Digital Signatures and PKI

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Under the Aegis of

Controller of Certifying Authorities (CCA)
Government of India

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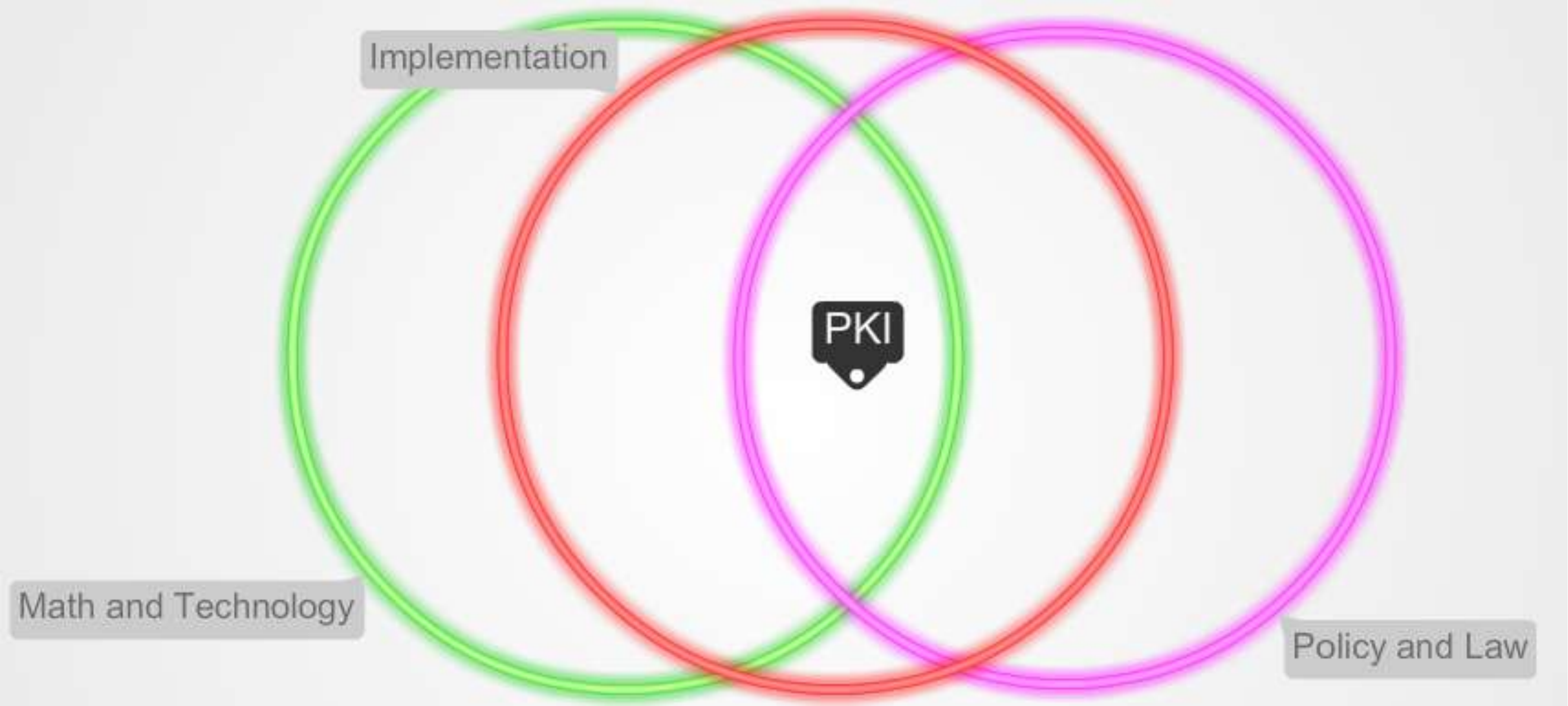
Agenda

- ✓ Dimensions of PKI
- ✓ What & Why: Digital Signature?
- ✓ Achieving Confidentiality
- ✓ What is Digital Signature Certificate?
- ✓ Certifying Authority & Trust Model
- ✓ Certificate Issuance, Types, Classes
- ✓ Certificate Life Cycle Management and Validation Methods
- ✓ Risks and Precautions with DS
- ✓ Policy and Legal Aspects of PKI
- ✓ Case Study
- ✓ e-Sign – A new Online way of Digital Signing in India
- ✓ PKI Applications in India

Dimensions of PKI



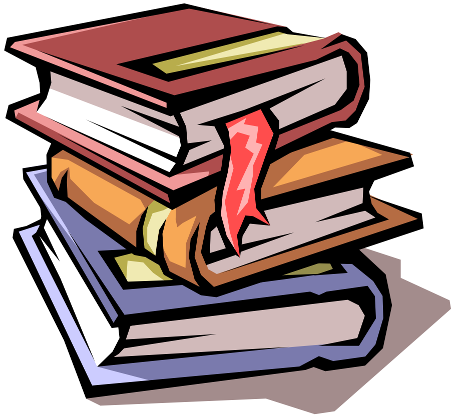
- PKI – Public Key Infrastructure ecosystem is an intersection of:
  - Cryptography (Math) – Cryptographers/Researchers
  - Technology & Implementation – PKI System Developer
  - Policy & Law – PKI System & Users

Basics

Paper Records v/s Electronic Records

Paper Records v/s Electronic Records

	Paper Record	Electronic Record
Document Form	Physical	Digital
Very easy to make copies	No	Yes
Very fast distribution	No	Yes
Archival and Retrieval	Challenging	Easy
Copies are as good as original	No. Copies are easily distinguishable	Yes
Easily modifiable	No	Yes
Environmental Friendly	No	Yes



Trust-worthiness in Transactions

The following properties must be assured:

Privacy (Confidentiality): Ensuring that only Authorized persons should read the Data/Message/Document

Authenticity: Ensuring that Data/Message/Document are genuine

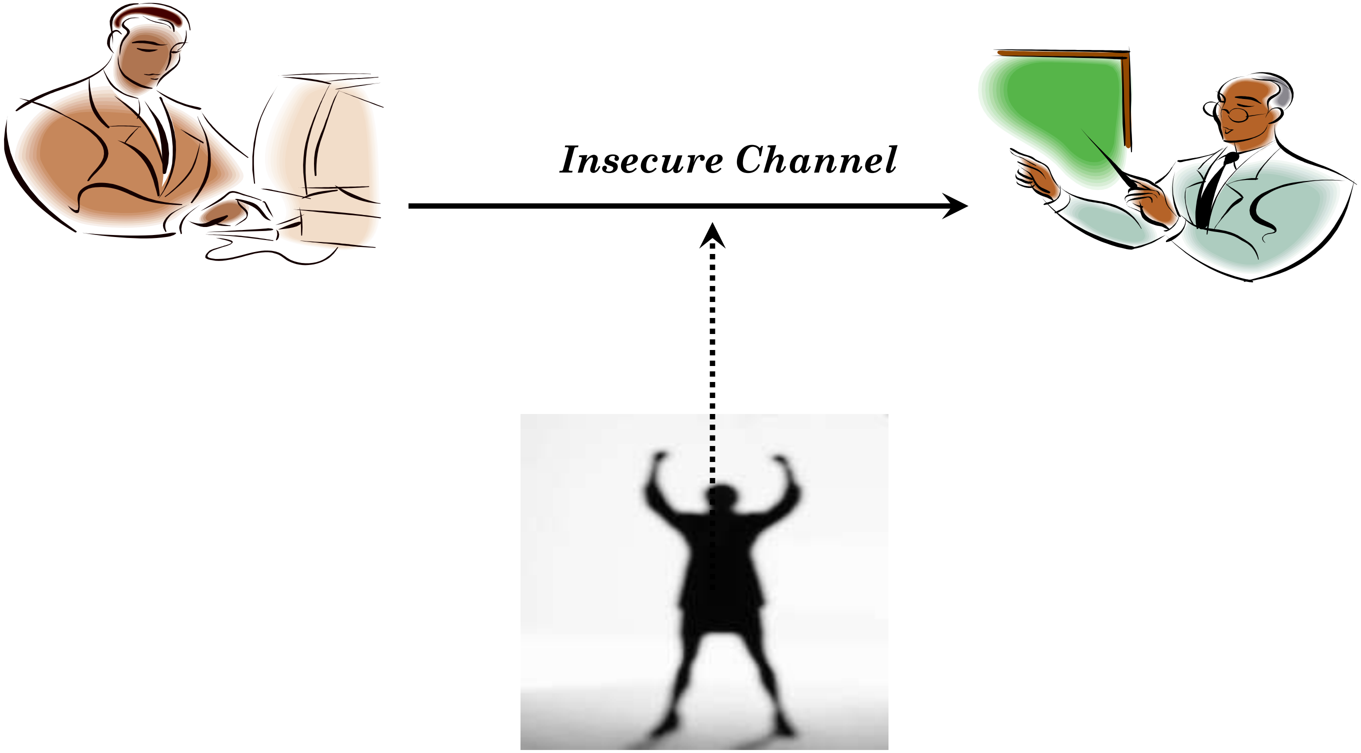
Integrity : Ensuring that Data/Message/Document are unaltered by unauthorized person during transmission

Non-Repudiation: Ensuring that one party of a transaction cannot deny having sent a message

