CNS-S-2018

1. **Distinguish between encryption and decryption.**

   Ans: Encryption is the process of translating plain text data (plaintext) into something that appears to be random and meaningless (ciphertext). Decryption is the process of converting ciphertext back to plaintext

   a. **Differentiate between symmetric and asymmetric key cryptography**

   Ans: Symmetric Cryptography:

   - It is easy to use but less secure.
   - It also requires a safe method to transfer the key from one party to another.
   - It only requires a single key for both encryption and decryption.
   - The size of cipher text is same or smaller than the original plain text.
   - The encryption process is very fast.
   - It is used when a large amount of data is required to transfer.
   - It only provides confidentiality.
   - Examples: 3DES, AES, DES and RC4

   Asymmetric Cryptography:

   - It is more secure than symmetric key encryption technique.
   - It requires two key one to encrypt and the other one to decrypt.
   - The size of cipher text is same or larger than the original plain text.
   - The encryption process is slow.
   - It is used to transfer small amount of data.
   - It provides confidentiality, authenticity and non-repudiation.
   - Examples: Diffie-Hellman, ECC, El Gamal, DSA and RSA

   b. **Define SSL. Explain how SSL works**.

   Ans: The SSL protocol provides

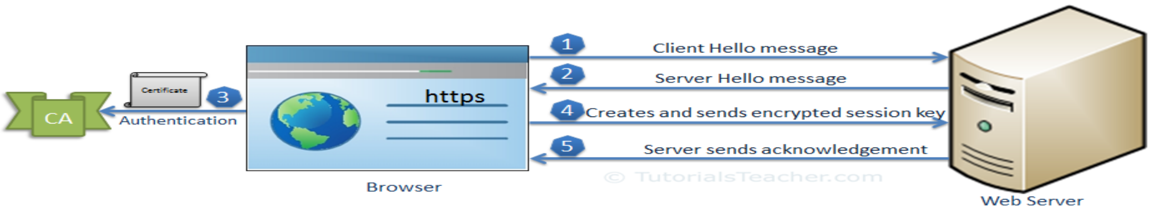
   - Confidentiality − Information is exchanged in an encrypted form.
   - Authentication − Communication entities identify each other through the use of digital certificates. Web-server authentication is mandatory whereas client authentication is kept optional.
   - Reliability − Maintains message integrity checks.

SSL communication between the browser and the web server is mainly divided into two steps: the SSL handshake and the actual data transfer.

SSL Handshake

The communication over SSL always begins with the SSL handshake. The SSL handshake is an asymmetric cryptography which allows the browser to verify the web server, get the public key and establish a secure connection before the beginning of the actual data transfer.

The following figure illustrates the steps involved in the SSL handshake:



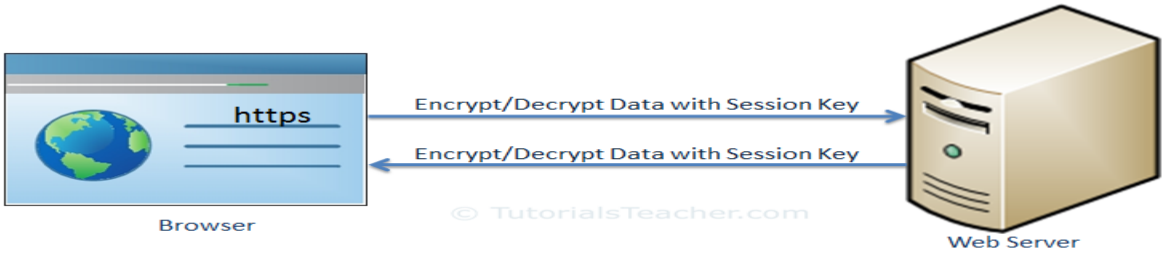
SSL Handshake

1. The client sends a "client hello" message. This includes the client's SSL version number, cipher settings, session-specific data and other information that the server needs to communicate with the client using SSL.
2. The server responds with a "server hello" message. This includes the server's SSL version number, cipher settings, session-specific data, an SSL certificate with a public key and other information that the client needs to communicate with the server over SSL.
3. The client verifies the server's SSL certificate from CA (Certificate Authority) and authenticates the server. If the authentication fails, then the client refuses the SSL connection and throws an exception. If the authentication succeeds, then proceed to step 4.
4. The client creates a session key, encrypts it with the server's public key and sends it to the server. If the server has requested client authentication (mostly in server to server communication), then the client sends his own certificate to the server.
5. The server decrypts the session key with its private key and sends the acknowledgement to the client encrypted with the session key.

