)
  - IETF version of SSL

- *i*KP (IBM)
- SEPP (Secure Encryption Payment Protocol)
  - MasterCard, IBM, Netscape
- STT (Secure Transaction Technology)
  - VISA, Microsoft

OBSOLETE

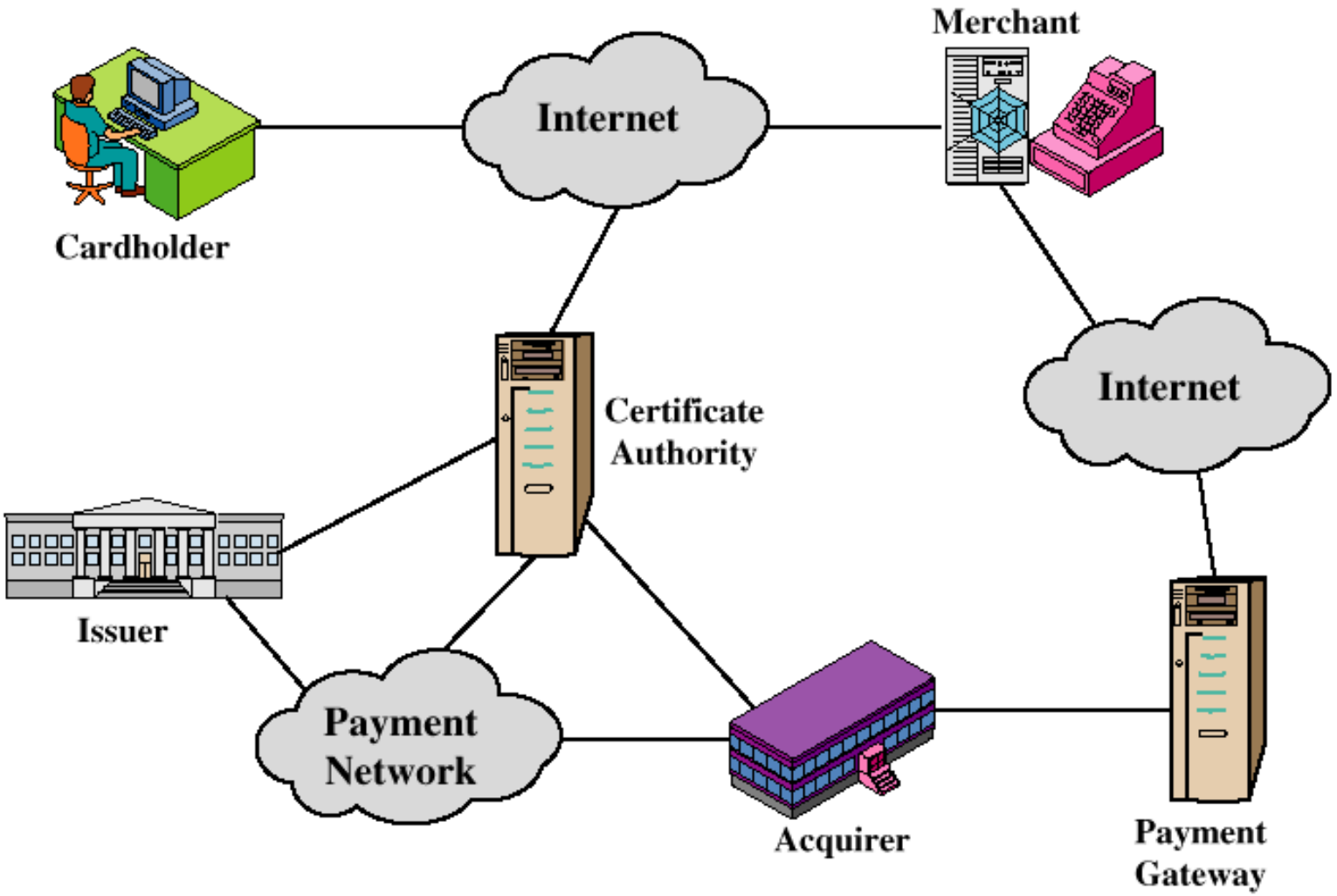
- SET (Secure Electronic Transactions)
  - MasterCard, VISA all parties have certificates

