UNIT 5

Web Security: Web security Considerations; Secure Socket layer (SSL) and Transport layer Security (TLS); Secure Electronic Transaction (SET). System security Intruders, Viruses and related threats

● Secure socket layer (SSL) provides security services between TCP and applications that use TCP. The Internet standard version is called transport layer service (TLS).

● SSL/TLS provides confidentiality using symmetric encryption and message integrity using a message authentication code.

● SSL/TLS includes protocol mechanisms to enable two TCP users to determine the security mechanisms and services they will use.

● Secure electronic transaction (SET) is an open encryption and security specification designed to protect credit card transactions on the Internet.

WEB SECURITY CONSIDERATIONS

The World Wide Web is fundamentally a client/server application running over the Internet and TCP/IP intranets.

The Internet is two way. Unlike traditional publishing environments, even electronic publishing systems involving teletext, voice response, or fax-back, the Web is vulnerable to attacks on the Web servers over the Internet.

The Web is increasingly serving as a highly visible outlet for corporate and product information and as the platform for business transactions. Reputations can be damaged and money can be lost if the Web servers are subverted.

Although Web browsers are very easy to use, Web servers are relatively easy to configure and manage, and Web content is increasingly easy to develop, the underlying software is extraordinarily complex.

Web Security Threats

provides a summary of the types of security threats faced in using the Web.

One way to group these threats is in terms of passive and active attacks.

Passive attacks include eavesdropping on network traffic between browser and server and gaining access to information on a Web site that is supposed to be restricted.

Active attacks include impersonating another user, altering messages in transit between client and server, and altering information on a Web site.

Table 17.1. A Comparison of Threats on the Web [RUBI97]

(This item is displayed on page 530 in the print version)

	Threats	Consequences	Countermeasures
Integrity	• Modification of user data • Trojan horse browser • Modification of memory • Modification of message traffic in transit	• Loss of information • Compromise of machine • Vulnerabilty to all other threats	Cryptographic checksums
Confidentiality	• Eavesdropping on the Net • Theft of info from server • Theft of data from client • Info about network configuration • Info about which client talks to server	• Loss of information • Loss of privacy	Encryption, web proxies
Denial of Service	• Killing of user threads • Flooding machine with bogus requests • Filling up disk or memory • Isolating machine by DNS attacks	• Disruptive • Annoying • Prevent user from getting work done	Difficult to prevent
Authentication	• Impersonation of legitimate users • Data forgery	• Misrepresentation of user • Belief that false information is valid	Cryptographic techniques

Another way to classify Web security threats is in terms of the location of the threat: Web server, Web browser, and network traffic between browser and

server. Issues of server and browser security fall into the category of computer system security;

WEB TRAFFIC SECURITY APPROACHES

A number of approaches to providing Web security are possible. The various approaches that have been considered are similar in the services they provide and, to some extent, in the mechanisms that they use, but they differ with respect to their scope of applicability and their relative location within the TCP/IP protocol stack.

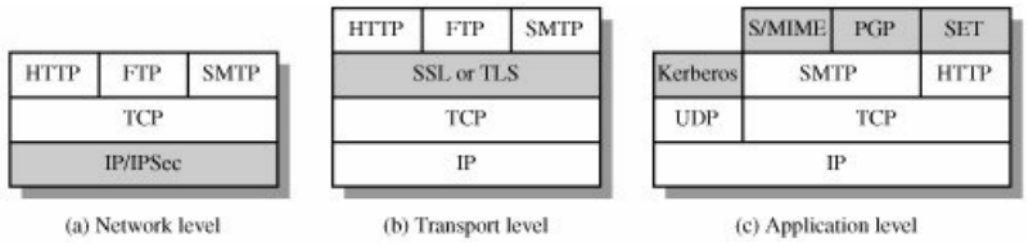
Figure 17.1 illustrates this difference. One way to provide Web security is to use IP Security (Figure

17.1a). The advantage of using IPSec is that it is transparent to end users and applications and provides a general-purpose solution. Further, IPSec includes a filtering capability so that only selected traffic need incur the overhead of IPSec processing.