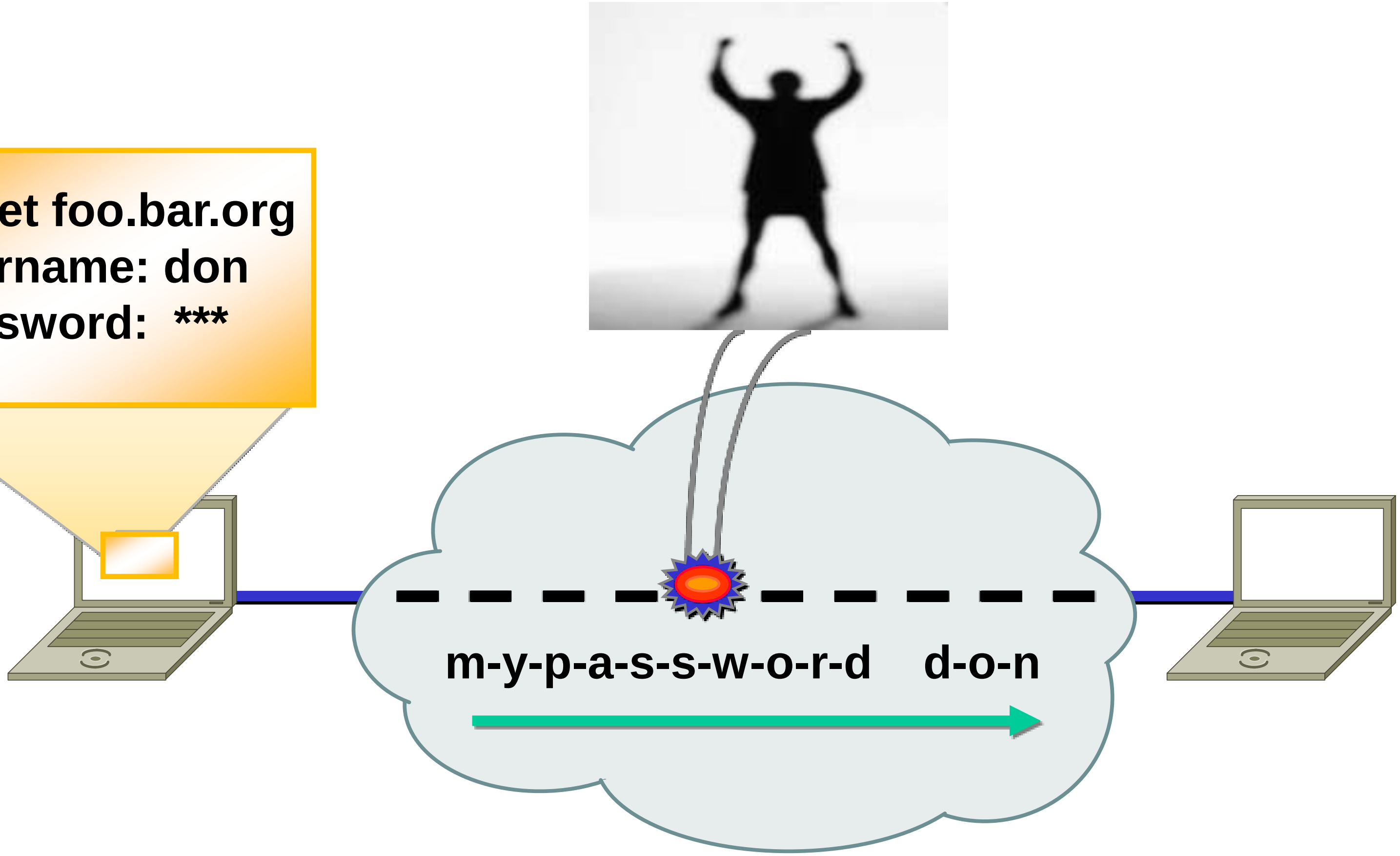
Paper Records v/s Electronic Records

	Paper Record	Electronic Record
Privacy (Confidentiality)	Sealed Envelope	Encryption
Authenticity	Hand Signature	Digital Signature
Integrity	Hand Signature	Digital Signature
Non-Repudiation	Hand Signature but it is Challenging	Digital Signature