Thus, at the end of the SSL handshake, both the client and the server have a valid session key which they will use to encrypt or decrypt actual data

Actual Data Transfer

The client and the server now use a shared session key to encrypt and decrypt actual data and transfer it. This is done using the same session key at both ends and so, it is a symmetric cryptography. The actual SSL data transfer uses symmetric cryptography because it is easy and takes less CPU consumption compared with the asymmetric cryptography.


https
Browser
Encrypt/Decrypt Data with Session Key
Encrypt/Decrypt Data with Session Key
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Web Server

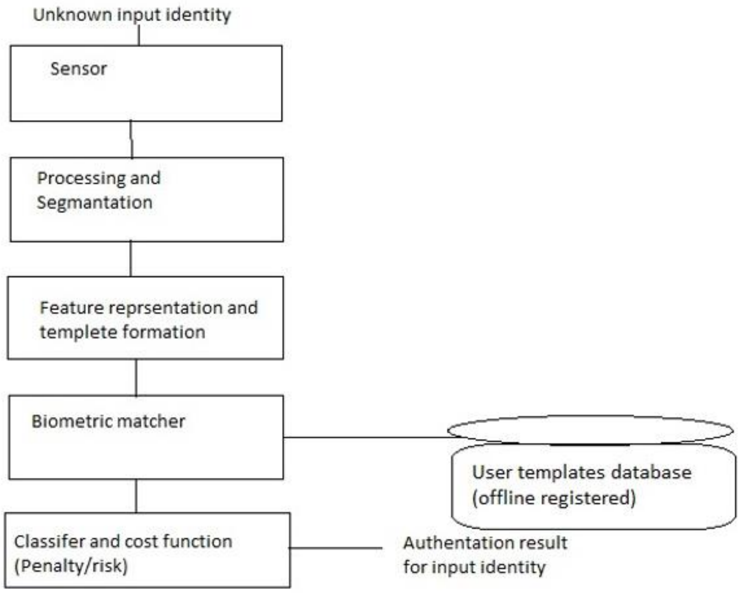
SSL Data Transfer

Thus, SSL fundamentally works using asymmetric cryptography and symmetric cryptography.

2. **What is time stamp protocol?**
   Ans: The Time-Stamp Protocol, or TSP is a cryptographic protocol for certifying timestamps using X. 509 certificates and public key infrastructure. The timestamp is the signer's assertion that a piece of electronic data existed at or before a particular time.
   a. **Describe Biometric Authentication**.

   Ans: Biometric authentication is considered the automatic identification or identity verification of an individual using either a biological feature possesses physiological characteristics like a signature. Biometric can be separated into two main categories:

- Physiological Characteristics: They are related to the shape of the body. The trait that has been used the longest, for over one hundred years, are fingerprints, other examples are face recognition, hand geometry and iris recognition.


Unknown input identity
Sensor
Processing and Segmantation
Feature reprsentation and templete formation
Biometric matcher
User templates database (offline registered)
Classifer and cost function (Penalty/risk)
Authentation result for input identity

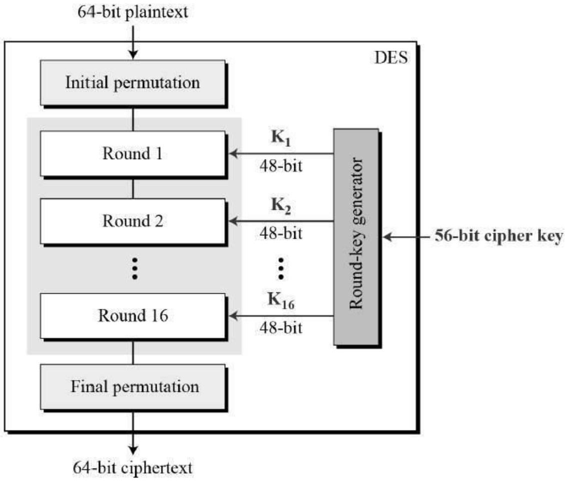
- Behavioural Characteristics: They are related to the behaviour of a person. The first characteristics to be used that is still widely used today is the signature.