VERY SLOW ACCEPTANCE

Secure Electronic Transaction (SET)

- Developed by Visa and MasterCard
- Designed to protect credit card transactions
- Confidentiality: all messages encrypted
- Trust: all parties must have digital certificates
- Privacy: information made available only when and where necessary

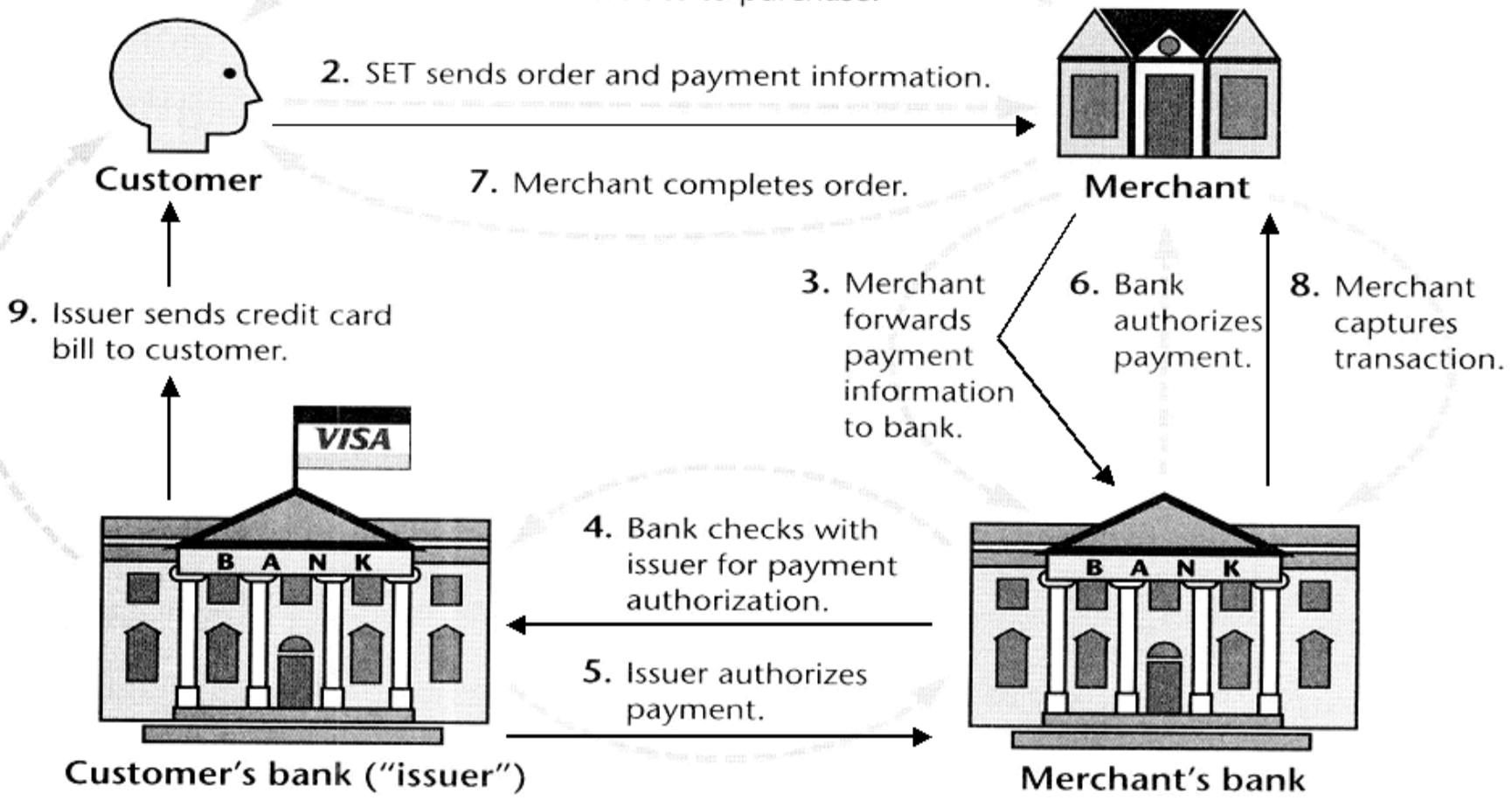
Participants in the SET System



SET Business 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 a credit card account
- Provide authentication that a merchant can accept credit card transactions through its relationship with a financial institution

SET Transactions



SET Transactions

- The customer opens an account with a card issuer.
  - MasterCard, Visa, etc.
- The customer receives a X.509 V3 certificate signed by a bank.
  - X.509 V3
- A merchant who accepts a certain brand of card must possess two X.509 V3 certificates.
  - One for signing & one for key exchange
- The customer places an order for a product or service with a merchant.
- The merchant sends a copy of its certificate for verification.