The Scenario

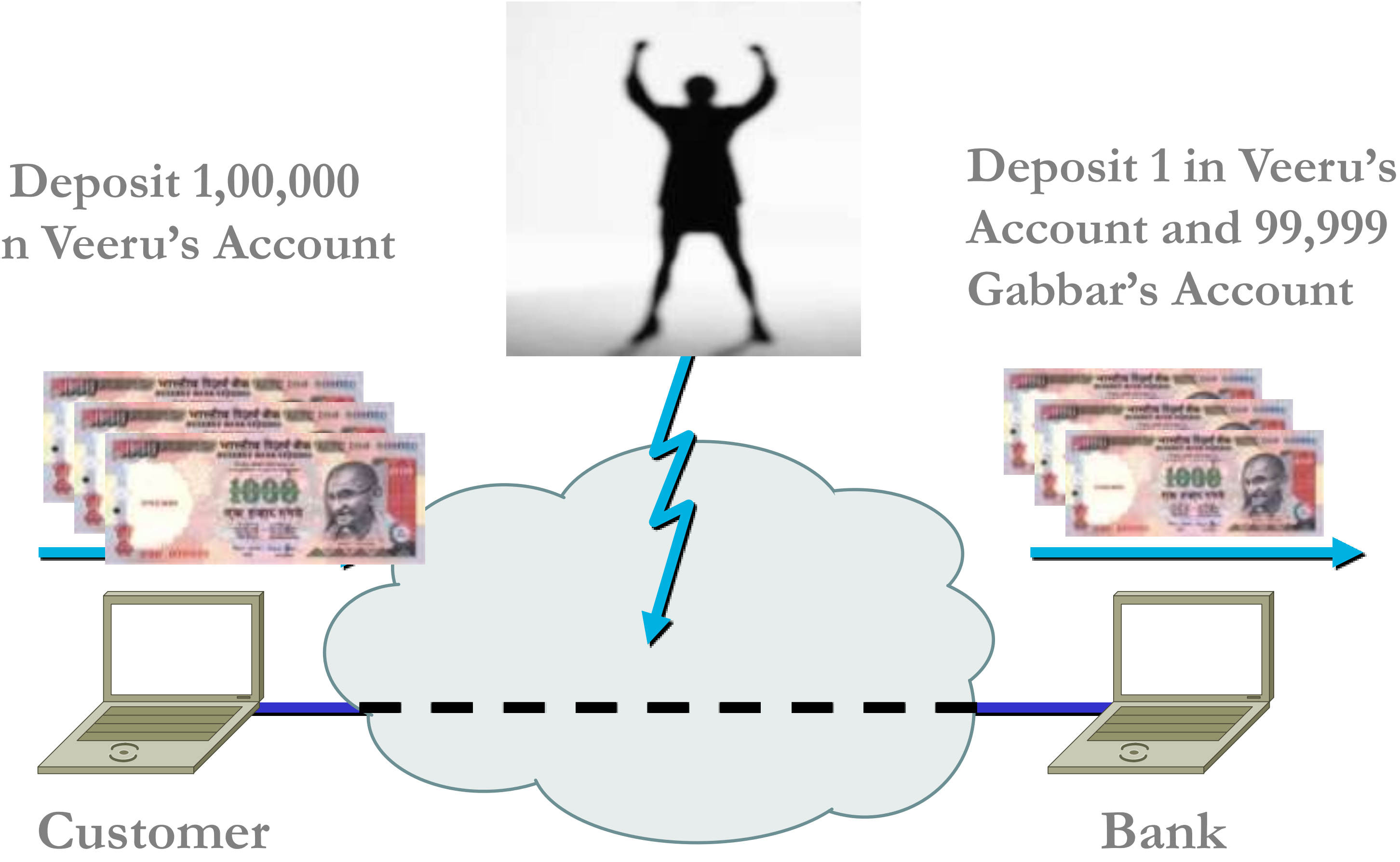


Threats: Packet Sniffing



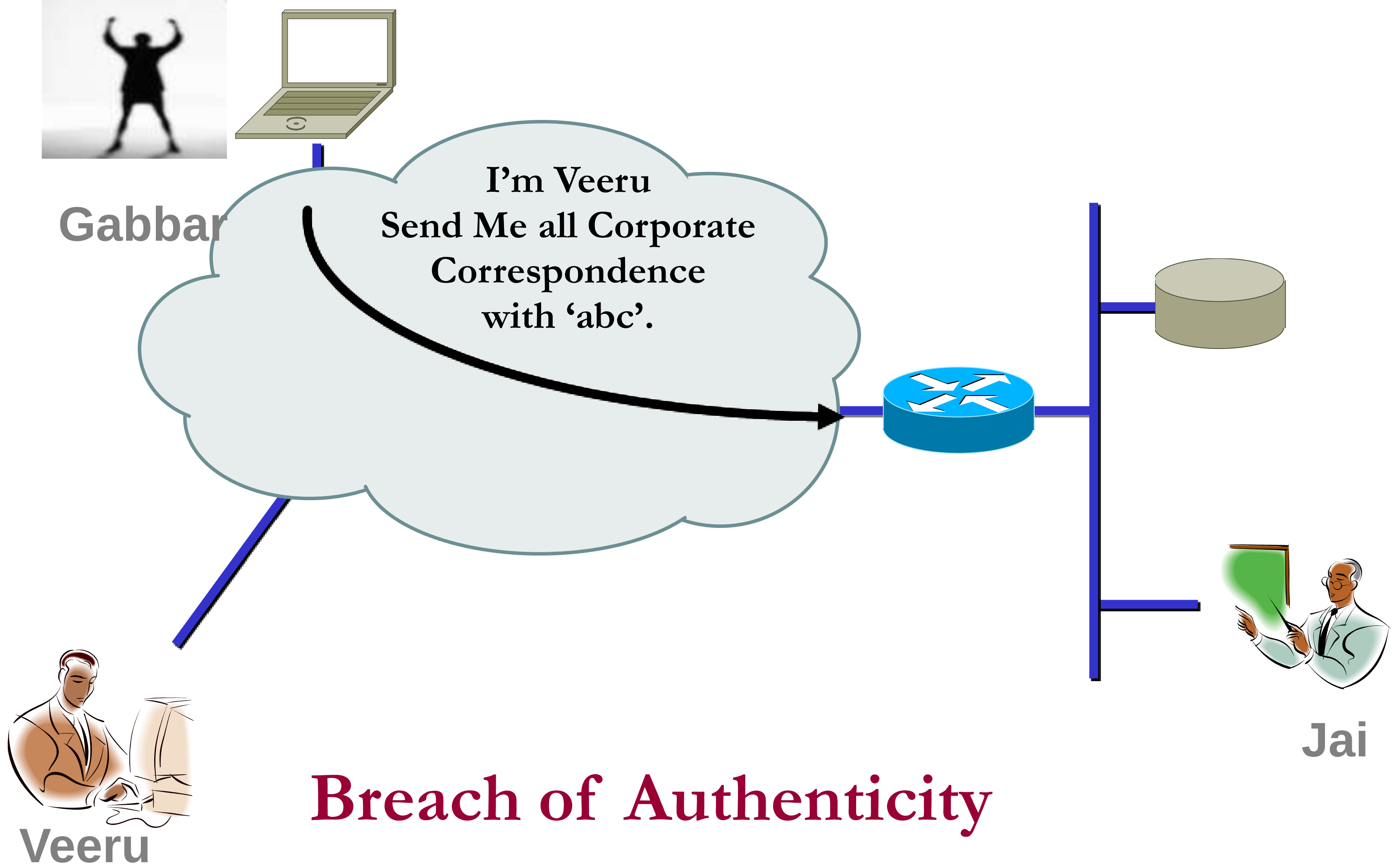
Breach of Confidentiality

Threats: Data Alteration



Breach of Integrity

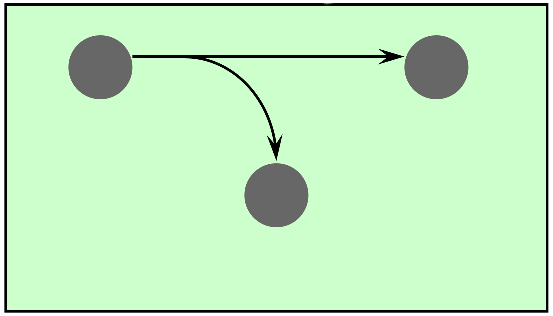
Threats: Spoofing



Breach of Authenticity

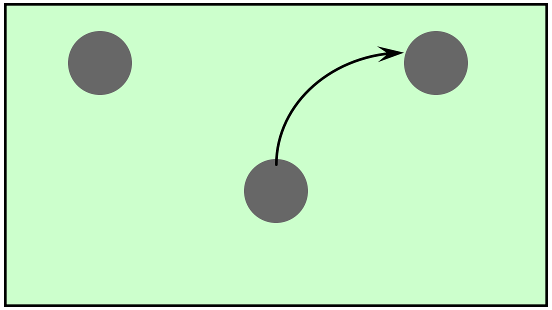
Understanding threats to PAIN

Privacy



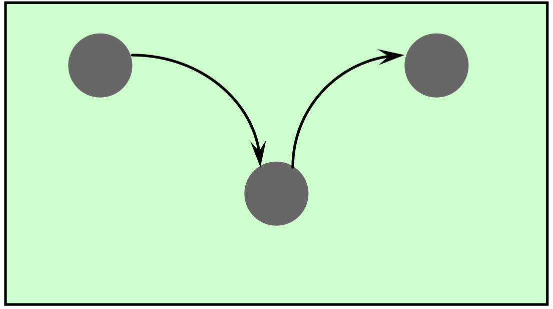
Interception

Authentication



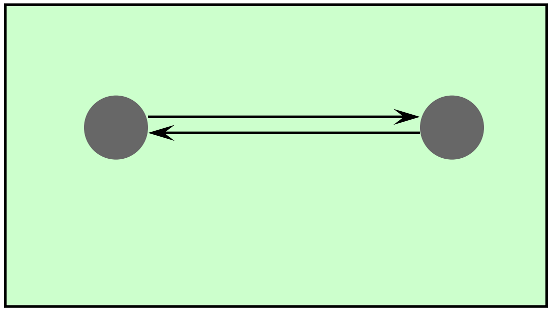
Spoofing

Integrity



Modification

Non-repudiation



Proof of parties involved

Why Digital Signature?

Why Digital Signatures?

- To provide **Authenticity, Integrity and Non-repudiation** to electronic documents
- To enable the use of Internet as the safe and secure medium for e-Commerce and e-Governance

Mathematical Perspective

Major Components of Digital Signature

- Major cryptographic components for creating Digital Signature are:
  - Hash Functions
  - Asymmetric Key Cryptography

Hash Function

- A hash function is a cryptographic mechanism that operates as one-way function
  - Creates a digital representation or "fingerprint“ (Message Digest)
  - Fixed size output
  - Change to a message produces different digest

Examples : MD5 , Secure Hashing Algorithm (SHA)