- Biometric samples are collected using an appropriate sensor. The samples are then processed to correct the deterministic variations like translational and rotational shifts due to interaction of a sensor with the external world. This leads to set of "discriminatory" attributes that are invariant to irrelevant transformation of the input at the sensor.
- Following this segmentation/identification is performed to extract/recognize the desired attributes from the biometric samples.
- Measurements performed on these attributes give features depending upon the representation method.
- The features so obtained are used to form a biometric template. The biometric template is stored in one of the many encrypted forms so as to avoid spoofing.
- Once the database is ready, a query template needs to be authenticated using a matcher so as to determine its similarity with templates in the database.

The output of the matcher is a matching score which gives the degree of similarity of the query template with various templates. This is used to arrive at a decision using a classifier

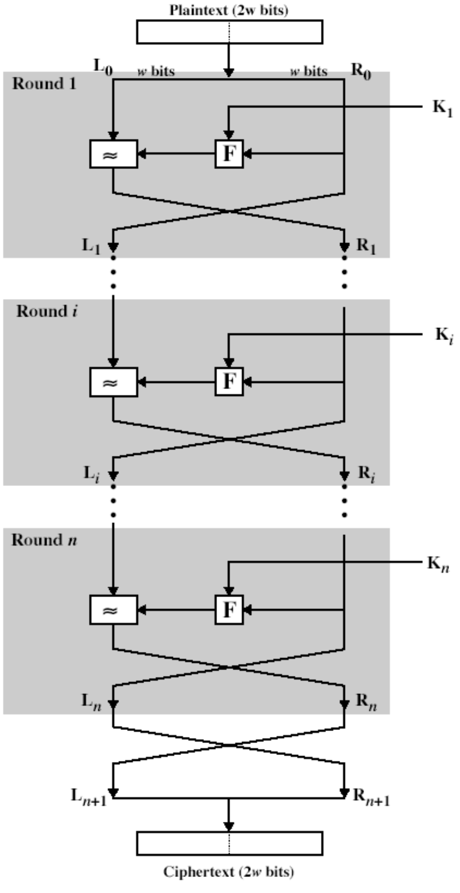
b. **What is DES? Explain its working**.

Ans: The Data Encryption Standard (DES) is a symmetric-key block cipher. DES is an implementation of a Feistel Cipher. It uses 16 round Feistel structure. The block size is 64-bit. General Structure of DES is given by



DES has three main phases − Round function, Key schedule, Initial and final permutation.

The input to the encryption algorithm are a plaintext block of length 64bits and a key K. the plaintext block is divided into two halves L_0 and R_0 of 32 bits each. The key K of 56 bits is compressed into 48 bits by discarding the 8th bit of each byte. The two halves of the data pass through 16 rounds of processing and then combine to produce the cipher text block. Each round "i" has inputs L_{i-1} and R_{i-1}, derived from the previous round, as well as the subkey K_i, derived from the overall key K. in general, the subkeys K_i are different from K and from each other. All rounds have the same structure. A substitution is performed on the left half of the data (as similar to S-DES). This is done by applying a round function F to the right half of the data and then taking the XOR of the output of that function and the left half of the data. The round function has the same general structure for each round but is parameterized by the round sub key K_i. Following this substitution, a permutation is performed that consists of the interchange of the two halves of the data. This structure is a particular form of the substitution-permutation network.



The process of decryption is essentially the same as the encryption process. The decryption algorithm will take the cipher text as input along with the subkey K_i in reverse order. At each round, the intermediate value of the

decryption process is same (equal) to the corresponding value of the encryption process with two halves of the value swapped.
After the last iteration of the encryption process, the two halves of the output are swapped, so that the cipher text is $R_{16} || L_{16}$. The output of that round is the cipher text.

3. **Different types of attacks?**

   Ans: The various types of attacks in computer system are Interruption, Interception, Modification, Fabrication

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b. **Explain Secure Electronic Transaction. Describe SET process**.

Ans: Secure Electronic Transaction (SET) is a standard protocol that is used for securing credit card transactions over insecure networks. SET itself is not a payment system. It is a a set of security protocols and formats that enables users to employ the existing credit card payment infrastructure on an open network in a secure fashion!