SET Transaction:

- **Customer Opens An Account:** Customer obtains a credit card account with a bank that supports electronic payment and SET.

- **Customer Receives A Certificate:** After suitable verification of identity, the customer receives an X.509v3 digital certificate signed by the bank.
  - It verifies the customer's RSA public key and its expiration date.

- **Merchants Have Own Certificates:** A merchant who accepts a bank card must be in possession of two certificates for the two public keys owned by the merchant:
  - One for signing messages
  - One for key exchange
  - Merchant has a copy of payment gateway's public-key certificate.
- **Customer Places An Order:** Customer send a list of items to be purchases to the merchant, who returns an order form containing the list of items to be purchased to the merchant.
  - Merchant returns an order form containing the list of items, their price, a total price, and an order number.

- **Merchant is Verified:** In addition to the order form, the merchant sends a copy of the certificate so that the customer can verify that he or she is dealing with a valid store.

SET Transactions

- **Order and Payment are Sent:** Customer sends both order and payment information to merchant along with customer's certificate.
  - The order confirms the purchase of items in the order form.
  - The payment contains credit card details.
  - The payment information is encrypted so that it cannot be read by the merchant.
  - The customer's certificate enables the merchant to verify the customer.

- **Merchant Requests Payment Authorization:** Merchant sends the payment information to the payment gateway.
  - This requests authorization that the customer's available credit is sufficient for this purchase.

- **Merchant Confirms Order:** Merchant sends a confirmation of the order to the customer.

- **Merchant Provides Goods or Service:** Merchant ships the goods or provides the service to the customer.

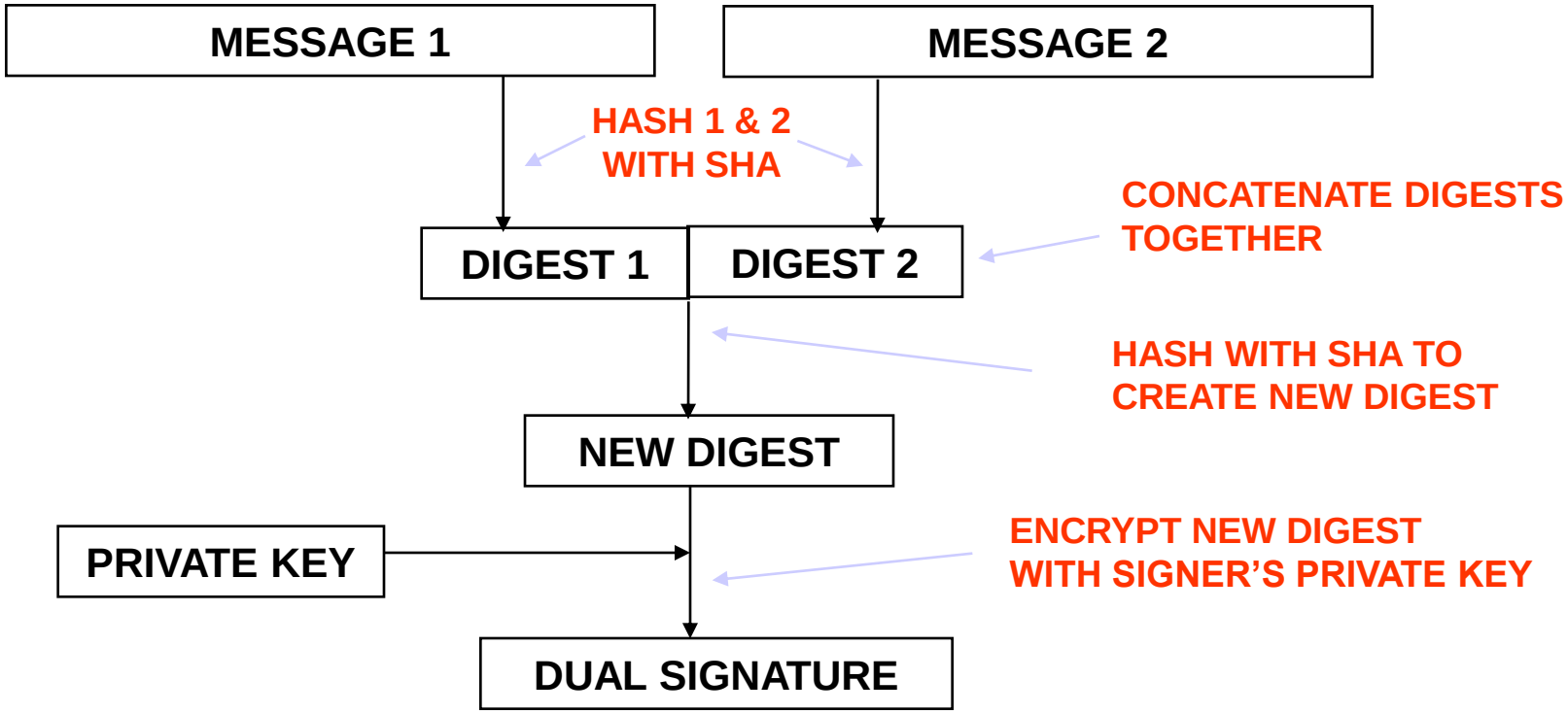
- **Merchant Requests Payment:** Request is sent to payment gateway to handle payment processing