Hash - Example

Message

Hi Jai,

I will be in the park at

3 pm

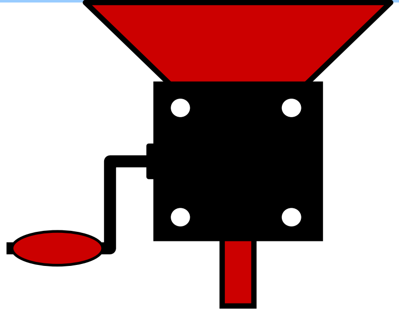
Veeru

Hi Jai,

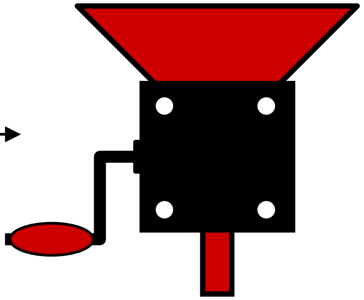
I will be in the park at

8 pm

Veeru



← Hash Algorithm →



Message Digest

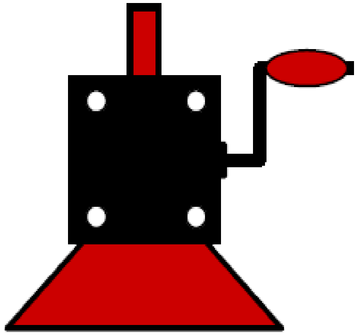
cfa2ce53017030315fde705b9382d9f4

d4216ytf6b9385fe502b165dfe8cec17

Digests are Different

Hash – One-way

cfa2ce53017030315fde705b9382d9f4



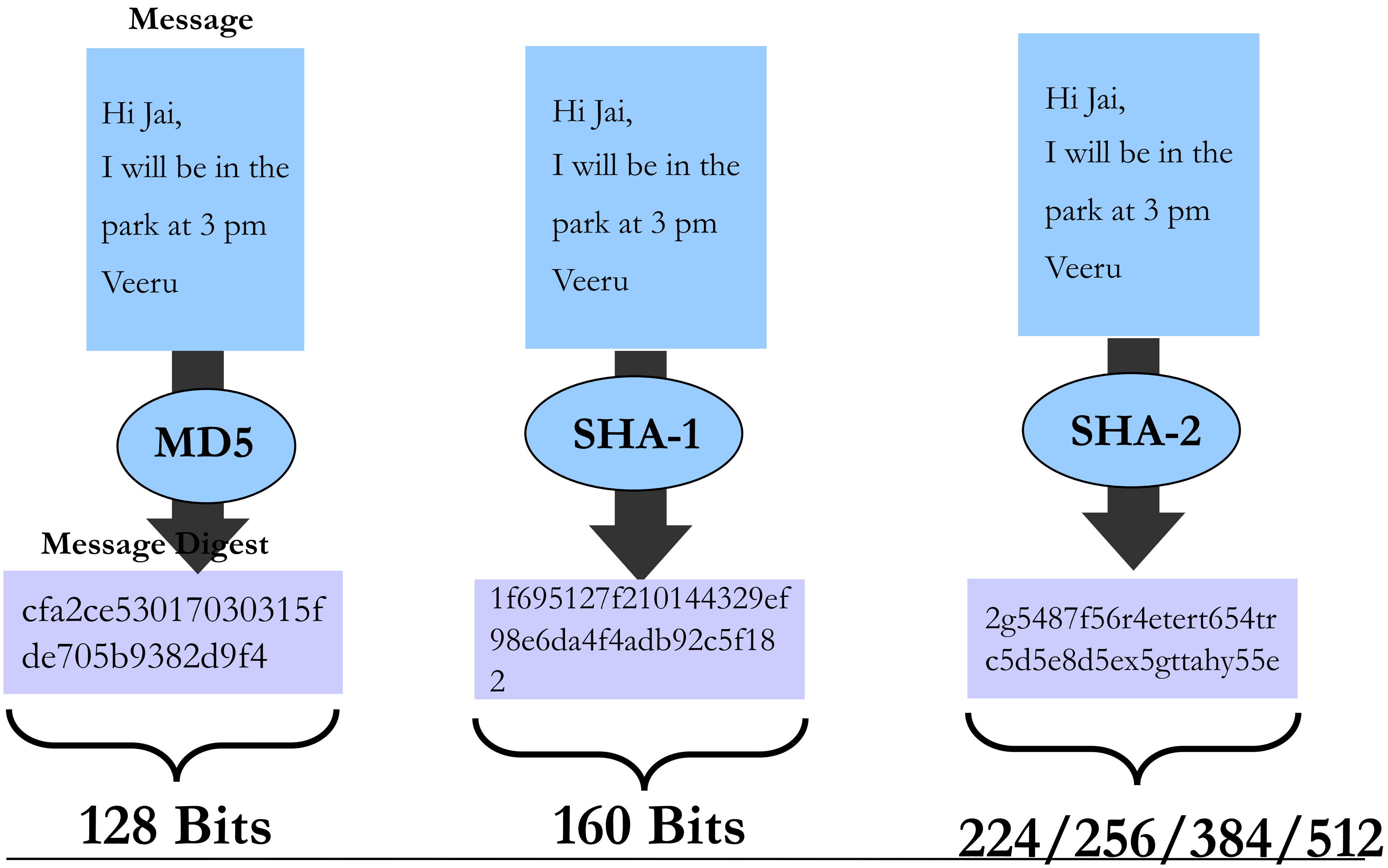
Hi Jai,

I will be in the park at

3 pm

Veeru

MD5 and SHA



Message

Hi Jai,

I will be in the park at 3 pm

Veeru

MD5

Message Digest

cfa2ce53017030315f de705b9382d9f4

128 Bits

Hi Jai,

I will be in the park at 3 pm

Veeru

SHA-1

1f695127f210144329ef 98e6da4f4adb92c5f18 2

160 Bits

Hi Jai,

I will be in the park at 3 pm

Veeru

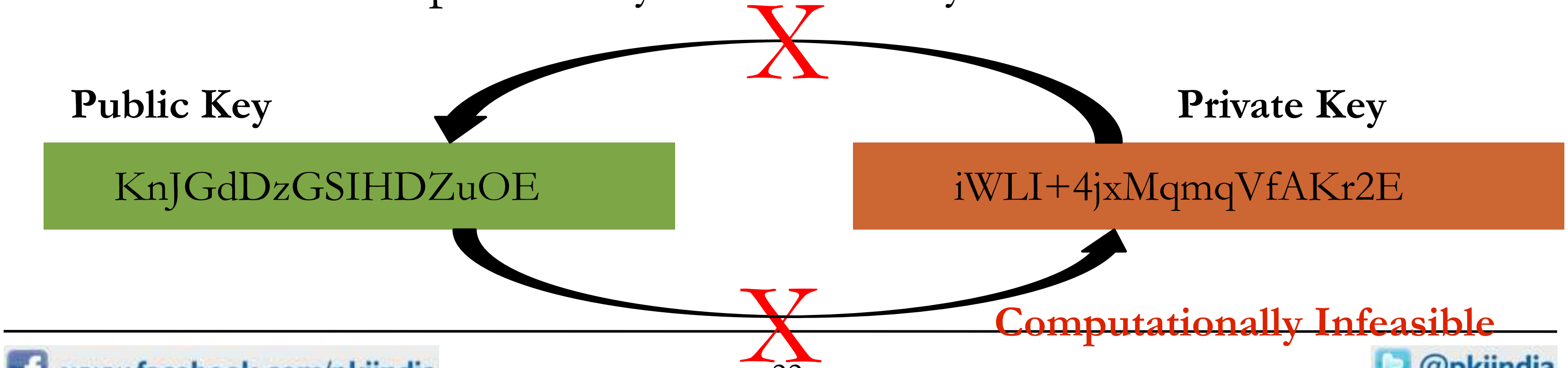
SHA-2

2g5487f56r4etert654tr c5d5e8d5ex5gttahy55e

224/256/384/512

Asymmetric Key Cryptography

- Also called as Public Key Cryptography
- Uses a related key pair wherein one is Private key and another is Public key
  - One for encryption, another for decryption
- Knowledge of the *encryption* key doesn't give you knowledge of the *decryption* key
- A tool generates a related key pair (public & private key)
  - Publish the public key in a directory



Public Key

KnJGdDzGSIHDZuOE

Private Key

iWLI+4jxMqmqVfAKr2E

Computationally Infeasible

RSA Key pair

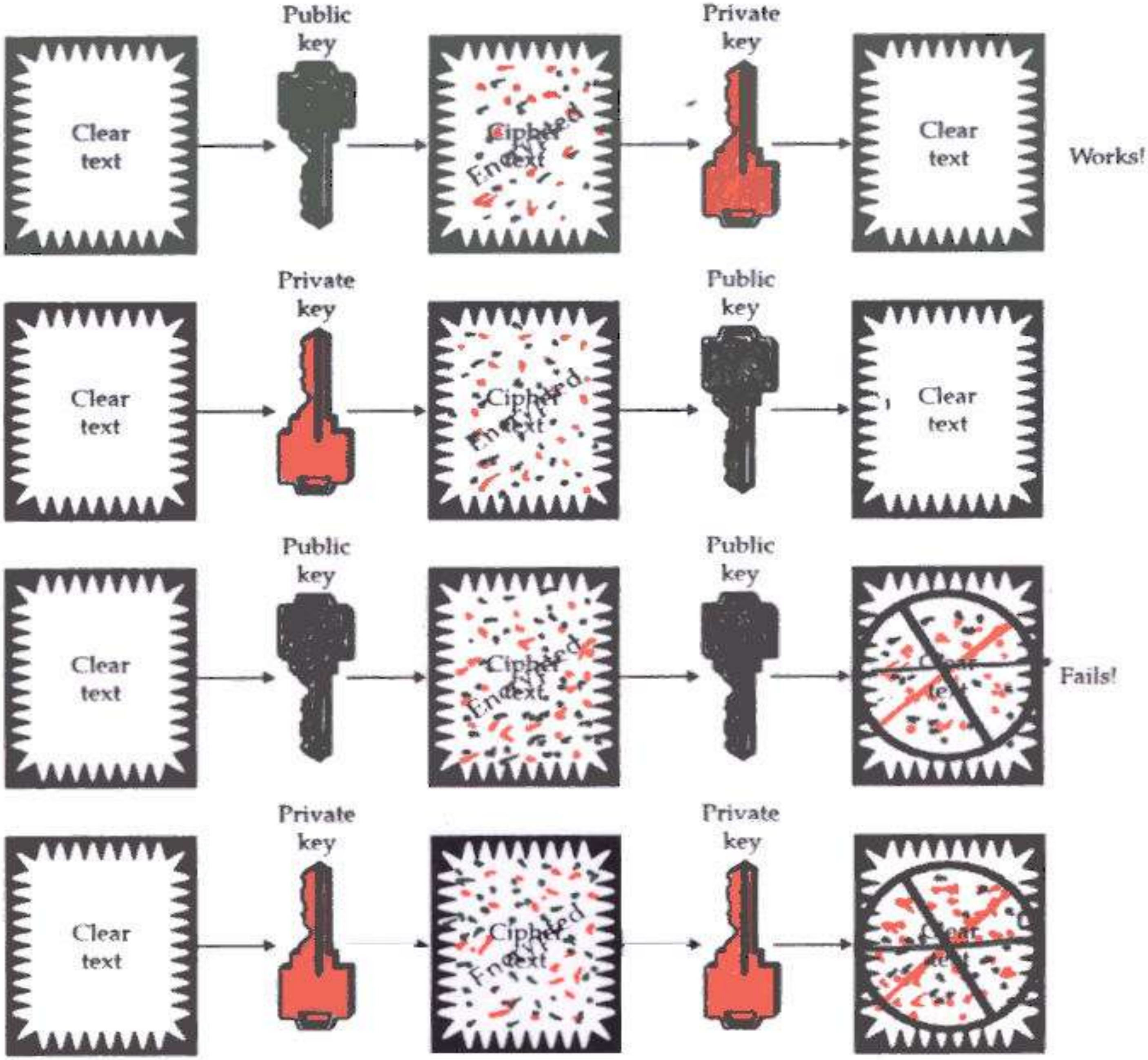
(including Algorithm identifier) [2048 bit]

Private Key

```
3082 010a 0282 0101 00b1 d311 e079 5543 0708 4ccb 0542 00e2 0d83
463d e493 bab6 06d3 0d59 bd3e c1ce 4367 018a 21a8 efbc ccd0 a2cc
b055 9653 8466 0500 da44 4980 d854 0aa5 2586 94ed 6356 ff70 6ca3
a119 d278 be68 2a44 5e2f cfcc 185e 47bc 3ab1 463d 1ef0 b92c 345f
8c7c 4c08 299d 4055 eb3c 7d83 deb5 f0f7 8a83 0ea1 4cb4 3aa5 b35f
5a22 97ec 199b c105 68fd e6b7 a991 942c e478 4824 1a25 193a eb95
9c39 0a8a cf42 b2f0 1cd5 5ffb 6bed 6856 7b39 2c72 38b0 ee93 a9d3
7b77 3ceb 7103 a938 4a16 6c89 2aca da33 1379 c255 8ced 9cbb f2cb
5b10 f82e 6135 c629 4c2a d02a 63d1 6559 b4f8 cdf9 f400 84b6 5742
859d 32a8 f92a 54fb ff78 41bc bd71 28f4 bb90 bcff 9634 04e3 459e
a146 2840 8102 0301 0001
```