Figure 17.1. Relative Location of Security Facilities in the TCP/IP Protocol Stack

(This item is displayed on page 531 in the print version)

[View full size image]



Another relatively general-purpose solution is to implement security just above TCP (Figure 17.1b). The foremost example of this approach is the Secure Sockets Layer (SSL) and the follow-on Internet standard known as Transport Layer Security (TLS). At this level, there are two implementation choices. For full generality, SSL (or TLS) could be provided as part of the underlying protocol suite and therefore be transparent to applications. Alternatively, SSL can be embedded in specific packages. For example, Netscape and Microsoft Explorer browsers come equipped with SSL, and most Web servers have implemented the protocol.

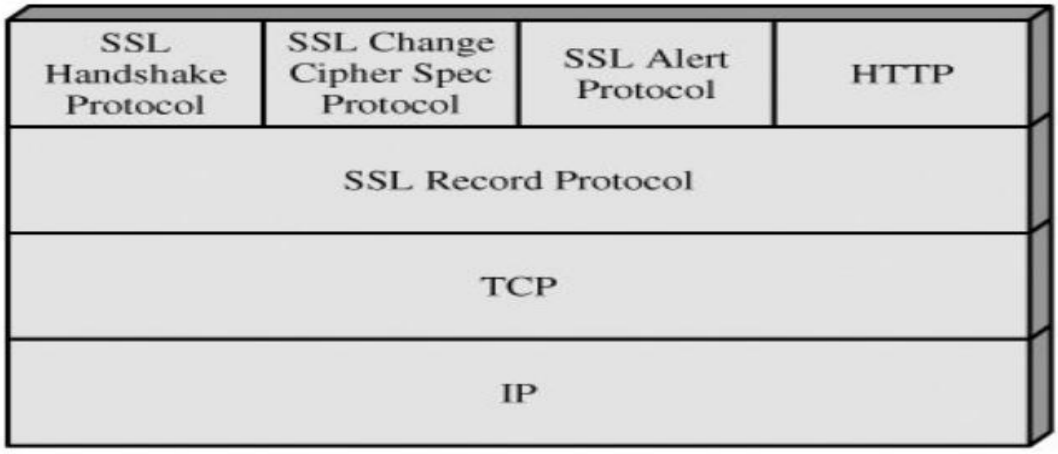
SECURE SOCKET LAYER AND TRANSPORT LAYER SECURITY

SSL Architecture

SSL is designed to make use of TCP to provide a reliable end-to-end secure service. SSL is not a single protocol but rather two layers of protocols

Figure 17.2. SSL Protocol Stack

(This item is displayed on page 532 in the print version)



- The SSL Record Protocol provides basic security services to various higher-layer protocols.
- In particular, the Hypertext Transfer Protocol (HTTP), which provides the transfer service for Web client/server interaction, can operate on top of SSL.
- Three higher-layer protocols are defined as part of SSL: the Handshake Protocol, The Change Cipher Spec Protocol, and the Alert Protocol.

Two important SSL concepts are the SSL session and the SSL connection, which are defined in the specification as follows:

● **Connection:** A connection is a transport (in the OSI layering model definition) that provides a suitable type of service. For SSL, such connections are peer-to-peer relationships. The connections are transient. Every connection is associated with one session.

● **Session:** An SSL session is an association between a client and a server. Sessions are created by the Handshake Protocol. Sessions define a set of cryptographic security parameters, which can be shared among multiple connections. Sessions are used to avoid the expensive negotiation of new security parameters for each connection.

