CNS Assignment-2

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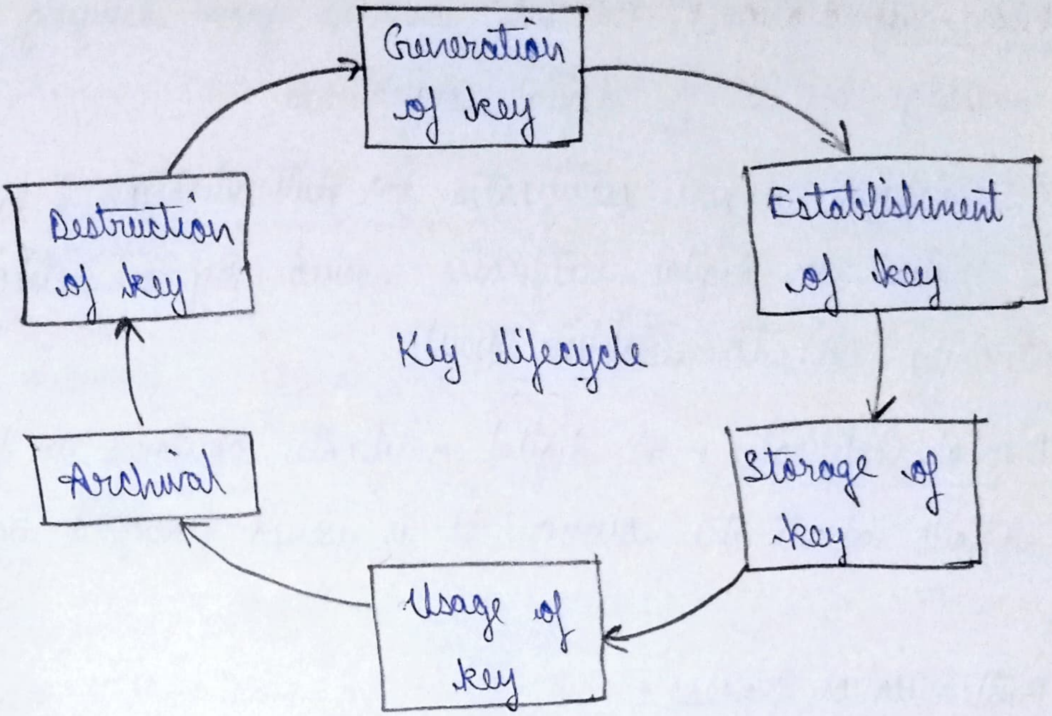
① Define Public Key Infrastructure (PKI) & explain its role in ensuring securing communication on the internet. How does PKI utilize digital certificates for authentication & encryption?

Ans:- Public Key Infrastructure (PKI) is the governing body behind issuing digital certificates. It helps to protect confidential data & gives unique identities to users & systems. Thus, it ensures security in communications. The public key infrastructure uses a pair of keys: the public key & the private key to achieve security. The public keys are prone to attacks & thus an intact infrastructure is needed to maintain them.

Managing keys in the Crypto System:-

→ The security of a cryptosystem relies on its keys. Thus, it is important that we have a solid key management system in place.

→ It involves managing the key life cycle which is as follows:-



Public Key Infrastructure affirms the usage of a public key. PKI identifies a public key along with its purpose. It usually consists of the following components:-

→ A digital certificate also called a public key certificate
→ Private key token
→ Registration authority
→ Certification authority
→ CMS or Certification Management System

Role of PKI in Secure Communication:-

① Authentication:- Confirms the identity of individuals, websites and organizations

② Encryption:- Protects sensitive data by encoding it so that only the intended recipient can read it.

③ Data Integrity:- Ensures that transmitted data remains unchanged & has not ~~has~~ been tampered with.

(4) Non-repudiation :- Prevents senders from denying they sent a message by using digital signatures

PKI utilizes digital certificates for Authentication & Encryption

PKI relies on digital certificates issued by a Certificate Authority (CA) to establish trust.

(1) Digital Certificates :- A digital certificate contains a public key & details about the owner. It is issued & signed by a trusted CA

(2) Authentication Process :-

→ When a client (browser) connects to a website, it receives the server's digital certificate.

→ The client verifies the Certificate's Authenticity by checking the CA's signature & certificate validity.