SET has following features:

- Maintains confidentiality of information: Information is provided only to the concerned recipient.
- SET takes care of Integrity of data.
- SET employs a particular subset of protocol for carrying out cardholder account authentication.
- SET employs a particular subset of protocol for carrying out Merchant authentication.

SET process: A SET system includes the following participants:

- Cardholder
- Merchant
- Issuer
- Acquirer
- Payment gateway
- Certification authority

Both cardholders and merchants must register with the CA (certificate authority) first, before they can buy or sell on the Internet. Once registration is done, cardholder and merchant can start to do transactions, which involve nine basic steps in this protocol, which is simplified.

- Customer browses the website and decides on what to purchase
- Customer sends order and payment information, which includes two parts in one message:
  a. Purchase order – this part is for merchant
  b. Card information – this part is for merchant's bank only.
- Merchant forwards card information (part b) to their bank
- Merchant's bank checks with the issuer for payment authorization
- Issuer sends authorization to the merchant's bank
- Merchant's bank sends authorization to the merchant
- Merchant completes the order and sends confirmation to the customer
- Merchant captures the transaction from their bank
- Issuer prints credit card bill (invoice) to the customer

4. **Define Password. What is plaintext password**.

Ans: A password is a string of characters used for authenticating a user on a computer system. Plain text means that the stored passwords are unencrypted, meaning they are stored as letter and symbols exactly as entered by the user in the database.

a. **State and explain RSA algorithm**.

Ans: RSA cryptosystem is a public key cryptosystem which has two aspects. Firstly generation of key pair and secondly encryption-decryption algorithms.

1. Generation of RSA Key Pair

The process of generation of keys pair is described below −

a) Generate the RSA modulus (n)

- Select two large primes, p and q.
- Calculate n=p*q. For strong unbreakable encryption, let n be a large number, typically a minimum of 512 bits.

b) Find Derived Number (e)

- Number e must be greater than 1 and less than (p − 1)(q − 1).
- There must be no common factor for e and (p − 1)(q − 1) except for 1. In other words two numbers e and (p – 1)(q – 1) are co prime.

c) Form the public key

- The pair of numbers (n, e) form the RSA public key and is made public.

d) Generate the private key

- Private Key d is calculated from p, q, and e. For given n and e, there is unique number d.
- Number d is the inverse of e modulo (p - 1)(q – 1). This means that d is the number less than (p - 1)(q - 1) such that when multiplied by e, it is equal to 1 modulo (p - 1)(q - 1).
- This can be written as : ed = 1 mod (p − 1)(q − 1)

The Extended Euclidean Algorithm takes p, q, and e as input and gives d as output.

Example

- Let two primes be p = 7 and q = 13. Thus, modulus n = pq = 7 x 13 = 91.

- Select e = 5, which is a valid choice since there is no number that is common factor of 5 and (p − 1)(q − 1) = 6 × 12 = 72, except for 1.
- The pair of numbers (n, e) = (91, 5) forms the public key.
- Input p = 7, q = 13, and e = 5 to the Extended Euclidean Algorithm. The output will be d = 29.
- Hence, public key is (91, 5) and private keys is (91, 29).

2. Encryption and Decryption

RSA Encryption :

- Suppose the sender wish to send some text message to someone whose public key is (n, e).
- The sender then represents the plaintext as a series of numbers less than n.
- To encrypt the first plaintext P=10 which is a number modulo n, the encryption process is $C = P^e \bmod n$
- plaintext P , we get cipher text $C = 10^5 \bmod 91=82$

RSA Decryption :

- Receiver after getting C, the plaintext $P = C^d \bmod n$
- Plaintext = $82^{29} \bmod 91 = 10$

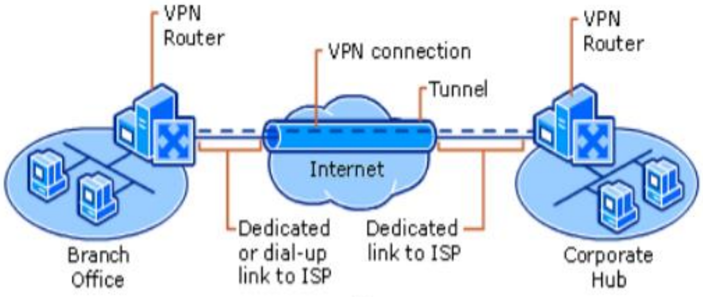
b. Describe VPN and its architecture.