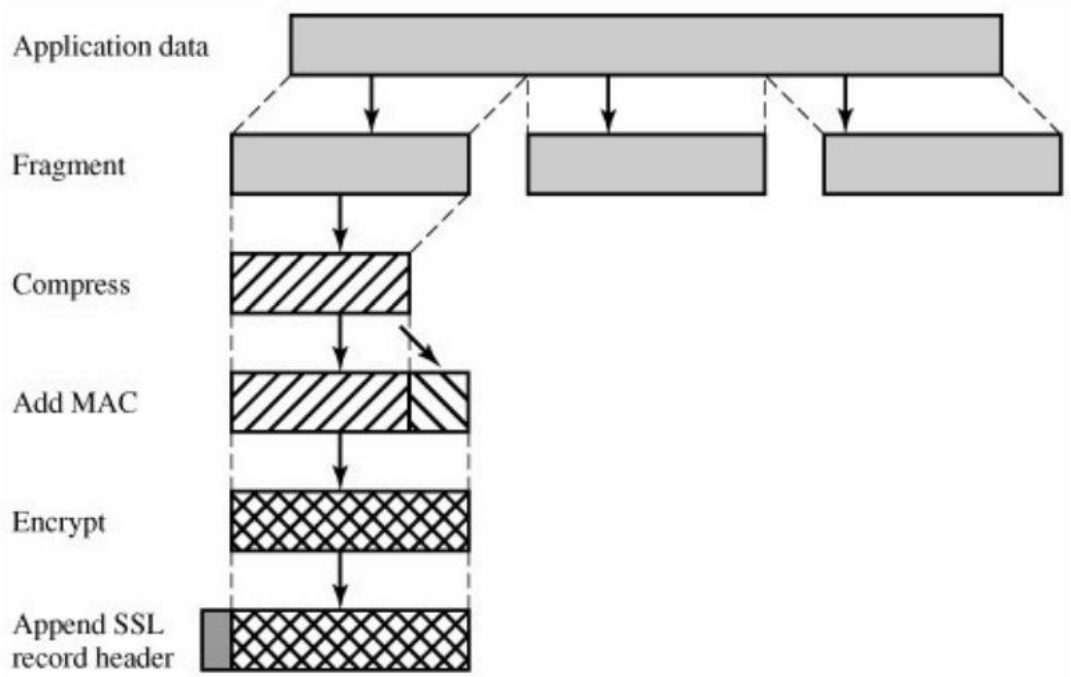
SSL Record Protocol

Confidentiality: The Handshake Protocol defines a shared secret key that is used for conventional encryption of SSL payloads.

Message Integrity: The Handshake Protocol also defines a shared secret key that is used to form a message authentication code (MAC).

Figure 17.3. SSL Record Protocol Operation

(This item is displayed on page 534 in the print version)



The first step is **fragmentation**. Each upper-layer message is fragmented into blocks of 214 bytes (16384 bytes) or less. Next, **compression** is optionally applied. Compression must be lossless and may not increase the content length by more than 1024 bytes.
Next, the compressed message plus the MAC are **encrypted** using symmetric encryption.

