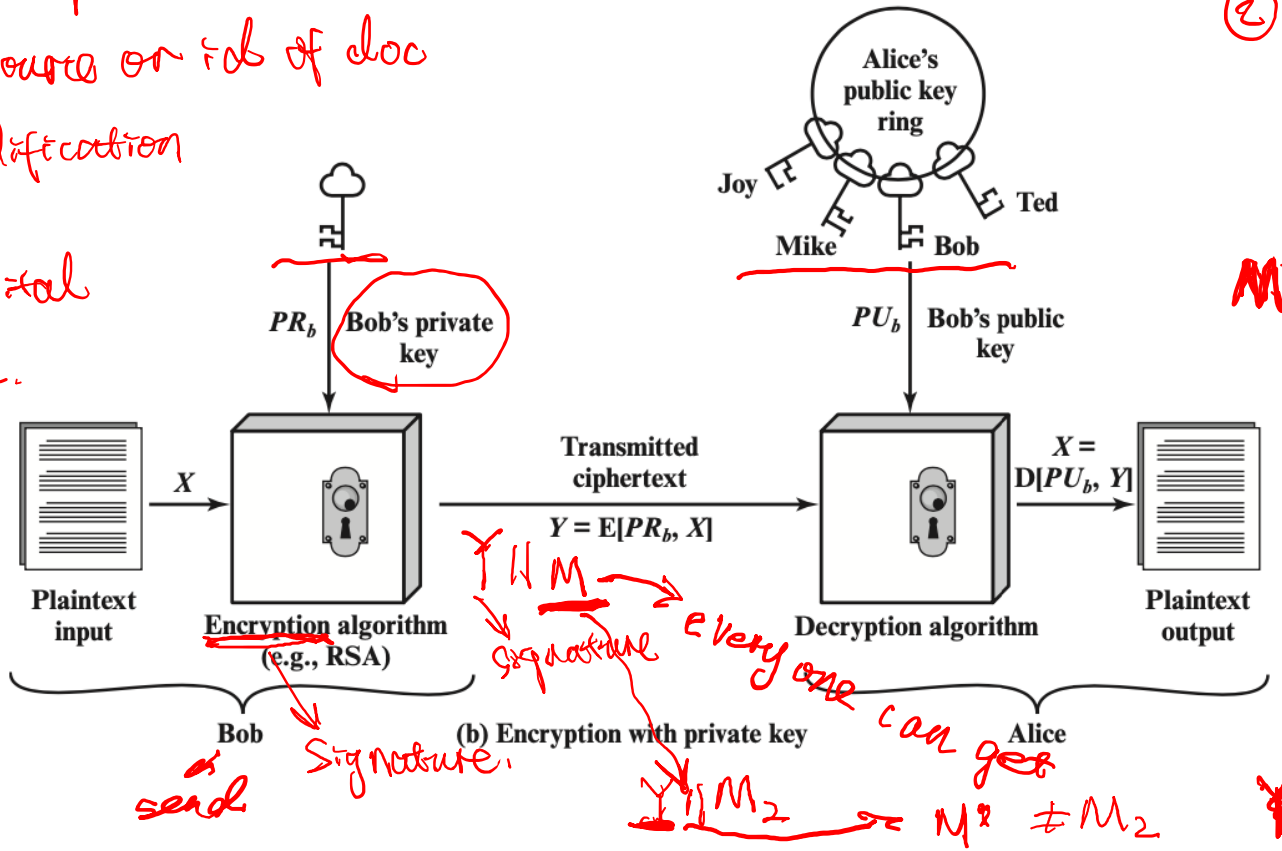
Encryption steps

- step1: generate a pair of keys
- step2: keep the private key / secret key (SK) and distribute the public key (PK) – place PK in a public register or other accessible file
- step3: Bob encrypts the message with Alice's PK
- step4: upon receiving the ciphertext (CT), Alice decrypt CT with SK