Public Key

```
3082 01e4 f267 0142 0f61 dd12 e089 5547 0f08 4ccb 0542 00e2 0d83 463d
e493 bab6 0673 0d59 bf3e c1ce 4367 012a 11a8 efbc ccd0 a2cc b055 9653
8466 0500 da44 4980 d8b4 0aa5 2586 94ed 6356 ff70 6ca3 a119 d278 be68
2a44 5e2f cfcc 185e 47bc 3ab1 463d 1df0 b92c 345f 8c7c 4c08 299d 4055
eb3c 7d83 deb5 f0f7 8a83 0ea1 4cb4 3aa5 b35f 5a22 97ec 199b c105 68fd
e6b7 a991 942c e478 4824 1a25 193a eb95 9c39 0a8a cf42 b250 1cd5 5ffb
6bed 6856 7b39 2c72 38b0 ee93 a9d3 7b77 3ceb 7103 a938 4a16 6c89 2aca
da33 1379 c255 8ced 9cbb f2cb 5b10 f82e 6135 c629 4c2a d02a 63d1 6559
b4f8 cdf9 f400 84b6 5742 859d 32a8 f92a 54fb ff78 41bc bd71 28f4 bb90
bcff 9634 04de 45de af46 2240 8410 02f1 0001
```


Public key
Private key
Clear text
Ciphered text
Clear text
Works!
Private key
Public key
Clear text
Ciphered text
Clear text
Public key
Public key
Clear text
Ciphered text
Clear text
Fails!
Private key
Private key
Clear text
Ciphered text
Clear text

Matrix of Knowledge of Keys

Key details	***A* should know**	***B* should know**
A’s private key	Yes	No
A’s public key	Yes	Yes
B’s private key	No	Yes
B’s public key	Yes	Yes

Technology & Implementation Perspective

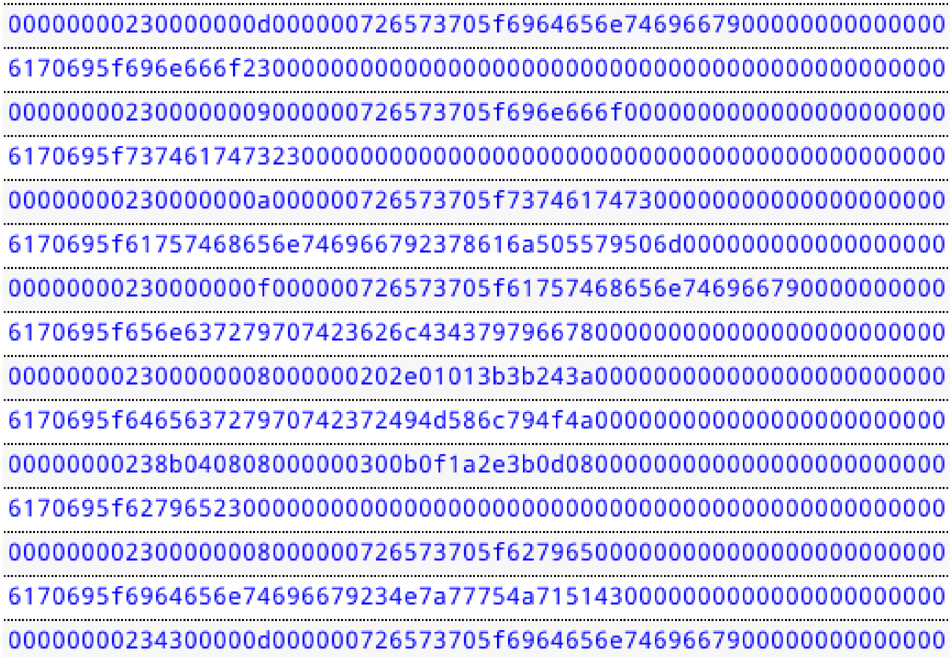
Digital Signature

Hand Signature Vs Digital Signature

- A ***Hand Signature*** on a document is
  - a **unique pattern** dependant on some secret known only to the signer and
  - **Independent of the content** of the message being signed

Digital Signature

- A ***Digital signature*** of a message is
  - **a number** dependent on some secret known only to the signer and
  - **Dependent on the content** of the message being signed
- Properties of Signatures
  - Must be verifiable
  - Provide Authentication
  - Provide Data Integrity
  - Provide Non-repudiation



```
00000000230000000d000000726573705f6964656e7469667900000000000000
6170695f696e666f230000000000000000000000000000000000000000000000
000000002300000009000000726573705f696e666f0000000000000000000000
6170695f73746174732300000000000000000000000000000000000000000000
00000000230000000a000000726573705f737461747300000000000000000000
6170695f61757468656e746966792378616a505579506d000000000000000000
00000000230000000f000000726573705f61757468656e746966790000000000
6170695f656e6372797074236 26c434379796678000000000000000000000000
000000002300000008000000202e01013b3b243a000000000000000000000000
6170695f646563727970742372494d586c794f4a000000000000000000000000
00000000238b040808000000300b0f1a2e3b0d08000000000000000000000000
6170695f62796523000000000000000000000000000000000000000000000000
000000002300000008000000726573705f627965000000000000000000000000
6170695f6964656e74696679234e7a77754a7151430000000000000000000000
00000000234300000d000000726573705f6964656e7469667900000000000000
```

What is Digital Signature?

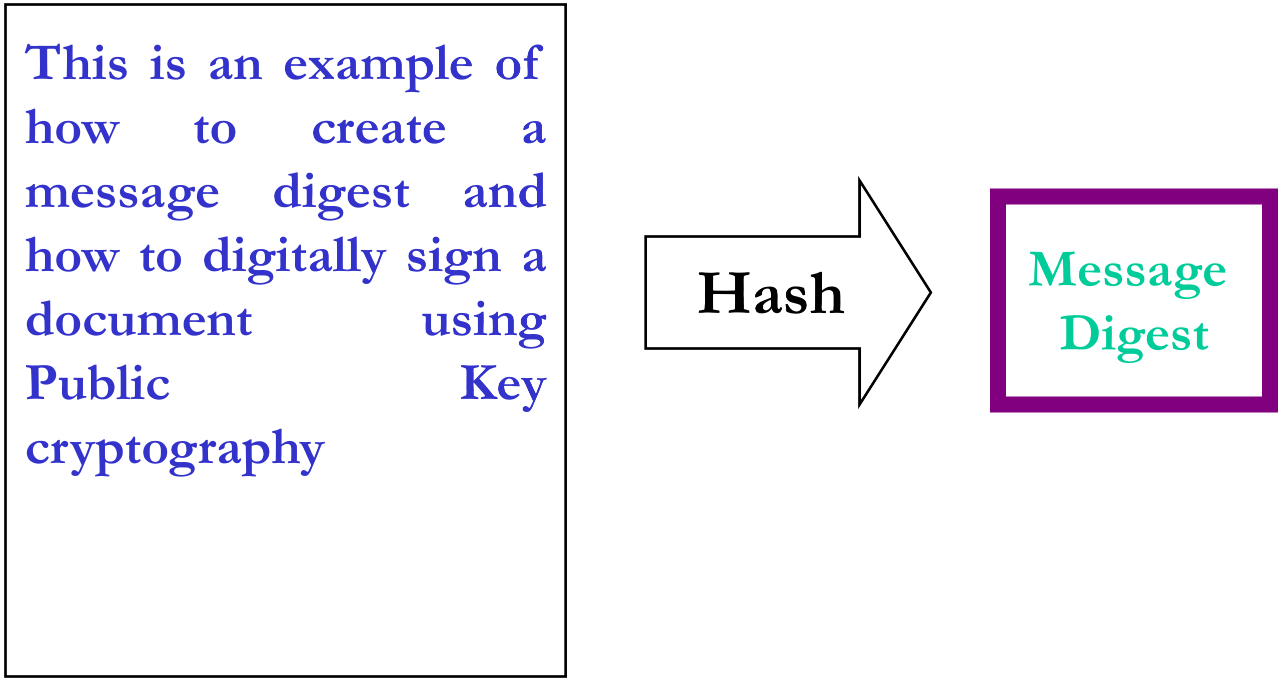
- Hash value of a message when encrypted with the private key of a person is his digital signature on that e-Document
  - Digital Signature of a person therefore **varies from document to document** thus ensuring authenticity of each word of that document.
  - As the public key of the signer is known, anybody can verify the message and the digital signature

Creating Digital Signature

- Key pairs of every individual
  - ***Public key*** : known to everyone
  - ***Private key*** : known only to the owner
- To ***digitally sign*** an electronic document the signer uses his/her ***Private key***
- To ***verify*** a digital signature the verifier uses the signer's ***Public key***