Change Cipher Spec Protocol

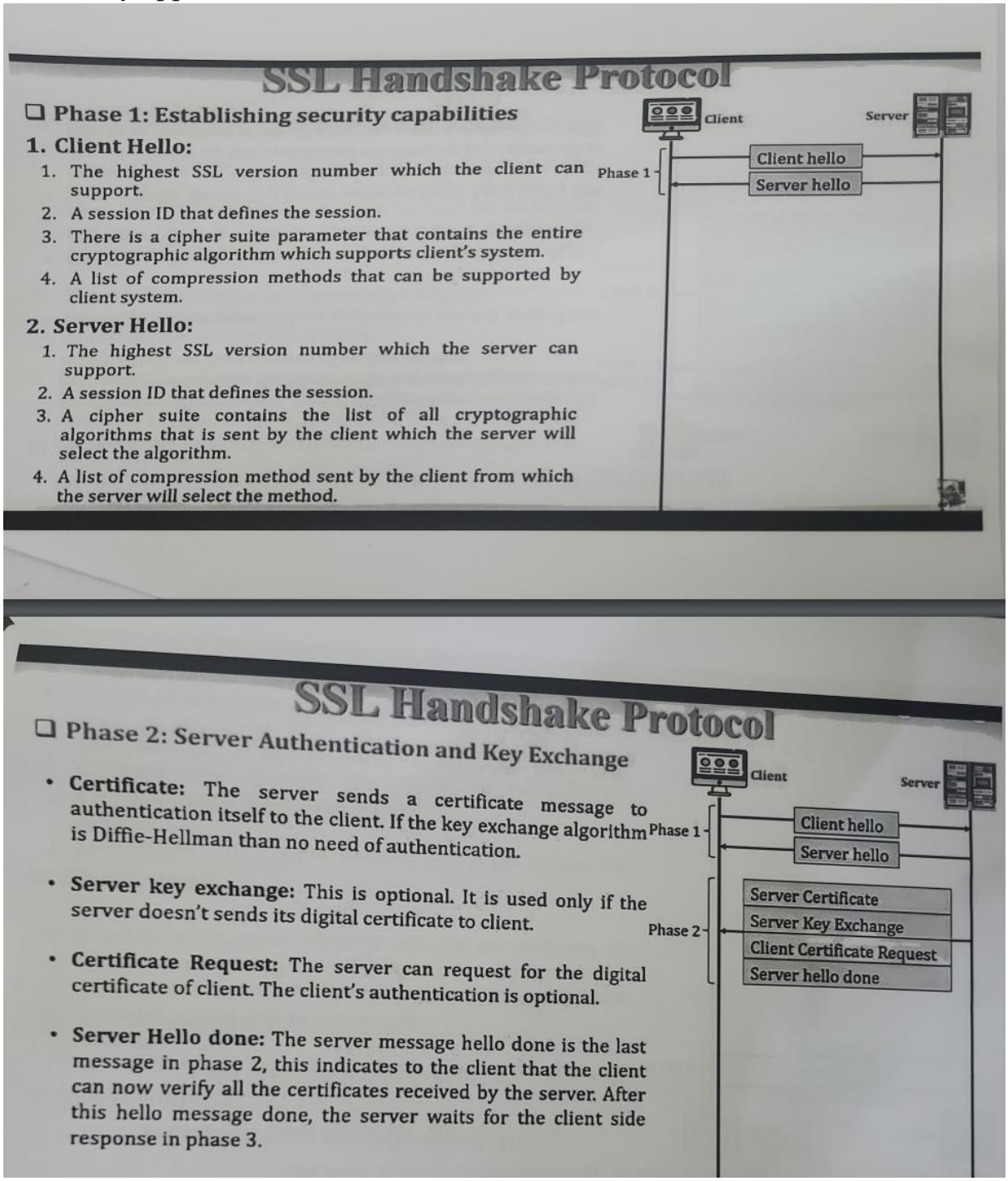
The Change Cipher Spec Protocol is one of the three SSL-specific protocols that use the SSL Record Protocol, and it is the simplest. This protocol consists of a single message (Figure 17.5a), which consists of a single byte with the value 1. The sole purpose of this message is to cause the pending state to be copied into the current state, which updates the cipher suite to be used on this connection.