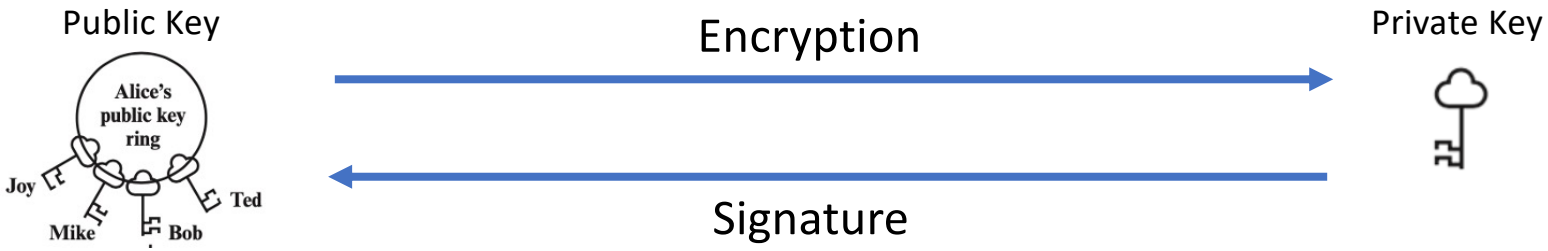
Public-Key Encryption: Definition

- Three parts:
  - KeyGen() → *PK*, *SK*: Generate a public/private keypair, where *PK* is the public key, and *SK* is the private (secret) key
  - Enc(*PK*, *M*) → *C*: Encrypt a plaintext *M* using public key *PK* to produce ciphertext *C*
  - Dec(*SK*, *C*) → *M*: Decrypt a ciphertext *C* using secret key *SK*
- Properties
  - **Correctness**: Decrypting a ciphertext should result in the message that was originally encrypted
    - Dec(*SK*, Enc(*PK*, *M*)) = *M* for all *PK*, *SK* ← KeyGen() and *M*
  - **Efficiency**: Encryption/decryption should be fast
  - **Security**: 1. Alice (the challenger) just gives Eve (the adversary) the public key, and Eve doesn't request encryptions. Eve cannot guess out anything; 2. computationally infeasible to recover M with PK and ciphertext

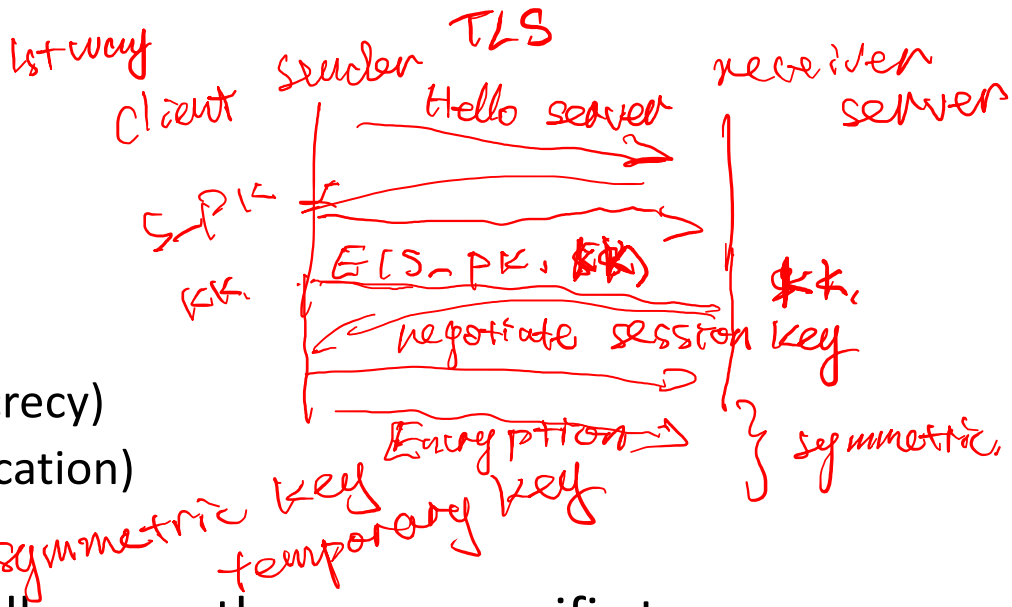
Public-Key Cryptography - Signature



Review


Public Key
Alice's public key ring
Joy
Ted
Mike
Bob
Encryption
Private Key
Signature

Public-Key application



- can classify uses into 3 categories:
  - **encryption/decryption** (provide secrecy)
  - **digital signatures** (provide authentication)
  - **key exchange** (of session keys)
- some algorithms are suitable for all uses; others are specific to one
- Either of the two related keys can be used for encryption, with the other used for decryption

Algorithm	Encryption/Decryption	Digital Signature	Key Exchange
RSA	Yes	Yes	Yes
Diffie–Hellman	No	No	Yes
DSS	No	No	Yes
Elliptic curve	Yes	Yes	Yes

Security of Public Key Schemes

- Keys used are very large (>512bits)
  - like private key schemes brute force **exhaustive search** attack is always theoretically possible
- Security relies on a large enough difference in difficulty between easy (en/decrypt) and hard (cryptanalyze) problems
  - more generally the hard problem is known, it's just made too hard to do in practice
- Requires the use of very large numbers, hence is slow compared to private/symmetric key schemes