Ans: VPN allows private communication through public internet. It is essentially a logical (virtual) network within a conventional network. It makes use of cryptography (IPSec in tunnel mode) to perform private communication through insecure and public internet.

There are two common types of VPNs.

- Remote-Access—Also called a Virtual Private Dial-up Network (VPDN), this is a user-to-LAN connection used by a company that has employees who need to connect to the private network from various remote locations.
- Site-to-Site—Through the use of dedicated equipment and large-scale encryption, a company can connect multiple fixed sites over a public network such as the Internet. Each site needs only a local connection to the same public network, thereby saving money on long private leased-lines.

VPN Architecture:



VPN Architecture

Tunneling is the process of encapsulating an entire packet within another packet and sending it over a network. Data tunneling is helpful in cases where it is desirable to hide the identity of the device originating the traffic. For example, a single device that uses IPsec encapsulates traffic that belongs to a number of hosts behind it and adds its own header on top of the existing packets. By encrypting the original packet and header (and routing the packet based on the additional layer 3 header added on top), the tunneling device effectively hides the actual source of the packet. Only the trusted peer is able to determine the true source, after it strips away the additional header and decrypts the original header. All the encryption protocols listed here also use tunneling as a means to transfer the encrypted data across the public network. It is important to realize that tunneling, by itself, does not provide data security. The original packet is merely encapsulated inside another protocol and might still be visible with a packet-capture device if not encrypted. It is mentioned here, however, since it is an integral part of how VPNs function.

A VPN offers following features.

- Data Confidentiality— Since your private data travels over a public network, data confidentiality can be attained by encrypting the data using IPsec protocol. This is the process of taking all the data that one computer is sending to another and encoding it into a form that only the other computer will be able to decode.
- IPsec— IPsec has two encryption modes: tunnel and transport. Tunnel mode encrypts the header and the payload of each packet while transport mode only encrypts the payload. Only systems that are IPsec-compliant can take advantage of this protocol. Also, all devices must use a common key or certificate and must have very similar security policies set up.
- Data Integrity— IPsec has a mechanism to ensure that the encrypted portion of the packet, or the entire header and data portion of the packet, has not been tampered with. If tampering is detected, the packet is dropped. Data integrity can also involve authenticating the remote peer.
- Data Origin Authentication—The identity of the source of the data that is sent can also verified.

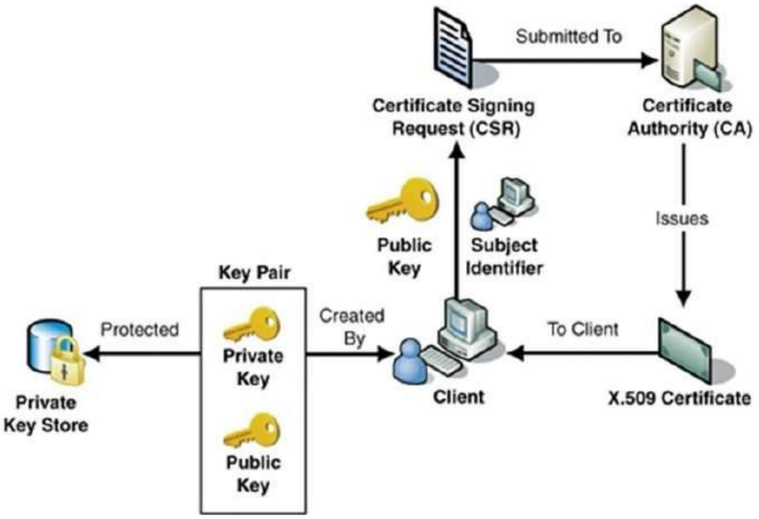
5. **Define IP security.**

Ans: The IP security (IPSec) is a protocols between two communication points across the IP network that provide data authentication, integrity, and confidentiality. It also defines the encrypted, decrypted and authenticated packets.

a. **Explain Digital certificate. What are certificate creation steps involve in it**.

Ans: A Digital Certificate is an electronic document which provides information to prove the identity of an entity. It binds the identity of an entity to its public key. Digital certificates contain some standard information such as the name of the certificate holder, public key, validity period, and also the digital signature of the certification authority. It is issued by a certification authority (CA). These are used with self-signatures and message encryption. Digital certificates are also known as public key certificates or identity certificates.