Key Technologies of SET

- Confidentiality of information: DES
- Integrity of data: RSA digital signatures with SHA-1 hash codes
- Cardholder account authentication: X.509v3 digital certificates with RSA signatures
- Merchant authentication: X.509v3 digital certificates with RSA signatures
- Privacy: separation of order and payment information using dual signatures

Dual Signatures

- Links two messages securely but allows only one party to read each.



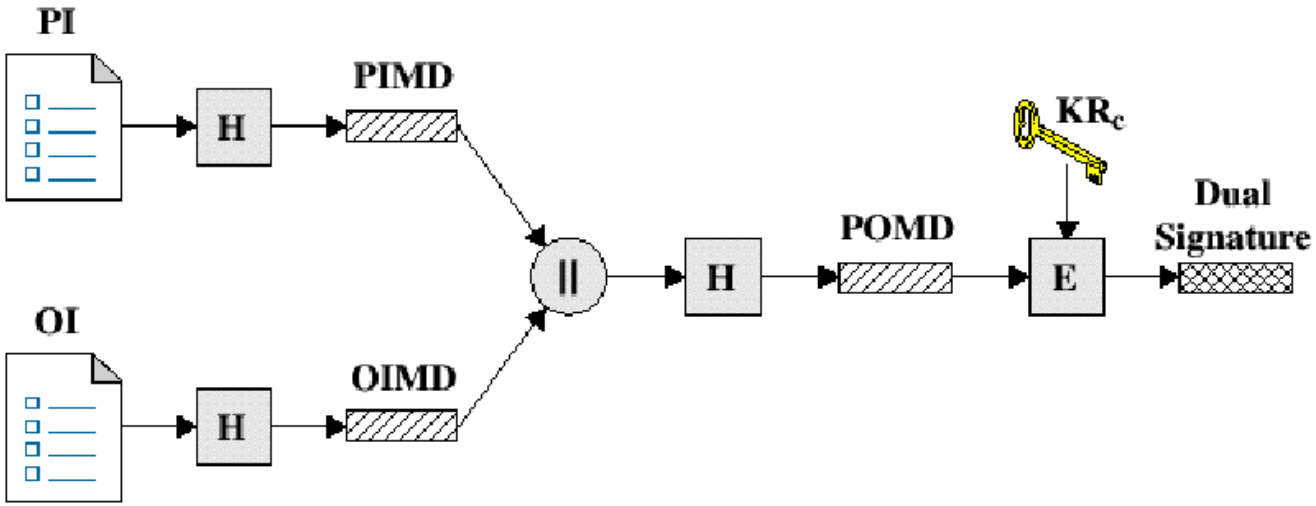
Dual Signature for SET

- Concept: Link Two Messages Intended for Two Different Receivers:
  - Order Information (OI): Customer to Merchant
  - Payment Information (PI): Customer to Bank
- Goal: Limit Information to A "Need-to-Know" Basis:
  - Merchant does not need credit card number.
  - Bank does not need details of customer order.
  - Afford the customer extra protection in terms of privacy by keeping these items separate.
- This link is needed to prove that payment is intended for this order and not some other one.