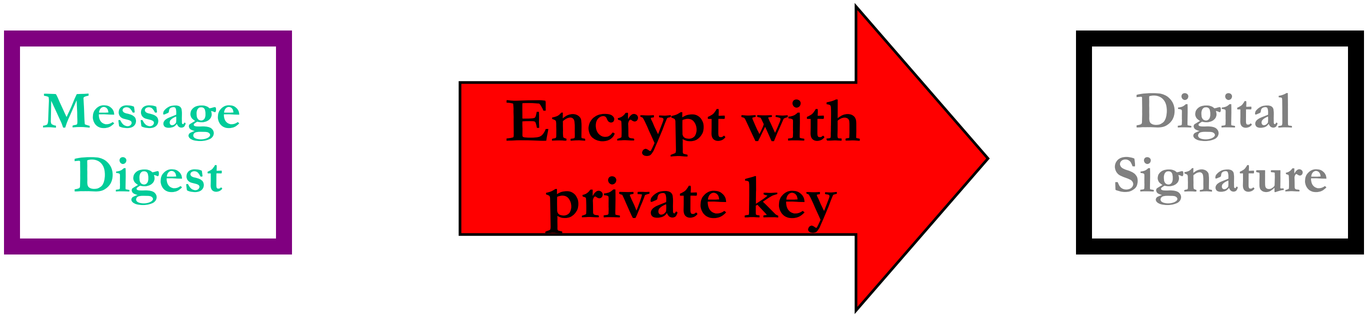
Achieving **Authenticity**, **Integrity** and **Non-Repudiation** using Digital Signatures

Digital Signing – Step 1

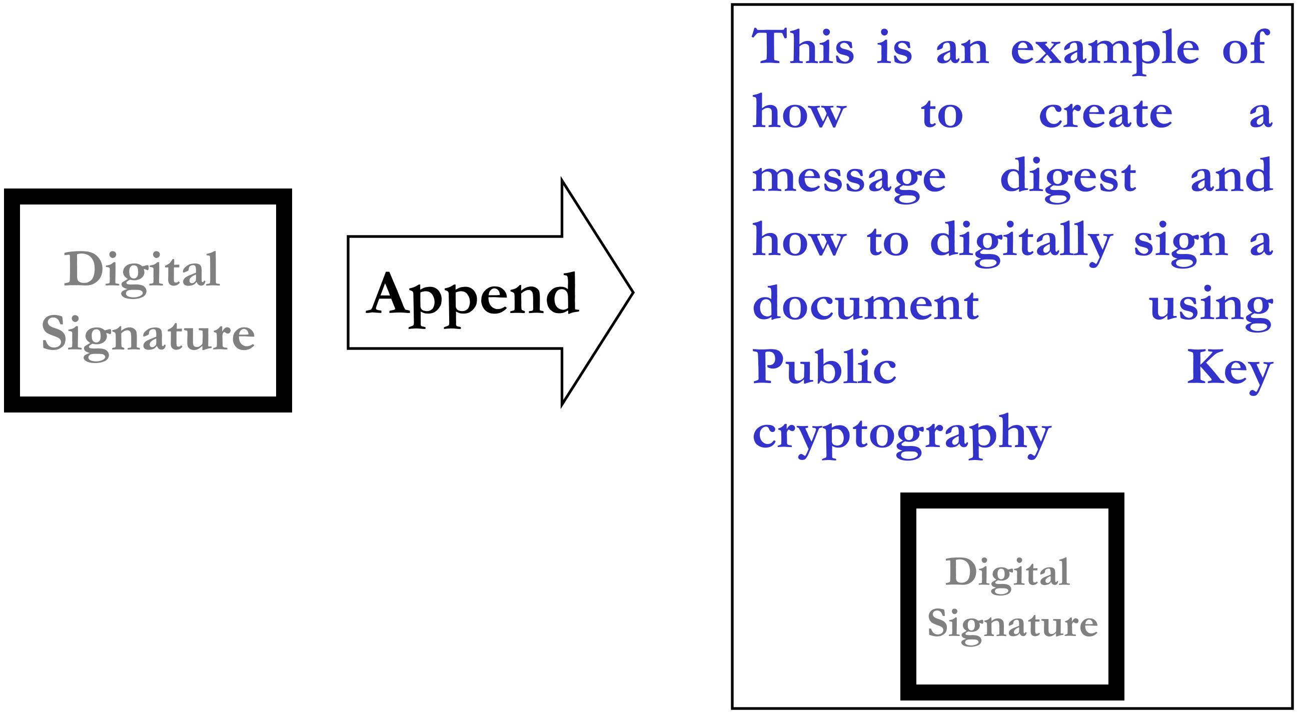


This is an example of how to create a message digest and how to digitally sign a document using Public Key cryptography

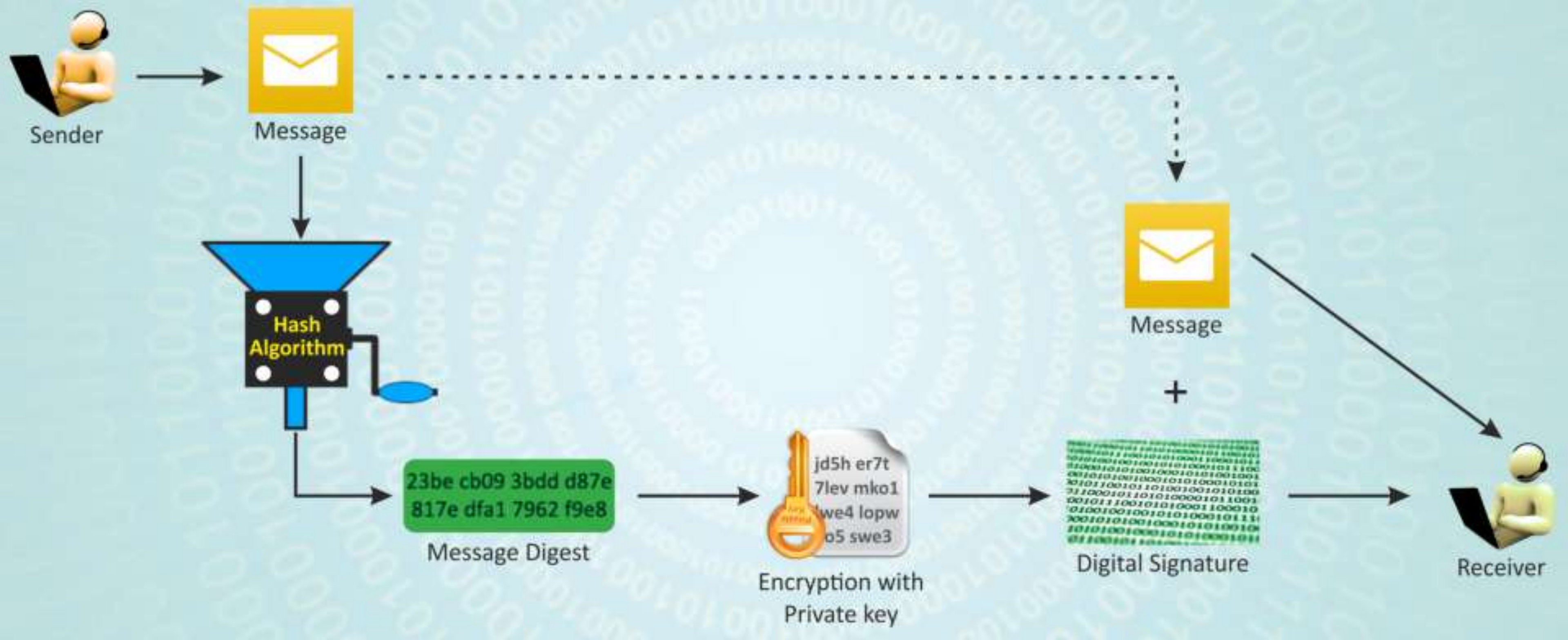
Digital Signing – Step 2



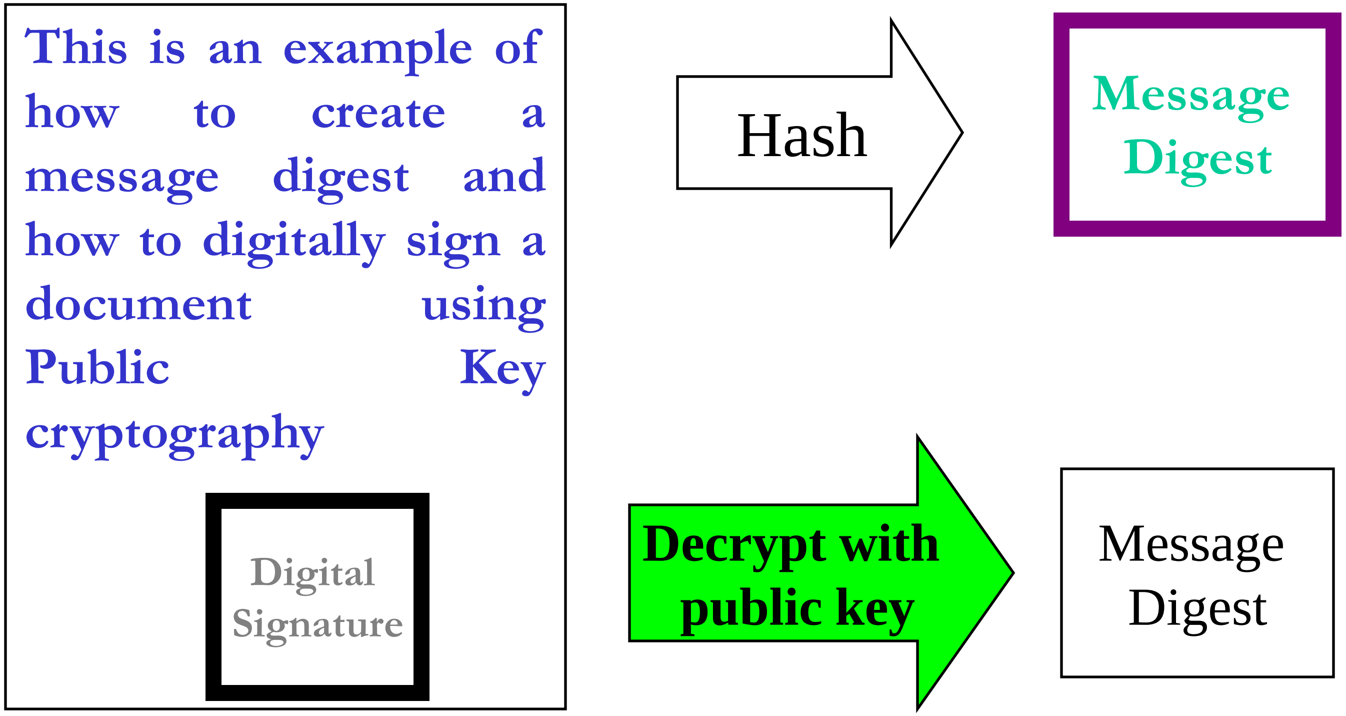
Digital Signing – Step 3


Digital Signature
Append
This is an example of how to create a message digest and how to digitally sign a document using Public Key cryptography
Digital Signature