Digital certificate creation procedure: The CA accepts the application from a client to certify his public key. The CA, after duly verifying identity of client, issues a digital certificate to that client.



- Digital certificates are based on the ITU standard X.509 which defines a standard certificate format for public key certificates and certification validation. Hence digital certificates are sometimes also referred to as X.509 certificates.
  Public key pertaining to the user client is stored in digital certificates by The Certification Authority (CA) along with other relevant information such as client information, expiration date, usage, issuer etc.
- CA digitally signs this entire information and includes digital signature in the certificate.
- Anyone who needs the assurance about the public key and associated information of client, he carries out the signature validation process using CA's public key. Successful validation assures that the public key given in the certificate belongs to the person whose details are given in the certificate.

b. **Define authentication token. Explain it's feature**.

Ans: : A security token is a peripheral device used to gain access to an electronically restricted resource. The token is used in addition to or in place of a password. It acts like an electronic key to access something. Examples include a wireless keycard opening a locked door, or in the case of a customer trying to access their bank account online, the use of a bank-provided token can prove that the customer is who they claim to be.

Working:

A token is a piece of data created by server, and contains information to identify a particular user and token validity. The token will contain the user's information, as well as a special token code that user can pass to the server with every method that supports authentication, instead of passing a username and password directly.

Token-based authentication is a security technique that authenticates the users who attempt to log in to a server, a network, or some other secure system, using a security token provided by the server.

An authentication is successful if a user can prove to a server that he or she is a valid user by passing a security token. The service validates the security token and processes the user request.

After the token is validated by the service, it is used to establish security context for the client, so the service can make authorization decisions or audit activity for successive user requests.

Types of tokens:

Static password token

The device contains a password which is physically hidden (not visible to the possessor), but which is transmitted for each authentication. This type is vulnerable to replay attacks.

Synchronous dynamic password token

A timer is used to rotate through various combinations produced by a cryptographic algorithm. The token and the authentication server must have synchronized clocks.

Asynchronous password token

A one-time password is generated without the use of a clock, either from a one-time pad or cryptographic algorithm.

Challenge response token

Using public key cryptography, it is possible to prove possession of a private key without revealing that key. The authentication server encrypts a challenge (typically a random number, or at least data with some random parts) with a public key; the device proves it possesses a copy of the matching private key by providing the decrypted challenge.

6. Distinguish between plain text and cipher text.

Ans: The original intelligible messages are plane text and the transformed messages are called cipher text.

a. Explain private key management.

Ans: Since private or symmetric-key cryptography can be used for privacy and user authentication, various key management techniques used for the distribution of keys. Symmetric-key distribution involves the following problem:

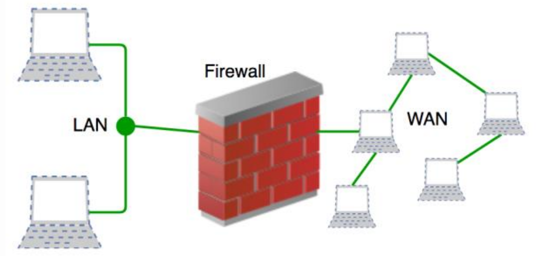
- For n people to communicate with each other requires n(n-1)/2 keys. The problem is aggravated as n becomes very large.
- Each person needs to remember (n-1) keys to communicate with the the remaining (n-1) persons.
- How the two parties will acquire the shared key in a secured manner?
- To address this problem, the concept of session key has emerged. A session key is created for each session and destroyed when the session is over.

  The Diffie-Hellman protocol is one of the most popular approach for providing one-time session key for both the parties.
- Used to establish a shared secret key Prerequisite: N is a large prime number such that (N-1)/2 is also a prime number. G is also a prime number. Both N and G are known to Sender and receiver • Sender chooses a large random number X and calculates R1 = G^X mod N and sends it to receiver
- Receiver chooses another large random number Y and calculates R2 = G^Y mod N and sends it to Sender
- The receiver calculates key (K) = $(R1)^Y$ mod N
- The sender calculates key (K) = $(R2)^X$ mod N

b. Define firewall. Describe types of firewall.