Why Dual Signature?

- Suppose that customers send the merchant two messages:
  - The signed order information (OI).
  - The signed payment information (PI).
  - In addition, the merchant passes the payment information (PI) to the bank.
- If the merchant can capture another order information (OI) from this customer, the merchant could claim this order goes with the payment information (PI) rather than the original.

Dual Signature Operation



- The operation for dual signature is as follows:
  - Take the hash (SHA-1) of the payment and order information.
  - These two hash values are concatenated [H(PI) || H(OI)] and then the result is hashed.
  - **Customer encrypts the final hash with a private key creating the dual signature**.

$$DS = E_{KRC} [H(H(PI) || H(OI))]$$

DS Verification by Merchant

- The merchant has the public key of the customer obtained from the customer's certificate.
- Now, the merchant can compute two values:

  $H(PIMD \mid\mid H(OI))$

  $D_{KUC}[DS]$
- Should be equal!

DS Verification by Bank

- 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:

  $H(H(PI) \,||\, OIMD)$

  D_{KUC} [DS]

What did we accomplish?

- 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.

SET Supported Transactions

- card holder registration
- merchant registration
- purchase request
- payment authorization
- payment capture
- certificate query
- purchase inquiry

- **purchase notification**
- **sale transaction**
- **authorization reversal**
- **capture reversal**
- **credit reversal**

Purchase Request

- Browsing, Selecting, and Ordering is Done
- Purchasing Involves 4 Messages:
  - Initiate Request
  - Initiate Response
  - Purchase Request
  - Purchase Response

Purchase Request: Initiate Request

- Basic Requirements:
  - Cardholder Must Have Copy of Certificates for Merchant and Payment Gateway
- Customer Requests the Certificates in the Initiate Request Message to Merchant
  - Brand of Credit Card
  - ID Assigned to this Request/response pair by customer
  - Nonce