Digital Signing Process

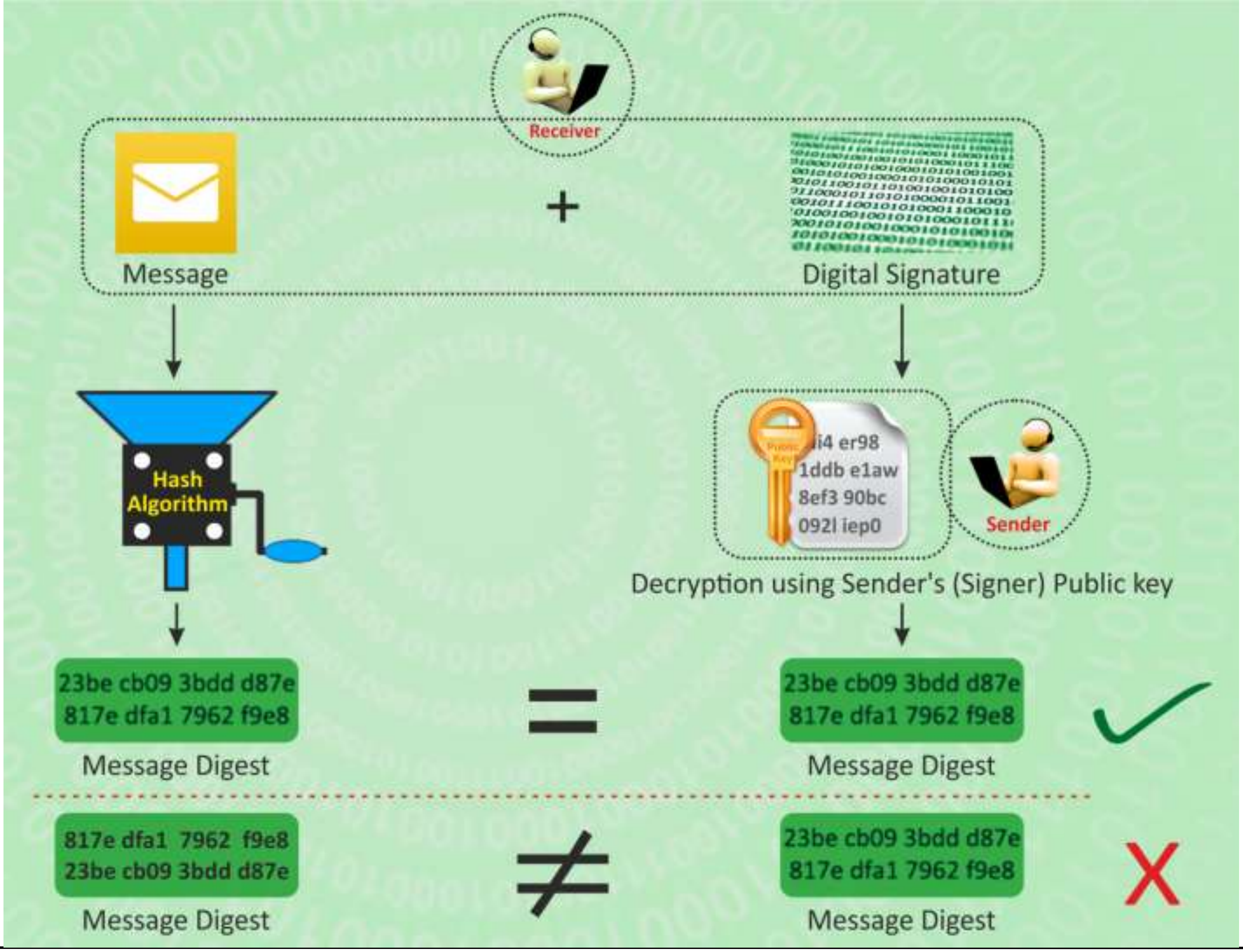


Digital Signature Verification



This is an example of how to create a message digest and how to digitally sign a document using Public Key cryptography

Digital Signature Verification



General Conventions

- Signing – Private Key of the Signer
- Verification – Public Key of the Signer

Digital Signatures - Examples

I agree

efcc61c1c03db8d8ea8569545c073c814a0ed755

My place of birth is Gwalior.

fe1188eecd44ee23e13c4b6655edc8cd5cdb6f25

I am 62 years old.

0e6d7d56c4520756f59235b6ae981cdb5f9820a0

I am an Engineer.

ea0ae29b3b2c20fc018aaca45c3746a057b893e7

I am a Engineer.

01f1d8abd9c2e6130870842055d97d315dff1ea3

- These are digital signatures of same person on different documents

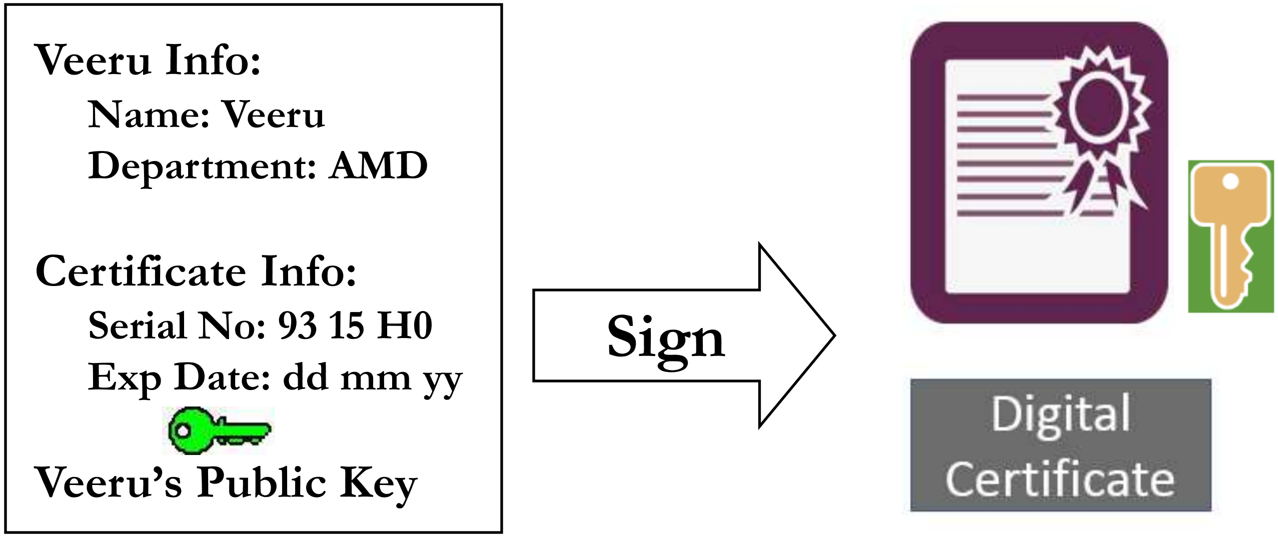
- **Digital Signatures are numbers**
- **They are content and signer dependent**

Digital Signature Certificate (DSC)

What is Digital Signature Certificate (DSC)?

DSC is an electronic document used to prove ownership of a public key. The certificate includes

- Information about its owner's identity,
- Information about the key,
- The Digital Signature of an entity that has verified the certificate's contents are correct.



Veeru Info:
Name: Veeru
Department: AMD

Certificate Info:
Serial No: 93 15 H0
Exp Date: dd mm yy
Veeru's Public Key

Certifying Authority (CA) ?