Ans: Firewall is a network security device, either hardware or software based, which monitors all incoming and outgoing traffic and based on defined set of security rules it accept, reject or drop that specific traffic.

Accept : allow the traffic
Reject : block the traffic but reply with an “unreachable error”
Drop : block the traffic with no reply
Firewall establishes a barrier between secured internal networks and outside untrusted network, such as Internet.



Types of firewall:

Packet Filtering Firewall : Packet filtering firewall is used to control network access by monitoring outgoing and incoming packet and allowing them to pass or stop based on source and destination IP address, protocols and ports. It analyses traffic at the transport protocol layer (but mainly uses first 3 layers). Packet firewalls treats each packet in Isolation. They have no ability to tell whether a packet is part of an existing stream of traffic. Only It can allow or deny the packets based on unique packet headers.

Stateful Inspection Firewall : Stateful firewalls (performs Stateful Packet Inspection) are able to determine the connection state of packet, unlike Packet filtering firewall, which makes it more efficient. It keeps track of the state of networks connection travelling across it, such as TCP streams. So the filtering decisions would not only be based on defined rules, but also on packet’s history in the state table.

Application Layer Firewall : Application layer firewall can inspect and filter the packets on any OSI layer, up to application layer. It has ability to block specific content, also recognize when certain application and protocols (like HTTP, FTP) are being misused.
In other words, Application layer firewalls are hosts that run proxy servers. A proxy firewall prevents direct connection between either side of firewall, each packet has to pass through the proxy. It can allow or block the traffic based on predefined rules.

Host- based Firewalls : Host-based firewall are installed on each network node which controls each incoming and outgoing packet. It is a software application or suit of applications, comes as a part of operating system. Host-based firewalls are needed because network firewalls cannot provide protection inside a trusted network. Host firewall protects each host from attacks and unauthorized access.
Network-based Firewalls : Network firewall function on network level. In other words, these firewalls filters all incoming and outgoing traffic across the network. It protects the internal network by filtering the traffic using rules defined on firewall. A Network firewall might have two or more network interface cards (NICs). Network-based firewall is usually a dedicated system with proprietary software installed.

7. **Differentiate between static and dynamic web pages.**

   Ans: Static" means unchanged or constant, while "dynamic" means changing or lively. Therefore, static Web pages contain the same prebuilt content each time the page is loaded, while the content of dynamic Web pages can be generated on-the-fly. ... Other types of Web pages, such as PHP, ASP, and JSP pages are dynamic Web pages.

   a. **Explain principle of security.**

Ans: Data Confidentiality, Data Integrity, Authentication, Availability and Non-repudiation are core principles of modern-day cryptography.

- Confidentiality refers to certain rules and guidelines usually executed under confidentiality agreements which ensure that the information is restricted to certain people or places.

Example: Let there are two people communicating via an encrypted email they know the decryption keys of each other and they read the email by entering these keys into the email program. If someone else can read these decryption keys when they are entered into the program, then the confidentiality of that email is compromised.

- Data integrity refers to maintaining and making sure that the data stays accurate and consistent over its entire life cycle.
  Example: Let's say you are doing an online payment of Rs.500, but your information is tampered without your knowledge in a way by sending to the seller Rs.5000, this would cost you too much.
- Authentication is the process of making sure that the piece of data being claimed by the user belongs to it.
- Availability refers to the ability to access data of a resource when it is needed, as such the information has value only if the authorized people can access at right time. Denying access to data nowadays has become a common attack. Imagine a downtime of a live server how costly it can be.
- Example: Let's say a hacker has compromised a webserver of a bank and put it down. You as an authenticated user want to do an e-banking transfer but it is impossible to access it, the undone transfer is money lost for the bank.
- Non-repudiation refers to ability to make sure that a person or a party associated with a contract or a communication cannot deny the authenticity of their signature over their document or the sending of a message.

b. Short notes

i. TCP/IP

Ans: TCP/IP stands for Transmission Control Protocol/Internet Protocol, which is a set of networking protocols that allows two or more computers to communicate.

- It is Connection-Oriented that is a virtual connection is established before any user data is transferred.
- It is Reliable that is every transmission of data is acknowledged by the receiver.
- It is Byte Stream that is the connection is treated as a stream of bytes
- It offers Buffering of data and determining when it is time to send a datagram.
- It is Full Duplex that means transfer of data in both directions.

ii. Smart card

Ans: A smart card is a special type of card like device which contains an integrated circuit chip embedded on it. The IC chip can be a microprocessor with memory or just simple memory circuit. In simple layman's words, a smart card is the card with which we can exchange the data, store it and manipulate data.