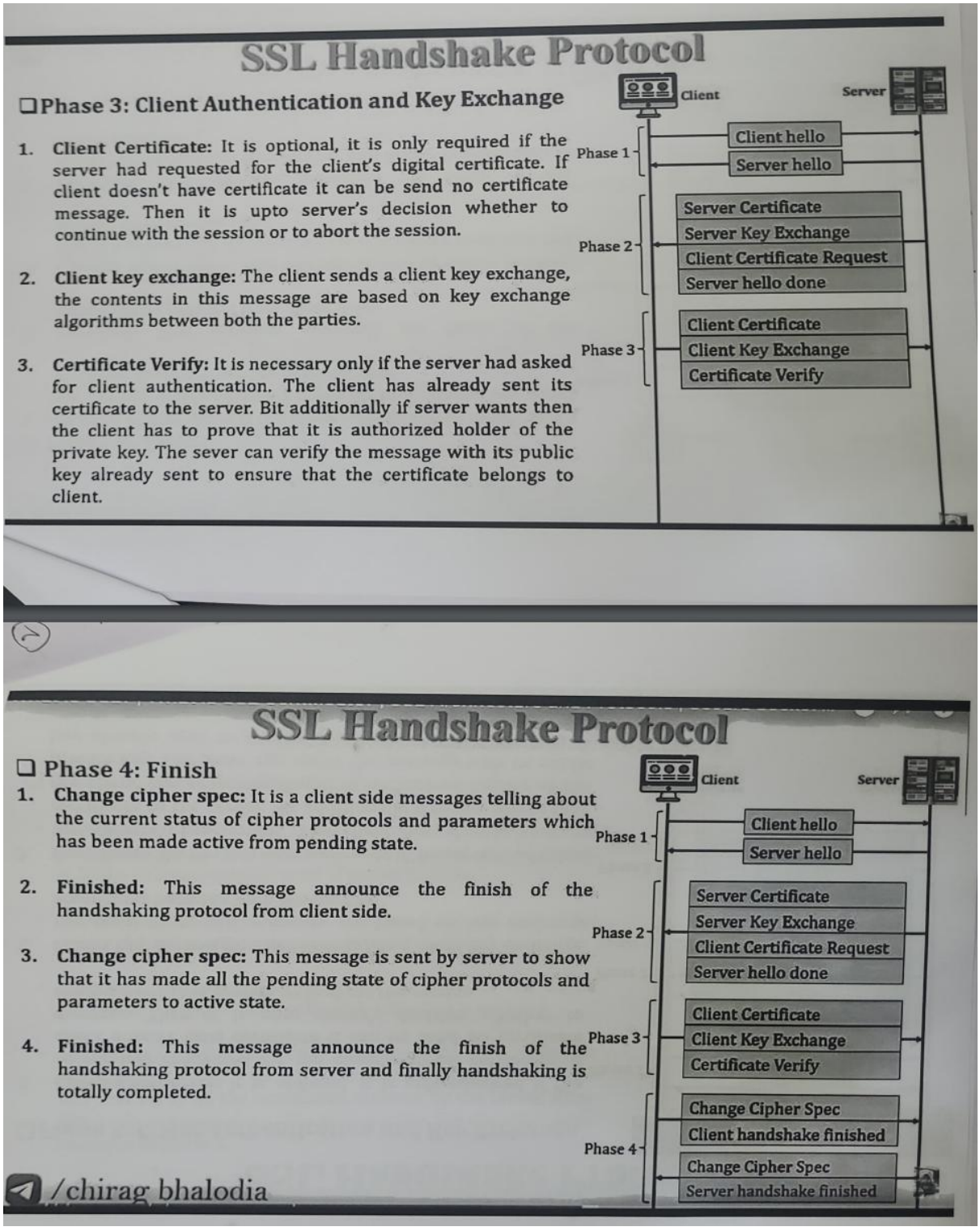
Alert Protocol

The Alert Protocol is used to convey SSL-related alerts to the peer entity. As with other applications that use SSL, alert messages are compressed and encrypted, as specified by the current state.

Handshake Protocol

The most complex part of SSL is the Handshake Protocol. This protocol allows the server and client to authenticate each other and to negotiate an encryption and MAC algorithm and cryptographic keys to be used to protect data sent in an SSL record. The Handshake Protocol is used before any application data is transmitted.





TRANSPORT LAYER SECURITY

TLS is an IETF standardization initiative whose goal is to produce an Internet standard version of SSL.

TLS is defined as a Proposed Internet Standard in RFC 2246.

RFC 2246 is very similar to SSLv3.

In this section, we highlight the differences.