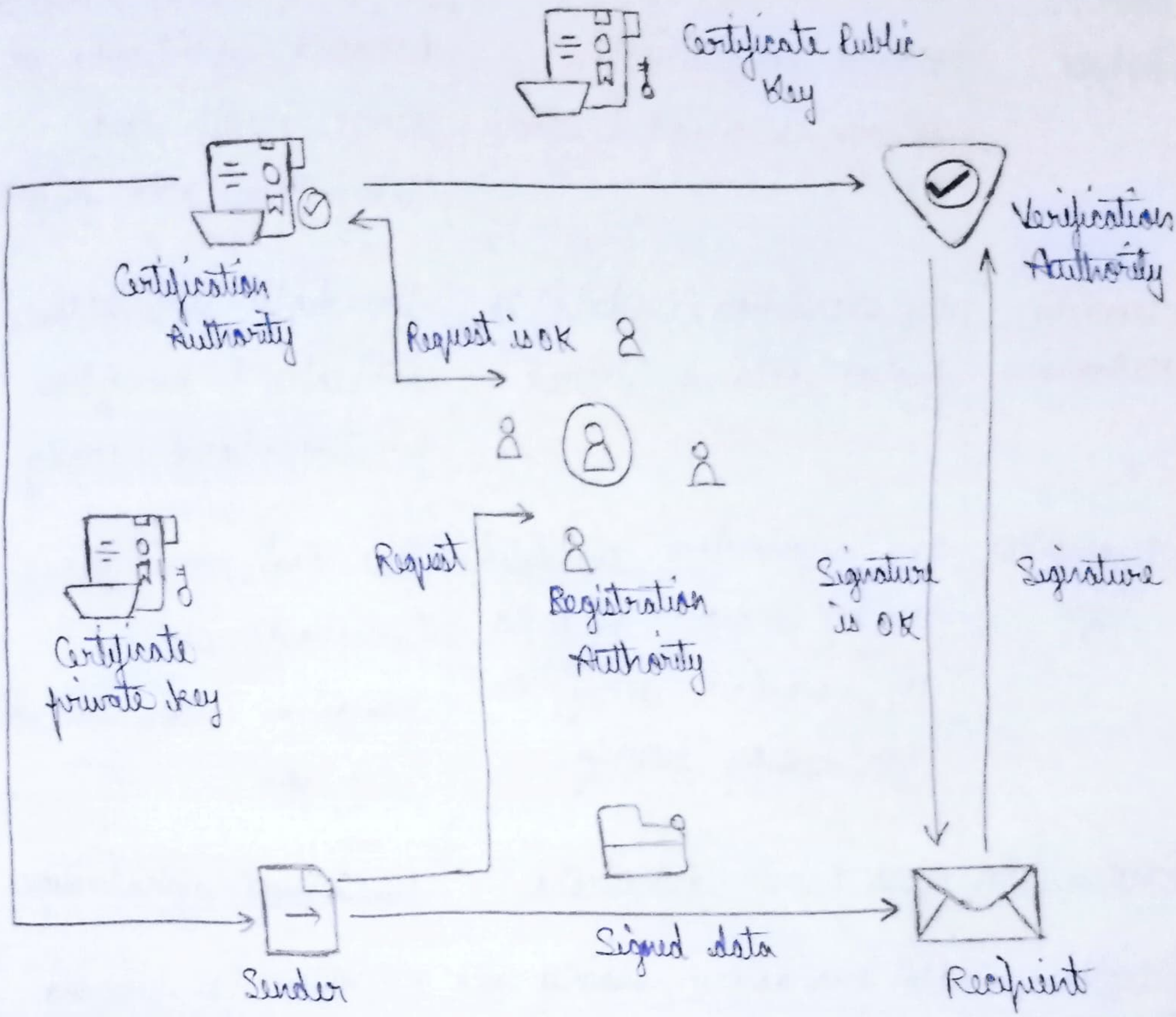
→ If valid, the client trusts the server's identity.

(3) Encryption Process :-

→ PKI uses asymmetric encryption to establish a secure session

→ The client encrypts a secret key using the server's public key from the certificate

→ Only the server can decrypt the secret key using its private key, establishing a secure encrypted channel.



② Compare and contrast secure socket layer (SSL) and secure electronic transaction (SET) protocols in terms of their

Ans: SSL & SET are both security protocols designed to secure online transactions, but they serve different purposes & have distinct security mechanisms.