Purchase Request: Initiate Response

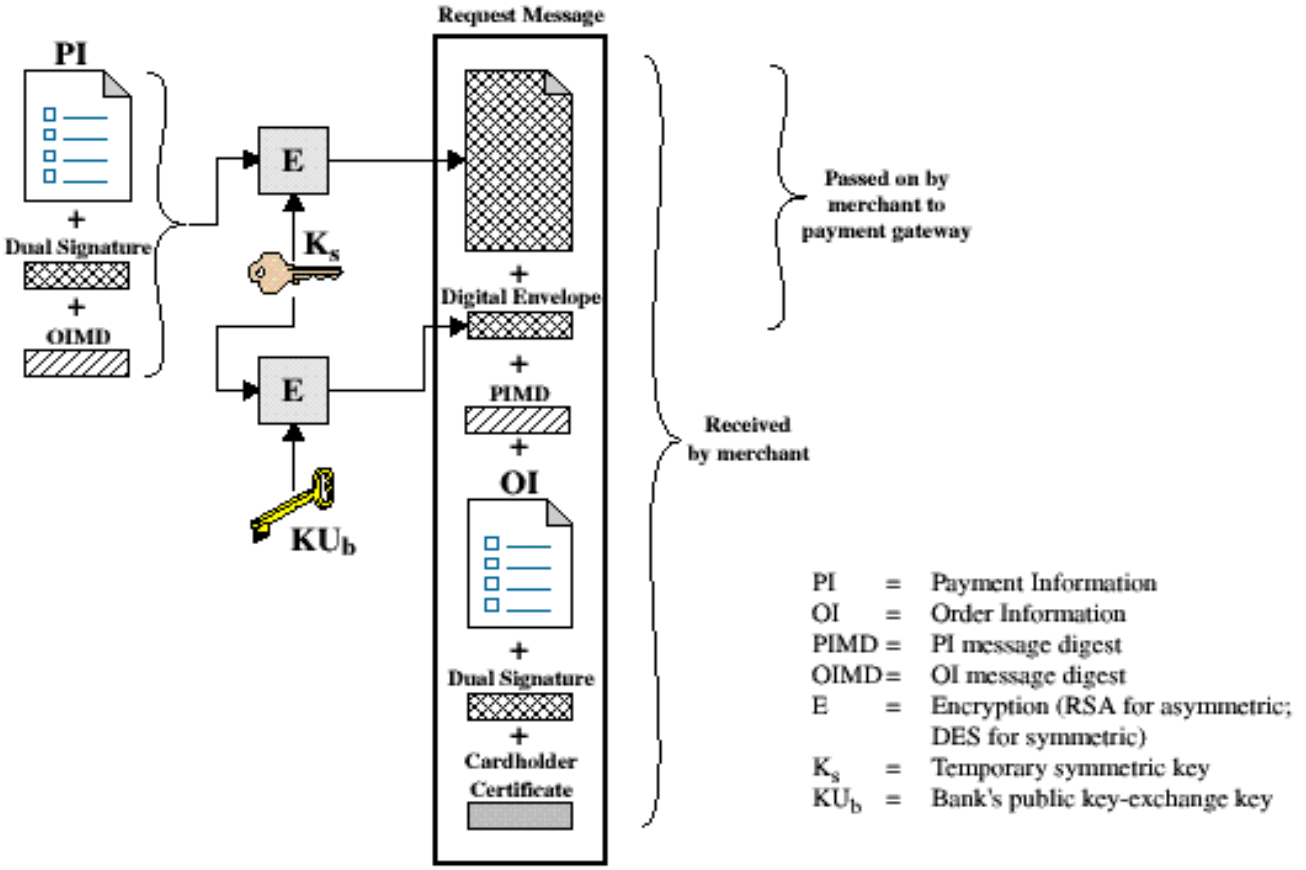
- Merchant Generates a Response
  - Signs with Private Signature Key
  - Include Customer Nonce
  - Include Merchant Nonce (Returned in Next Message)
  - Transaction ID for Purchase Transaction
- In Addition …
  - Merchant's Signature Certificate
  - Payment Gateway's Key Exchange Certificate

Purchase Request: Purchase Request

- Cardholder Verifies Two Certificates Using Their CAs and Creates the OI and PI.
- Message Includes:
  - Purchase-related Information
  - Order-related Information
  - Cardholder Certificate