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

- There are two differences between the SSLv3 and TLS MAC schemes: the actual algorithm and the scope of the MAC calculation. TLS makes use of the HMAC algorithm defined in RFC 2104

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.

Alert Codes

● **decryption_failed:** A ciphertext decrypted in an invalid way; either it was not an even multiple of the block length or its padding values, when checked, were incorrect.

● **record_overflow: A** TLS record was received with a payload (ciphertext) whose length exceeds 214 + 2048 bytes, or the ciphertext decrypted to a length of greater than 214 + 1024 bytes.

● **unknown_ca**: A valid certificate chain or partial chain was received, but the certificate was not accepted because the CA certificate could not be located or could not be matched with a known, trusted CA.

● **access_denied:** A valid certificate was received, but when access control was applied, the sender decided not to proceed with the negotiation.

Cipher Suites

● **Key Exchange:** TLS supports all of the key exchange techniques of SSLv3 with the exception of Fortezza.

● **Symmetric Encryption Algorithms:** TLS includes all of the symmetric encryption algorithms found in SSLv3, with the exception of Fortezza.

SECURE ELECTRONIC TRANSACTION

SET is an open encryption and security specification designed to protect credit card transactions 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, Terisa, and Verisign.

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

Key Features of SET

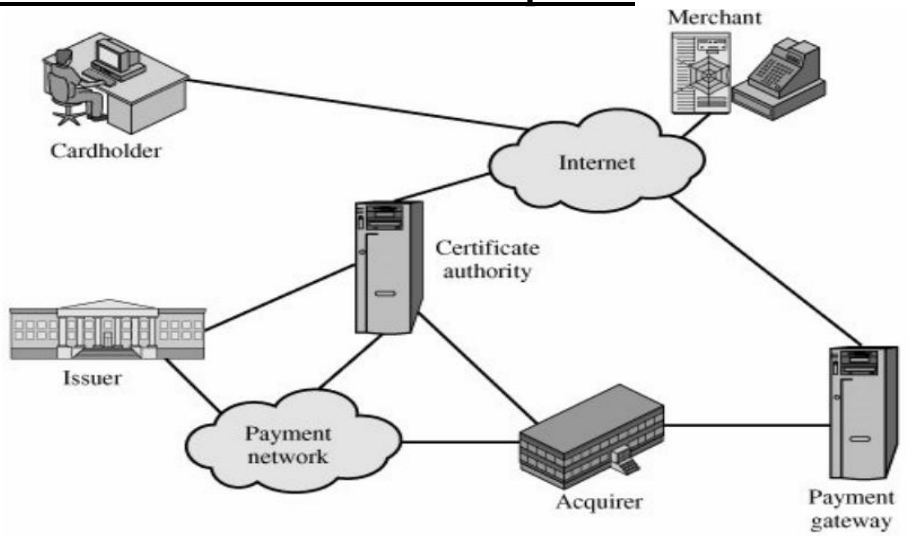
● **Confidentiality of information:** Cardholder account and payment information is secured as it travels across the network. An interesting and important feature of SET is that it prevents the merchant from learning the cardholder's credit card number; this is only provided to the issuing bank.

● **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.

● **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.

Secure Electronic Commerce Component



We now briefly describe the sequence of events that are required for a transaction.

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.

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.

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 are sent. 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 confirms 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 requests payment. This request is sent to the payment gateway, which handles all of the payment processing.

SYSTEM SECURITY INTRUDERS

One of the two most publicized threats to security is the intruder (the other is viruses), generally referred to as a hacker or cracker. In an important early study of intrusion, Anderson [ANDE80]

identified three classes of intruders:

● **Masquerader:** An individual who is not authorized to use the computer and who penetrates a system's access controls to exploit a legitimate user's account

● **Misfeasor:** A legitimate user who accesses data, programs, or resources for which such access is not authorized, or who is authorized for such access but misuses his or her privileges

● **Clandestine user:** An individual who seizes supervisory control of the system and uses this control to evade auditing and access controls or to suppress audit collection

The masquerader is likely to be an outsider; the misfeasor generally is an insider; and the clandestine user can be either an outsider or an insider.