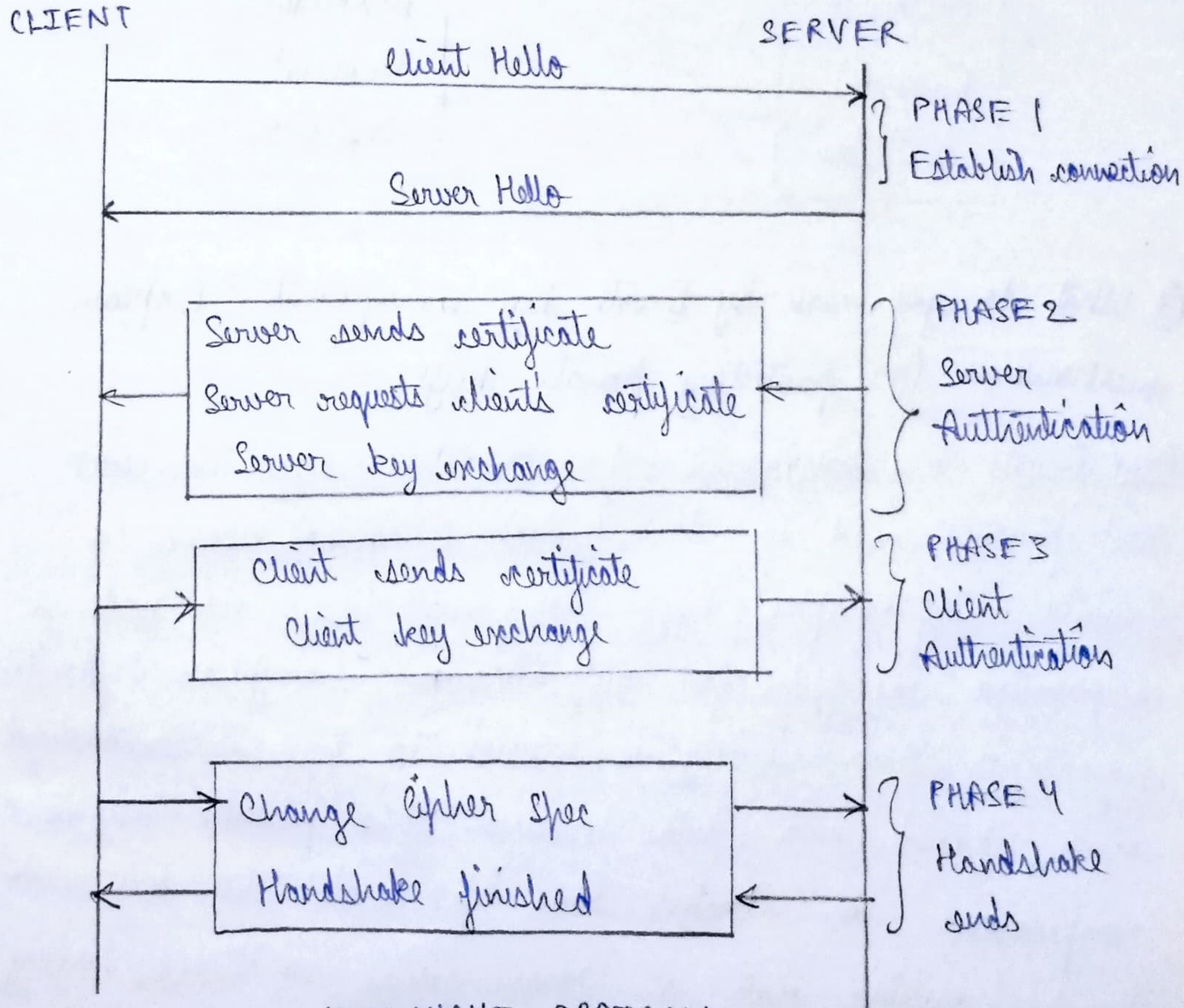
Feature	Secure Socket Layer (SSL)	Secure Electronic Transaction (SE
① Purpose	Secures communication between a client & server	Designed specifically for secure credit card transactions over interne
② Security Mechanisms	Uses encryption (SSL/TLS) to protect data in transit	Uses digital signatures, certificates & encryption for transactional security
③ Encryption Type	Uses asymmetric encryption for key exchange followed by symmetric encryption for session security.	Uses dual encryption (merchant sends transaction details but not card details
④ Authentication	Uses server authentication	Uses mutual authentication
⑤ Digital Signatures	Not mandatory, mainly used in SSL Certificates for website authentication	Mandatory for ensuring the integrity & authenticity of transactions
⑥ Certificate Authority (CA)	Certificates are issued to servers & sometimes clients	Involves multiples CAs for banks, merchants & customers
⑦ Ease of Implementation	Widely supported, easy to implement	Complex setup requiring special infrastructure & agreements between bank merchants & users
⑧ Usecase	General purpose secure communication (HTTPs, VPNs, emails, etc)	Used exclusively for online credit car transactions

