Assignment No. 2 B

RSA digital signature cryptosystem

Problem Statement :

Implement a client and a server on different computers using python. Perform the authentication of sender between these two entities by using RSA digital signature cryptosystem.

Theory:

Digital Signature

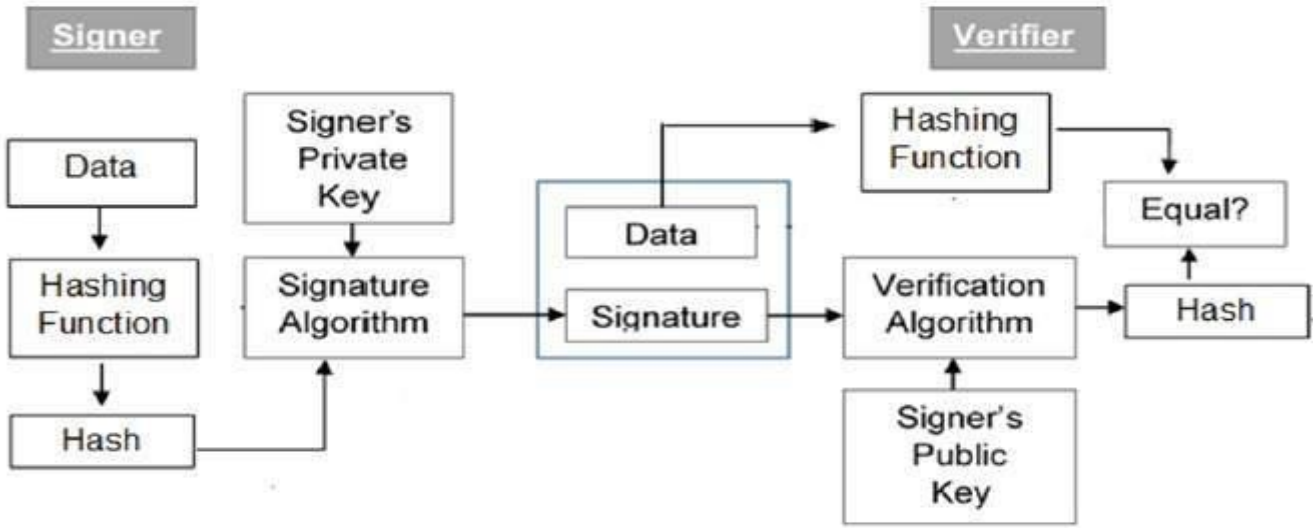
Digital signatures are the public-key primitives of message authentication. In the physical world, it is common to use handwritten signatures on handwritten or typed messages. They are used to bind signatory to the message. Similarly, a digital signature is a technique that binds a person/entity to the digital data. This binding can be independently verified by receiver as well as any third party.

Digital signature is a cryptographic value that is calculated from the data and a secret key known only by the signer.

In real world, the receiver of message needs assurance that the message belongs to the sender and he should not be able to repudiate the origination of that message. This requirement is very crucial in business applications, since likelihood of a dispute over exchanged data is very high.

Model of Digital Signature

The model of digital signature scheme is depicted in the following illustration −



The following points explain the entire process in detail −

- Each person adopting this scheme has a public-private key pair.
- Generally, the key pairs used for encryption/decryption and signing/verifying are different. The private key used for signing is referred to as the signature key and the public key as the verification key.
- Signer feeds data to the hash function and generates hash of data.
- Hash value and signature key are then fed to the signature algorithm which produces the digital signature on given hash. Signature is appended to the data and then both are sent to the verifier.
- Verifier feeds the digital signature and the verification key into the verification algorithm. The verification algorithm gives some value as output.
- Verifier also runs same hash function on received data to generate hash value.
- For verification, this hash value and output of verification algorithm are compared. Based on the comparison result, verifier decides whether the digital signature is valid.
- Since digital signature is created by 'private' key of signer and no one else can have this key; the signer cannot repudiate signing the data in future.

It should be noticed that instead of signing data directly by signing algorithm, usually a hash of data is created. Since the hash of data is a unique representation of data, it is sufficient to sign the hash in place of data. The most important reason of using hash instead of data directly for signing is efficiency of the scheme.

RSA is used as the signing algorithm. The encryption/signing process using RSA involves modular exponentiation.Signing large data through modular exponentiation is computationally expensive and time consuming. The hash of the data is a relatively small digest of the data, hence signing a hash is more efficient than signing the entire data.

Algorithm

RSA Key Generation:

- Choose two large prime numbers p and q
- Calculate n=p*q
- Select public key e such that it is not a factor of (p-1)*(q-1)
- Select private key d such that the following equation is true (d*e)mod(p-1)(q-1)=1 or d is inverse of E in modulo (p-1)*(q-1)

RSA Digital Signature Scheme: In RSA, d is private; e and n are public.

- Alice creates her digital signature using S=M^d mod n where M is the message
- Alice sends Message M and Signature S to Bob
- Bob computes M1=S^e mod n
- If M1=M then Bob accepts the data sent by Alice.

Conclusion – The **RSA** public-key cryptosystem provides a **digital signature scheme** (sign + verify), based on the math of the **modular exponentiations** and discrete logarithms and the computational difficulty.