Smart-Card Features

- Authentication: Smart cards provide ways to authenticate others who want to gain access to the card.
- Secure data storage: Smart cards provide a way to securely store data on the card.
- Encryption: Smart cards provide a robust set of encryption capabilities, including key generation, secure key storage, hashing, and digital signing.
- Strong device security: Smart-card technology is extremely difficult to duplicate or forge, and has built-in tamper resistance.

- Secure communications: Smart cards provide secure communication between the card and reader.
- Biometrics: Smart cards provide ways to securely store biometric templates and perform biometric matching functions so improves privacy.

iii. PKIA model

Ans: Public Key Infrastructure X.509 provides assurance of public key. It provides the identification of public keys and their distribution. PKIX has following components.

- Public Key Certificate, commonly referred to as ‘digital certificate’.
- Private Key tokens.
- Certification Authority.
- Registration Authority.
- Certificate Management System.

- Digital certificates are based on the ITU standard X.509 which defines a standard certificate format for public key certificates and certification validation. Hence digital certificates are sometimes also referred to as X.509 certificates.
- Public key pertaining to the user client is stored in digital certificates by The Certification Authority (CA) along with other relevant information such as client information, expiration date, usage, issuer etc.
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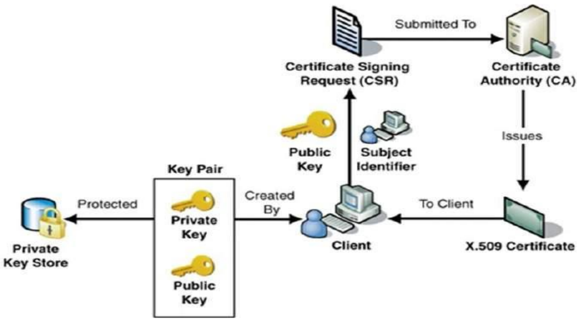

Certifying Authority (CA)

As discussed above, the CA issues certificate to a client and assist other users to verify the certificate. The CA takes responsibility for identifying correctly the identity of the client asking for a certificate to be issued, and ensures that the information contained within the certificate is correct and digitally signs it.

Registration Authority (RA)

CA may use a third-party Registration Authority (RA) to perform the necessary checks on the person or company requesting the certificate to confirm their identity. The RA may appear to the client as a CA, but they do not actually sign the certificate that is issued.

Private Key Tokens

While the public key of a client is stored on the certificate, the associated secret private key can be stored on the key owner's computer. This method is generally not adopted. If an attacker gains access to the computer, he can easily gain access to private key. For this reason, a private key is stored on secure removable storage token access to which is protected through a password.

The procedure is given below

- A client whose authenticity is being verified supplies his certificate, generally along with the chain of certificates up to Root CA.
- Verifier takes the certificate and validates by using public key of issuer. The issuer's public key is found in the issuer's certificate which is in the chain next to client's certificate.
- Now if the higher CA who has signed the issuer's certificate, is trusted by the verifier, verification is successful and stops here.
- Else, the issuer's certificate is verified in a similar manner as done for client in above steps. This process continues till either trusted CA is found in between or else it continues till Root CA.

iv. Digital signature

Ans: Digital signatures rely on certain types of encryption to ensure authentication. Encryption is the process of taking all the data that one computer is sending to another and encoding it into a form that only the other computer will be able to decode. Authentication is the process of verifying that information is coming from a trusted source. These two processes work hand in hand for digital signatures. Digital signature provides following securities:

Authentication: Digital signatures can be used to authenticate the source of messages. When ownership of a digital signature secret key is bound to a specific user, a valid signature shows that the message was sent by that user.

Integrity: if a message is digitally signed, any change in the message after signature invalidates the signature. Furthermore, there is no efficient way to modify a message and its signature to produce a new message with a valid signature, because this is still considered to be computationally infeasible by most cryptographic hash functions

Non-repudiation :By this non-repudiation property, an entity that has signed some information cannot at a later time deny having signed it. Similarly, access to the public key only does not enable a fraudulent party to fake a valid signature.