Suitability for online transactions :

→ SSL is suitable for general web security including e-commerce, banking & private communication

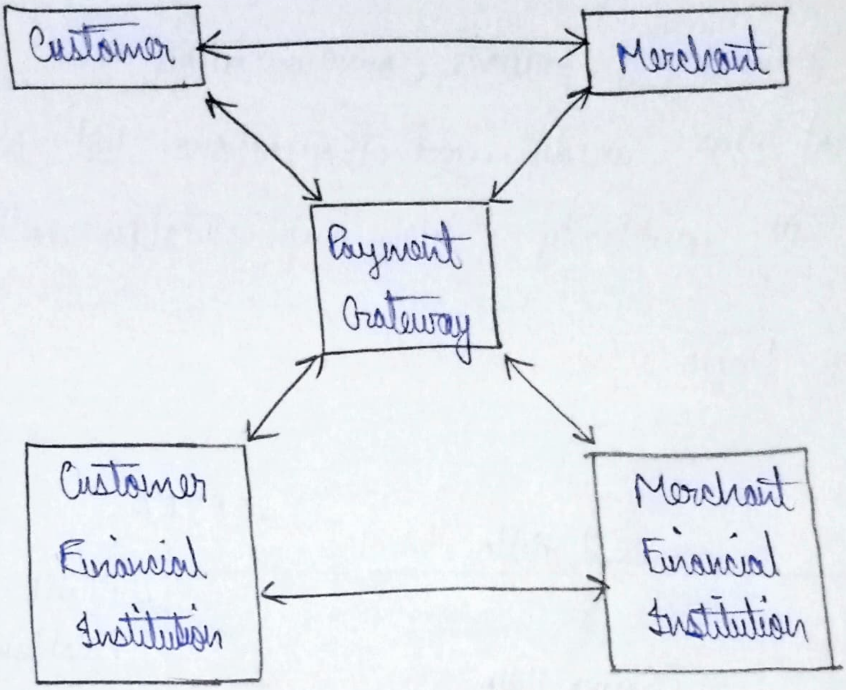
→ SET is ideal for credit card transactions but is rarely used due to its complexity & high implementation costs

Secure Socket Layer.



SSL HANDSHAKE PROTOCOL

Secure Electronic Transaction (SET) :


Customer
Merchant
Payment Gateway
Customer Financial Institution
Merchant Financial Institution

③ What do you mean by Private key management? Explain mechanisms for protecting private keys.

Ans: Private key management refers to the process, technologies, best practices used to store, protect & control access to private cryptographic keys. Since private keys are used in asymmetric encryption for authentication, encryption & digital signatures, thier security is crucial to prevent unauthorized access, fraud and data breaches. If a private key is compromised, an attacker can impersonate the key owner, decrypt sensitive data or forge digital signatures, leading to serious security risks.

Mechanisms for Protecting Private Keys :

(i) Hardware Security Modules (HSMs) :

→ Dedicated hardware devices designed to securely generate, store and manage private keys.

→ Prevents key extraction & provides tamper-proof security

→ Commonly used in banks, enterprise and cloud services

(ii) Secure Key Storage (Software & Hardware) :

→ Protects keys in Trusted Platform Modules (TPMs), secure enclaves and encrypted software storage (AES-256)

→ Prevents direct access to private keys, reducing risks of theft or leakage.

(iii) Multi Factor Authorization (MFA) for Key Access :

→ Requires multiple authentication methods (password + biometrics) to access private keys

→ Even if a password is compromised, attackers cannot ~~connect~~ access the key without additional verification

→ Used in cryptographic wallets, cloud key management systems & enterprise security.

(iv) Key Rotation & Expiry Policies :

→ Regularly updates and replaces private keys to maximize the risks associated with compromized keys.

→ If a key is exposed, its validity is limited to a short period.

→ Ex:- SSL/TLS Certificates expire every 1-2 years to enforce key updates

(v) <u>Access Control & Role based Policies:</u>

→ Limits access to private keys based on user roles & permissions

→ Ensures only authorized personnel or systems can access or use the keys.