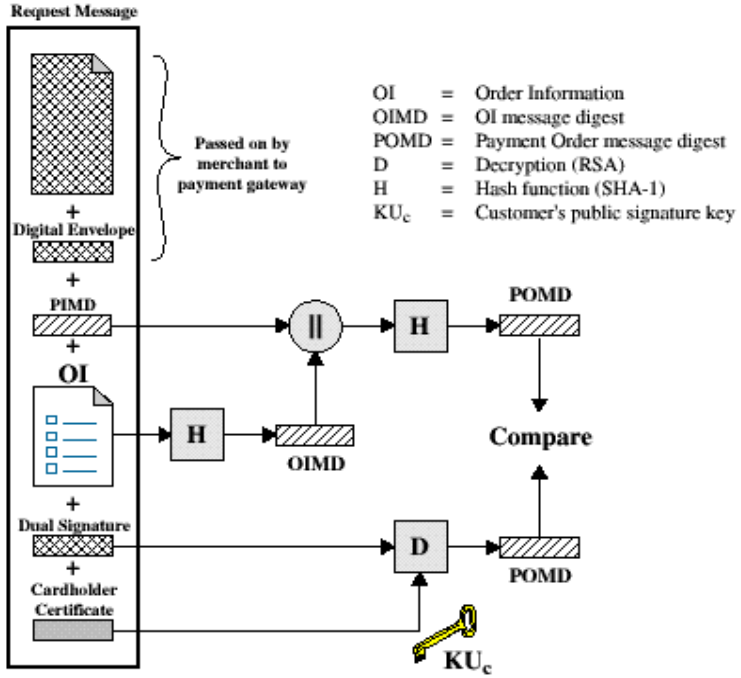
Purchase Request

- The cardholder generates a one-time symmetric encryption key, KS,



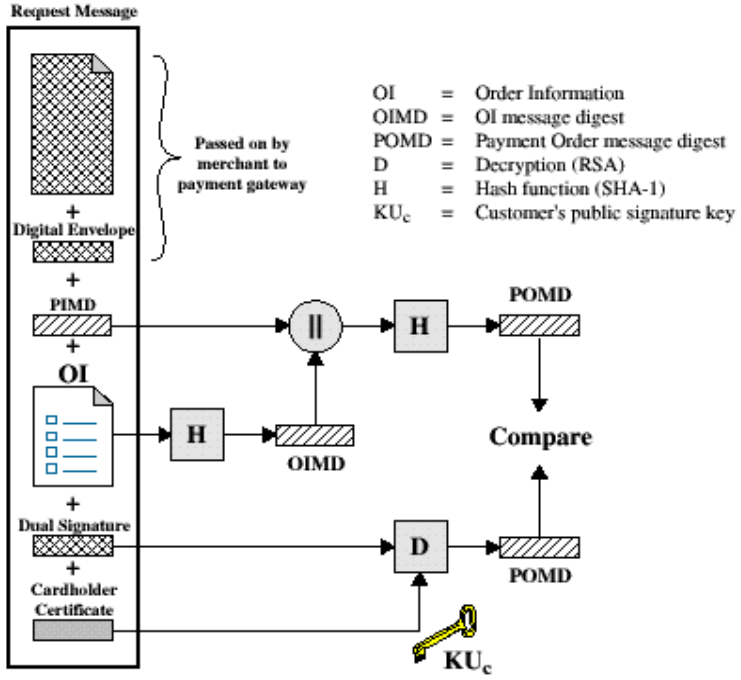
Merchant Verifies Purchase Request

- When the merchant receives the Purchase Request message, it performs the following actions:
  - Verify the cardholder certificates by means of its CA signatures.
  - Verifies the dual signature using the customer's public key signature.



Merchant Verification (cont'd)

- Processes the order and forwards the payment information to the payment gateway for authorization.
- Sends a purchase response to the cardholder.



Purchase Response Message

- Message that Acknowledges the Order and References Corresponding Transaction Number
- Block is
  - Signed by Merchant Using its Private Key
  - Block and Signature Are Sent to Customer Along with Merchant's Signature Certificate
- Upon Reception
  - Verifies Merchant Certificate
  - Verifies Signature on Response Block
  - Takes the Appropriate Action

Payment Process

- The payment process is broken down into two steps:
  - Payment authorization
  - Payment capture

Payment Authorization

- The merchant sends an authorization request message to the payment gateway consisting of the following:
  - Purchase-related information
    - PI
    - Dual signature calculated over the PI & OI and signed with customer's private key.
    - The OI message digest (OIMD)
    - The digital envelop
  - Authorization-related information
  - Certificates

Payment Authorization (cont'd)

- Authorization-related information
  - An authorization block including:
    - A transaction ID
    - Signed with merchant's private key
    - Encrypted one-time session key

- Certificates
  - Cardholder's signature key certificate
  - Merchant's signature key certificate
  - Merchant's key exchange certificate

Payment: Payment Gateway

- Verify All Certificates
- Decrypt Authorization Block Digital Envelope to Obtain Symmetric Key and Decrypt Block
- Verify Merchant Signature on Authorization Block
- Decrypt Payment Block Digital Envelope to Obtain Symmetric Key and Decrypt Block
- Verify Dual Signature on Payment Block
- Verify Received Transaction ID Received from Merchant Matches PI Received from Customer
- Request and Receive Issuer Authorization

Authorization Response

- Authorization Response Message
  - Authorization-related Information
  - Capture Token Information
  - Certificate

SET Overhead

Simple purchase transaction:

- Four messages between merchant and customer
- Two messages between merchant and payment gateway
- 6 digital signatures
- 9 RSA encryption/decryption cycles
- 4 DES encryption/decryption cycles
- 4 certificate verifications

Scaling:

- Multiple servers need copies of all certificates