Intruder attacks range from the benign to the serious. At the benign end of the scale, there are many people who simply wish to explore internets and see what is out there. At the serious end are individuals who are attempting to read privileged data, perform unauthorized modifications to data, or disrupt the system.

Intrusion Detection

1. **Statistical anomaly detection:** Involves the collection of data relating to the behavior of legitimate users over a period of time.

    a. **Threshold detection:** This approach involves defining thresholds, independent of user, for the frequency of occurrence of various events.

    b. **Profile based**: A profile of the activity of each user is developed and used to detect changes in the behavior of individual accounts.

2. Rule-based detection: Involves an attempt to define a set of rules that can be used to decide that a given behavior is that of an intruder.

a. Anomaly detection: Rules are developed to detect deviation from previous usage patterns.

c. **Penetration identification:** An expert system approach that searches for suspicious behavior.

VIRUSES AND RELATED THREATS

A virus is a piece of software that can "infect" other programs by modifying them; the modification includes a copy of the virus program, which can then go on to infect other programs.

A virus can do anything that other programs do. The only difference is that it attaches itself to another program and executes secretly when the host program is run. Once a virus is executing, it can perform any function, such as erasing files and programs.

During its lifetime, a typical virus goes through the following four phases:

● **Dormant phase:** The virus is idle. The virus will eventually be activated by some event, such as a date, the presence of another program or file, or the capacity of the disk exceeding some limit. Not all viruses have this stage.

● **Propagation phase:** The virus places an identical copy of itself into other programs or into certain system areas on the disk. Each infected program will now contain a clone of the virus, which will itself enter a propagation phase.

● **Triggering phase:** The virus is activated to perform the function for which it was intended. As with the dormant phase, the triggering phase can be caused by a variety of system events, including a count of the number of times that this copy of the virus has made copies of itself.

● **Execution phase:** The function is performed. The function may be harmless, such as a message on the screen, or damaging, such as the destruction of programs and data files.

Types of Viruses

● **Parasitic virus:** The traditional and still most common form of virus. A parasitic virus attaches itself to executable files and replicates, when the infected program is executed, by finding other executable files to infect.

● **Memory-resident virus:** Lodges in main memory as part of a resident system program. From that point on, the virus infects every program that executes.

● **Boot sector virus:** Infects a master boot record or boot record and spreads when a system is booted from the disk containing the virus.

● **Stealth virus:** A form of virus explicitly designed to hide itself from detection by antivirus software.

● **Polymorphic virus:** A virus that mutates with every infection, making detection by the "signature" of the virus impossible.

● **Metamorphic virus:** As with a polymorphic virus, a metamorphic virus mutates with every infection.

RELATED THREATS

We can also differentiate between those software threats that do not replicate and those that do. The former are programs or fragments of programs that are activated by a trigger. Examples are logic bombs, backdoors, and zombie programs. The latter consist of either a program fragment or an independent program that, when executed, may produce one or more copies of itself to be activated later on the same system or some other system. Viruses and worms are examples.

Backdoor

A backdoor, also known as a trapdoor, is a secret entry point into a program that allows someone that is aware of the backdoor to gain access without going through the usual security access procedures. Programmers have used backdoors legitimately for many years to debug and test programs.

Logic Bomb

One of the oldest types of program threat, predating viruses and worms, is the logic bomb. The logic bomb is code embedded in some legitimate program that is set to "explode" when certain conditions are met.

Trojan Horses

A Trojan horse is a useful, or apparently useful, program or command procedure containing hidden code that, when invoked, performs some unwanted or harmful function.

Zombie

A zombie is a program that secretly takes over another Internet-attached computer and then uses that computer to launch attacks that are difficult to trace to the zombie's creator. Zombies are used in denialof-service attacks, typically against targeted Web sites.