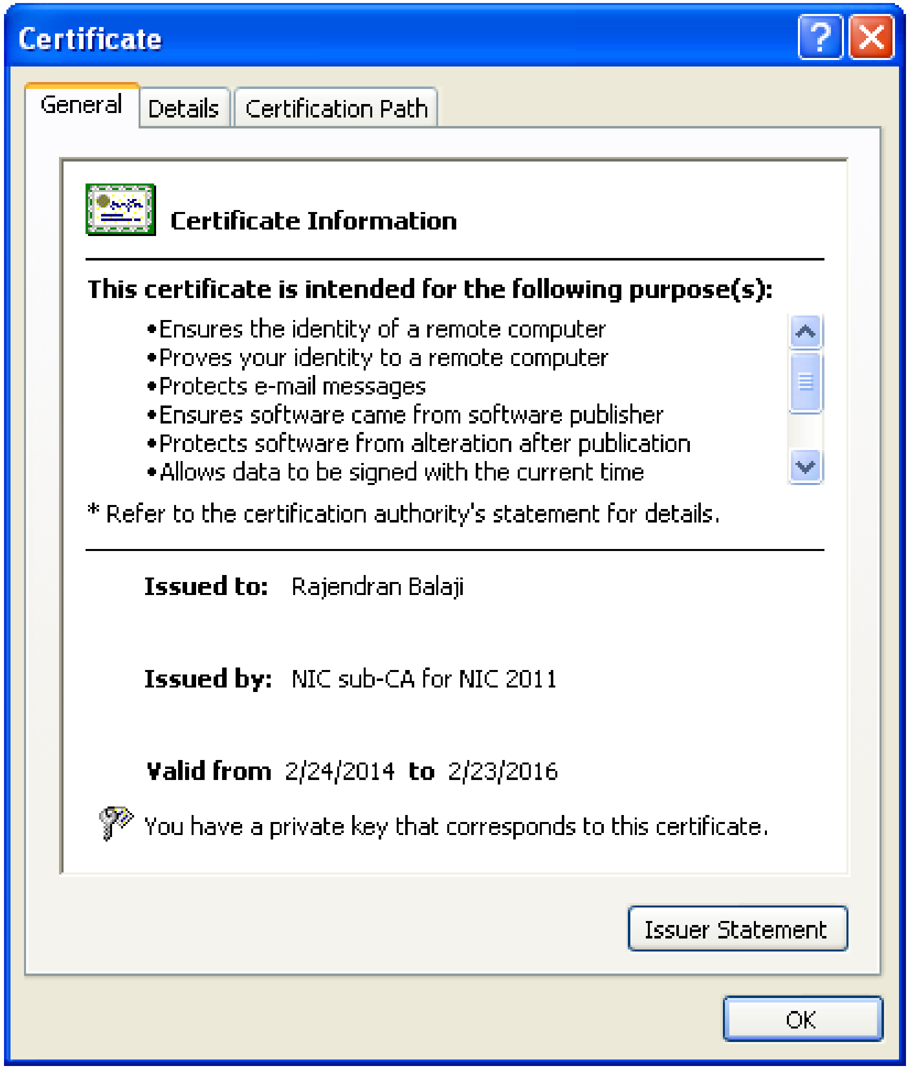
Certifying Authority (CA)

- Certifying authority is an entity which issues Digital Certificate
- It is a Trusted third party
- CA's are the important characteristics of Public Key Infrastructure (PKI)

Responsibilities of CA

- Verify the credentials of the person requesting for the certificate (RA's responsibility)
- Issue certificates
- Revoke certificate
- Generate and upload CRL

Sample Certificate



Certificate Information

This certificate is intended for the following purpose(s):

- Ensures the identity of a remote computer
- Proves your identity to a remote computer
- Protects e-mail messages
- Ensures software came from software publisher
- Protects software from alteration after publication
- Allows data to be signed with the current time

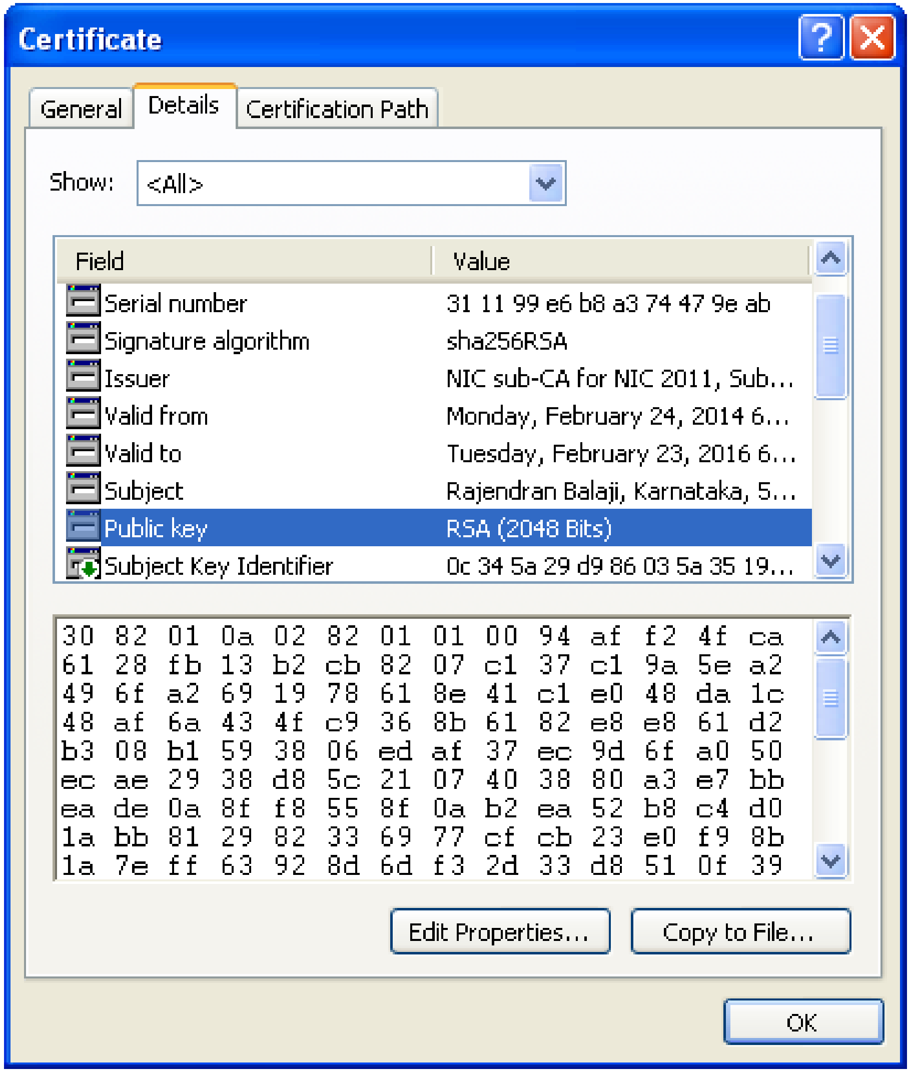
* Refer to the certification authority's statement for details.

Issued to: Rajendran Balaji

Issued by: NIC sub-CA for NIC 2011

Valid from 2/24/2014 **to** 2/23/2016

You have a private key that corresponds to this certificate.



Show: <All>

Field	Value
Serial number	31 11 99 e6 b8 a3 74 47 9e ab
Signature algorithm	sha256RSA
Issuer	NIC sub-CA for NIC 2011, Sub...
Valid from	Monday, February 24, 2014 6...
Valid to	Tuesday, February 23, 2016 6...
Subject	Rajendran Balaji, Karnataka, 5...
Public key	RSA (2048 Bits)
Subject Key Identifier	0c 34 5a 29 d9 86 03 5a 35 19...

```
30 82 01 0a 02 82 01 01 00 94 af f2 4f ca
61 28 fb 13 b2 cb 82 07 c1 37 c1 9a 5e a2
49 6f a2 69 19 78 61 8e 41 c1 e0 48 da 1c
48 af 6a 43 4f c9 36 8b 61 82 e8 e8 61 d2
b3 08 b1 59 38 06 ed af 37 ec 9d 6f a0 50
ec ae 29 38 d8 5c 21 07 40 38 80 a3 e7 bb
ea de 0a 8f f8 55 8f 0a b2 ea 52 b8 c4 d0
1a bb 81 29 82 33 69 77 cf cb 23 e0 f9 8b
1a 7e ff 63 92 8d 6d f3 2d 33 d8 51 0f 39
```

Smart Cards

- The Private key is generated in the crypto module residing in the smart card.
- The key is kept in the memory of the smart card.
- The key is highly secured as it doesn't leave the card, the message digest is sent inside the card for signing, and the signatures leave the card.
- The card gives mobility to the key and signing can be done on any system. (Having smart card reader)

Hardware Tokens

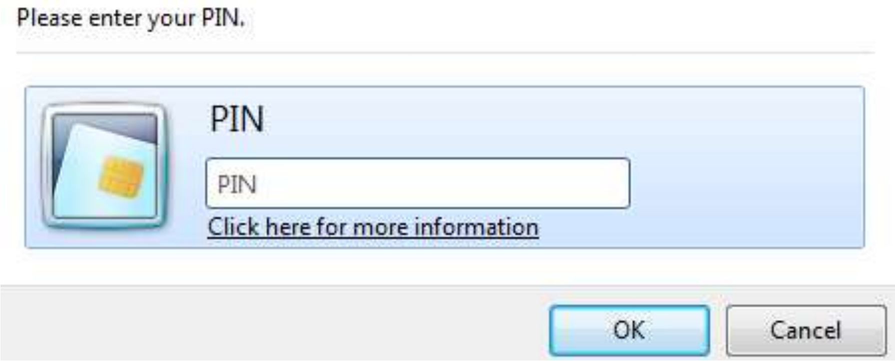
- They are similar to smart cards in functionality as
  - Key is generated inside the token.
  - Key is highly secured as it doesn’t leave the token.
  - Highly portable.
  - Machine Independent.

- iKEY is one of the most commonly used token as it doesn’t need a special reader and can be connected to the system using USB port.

Private key protection

- The Private key generated is to be protected and kept secret. The responsibility of the secrecy of the key lies with the owner.

- The key is secured using
  - PIN Protected Soft token
  - Smart Cards
  - Hardware USB Tokens



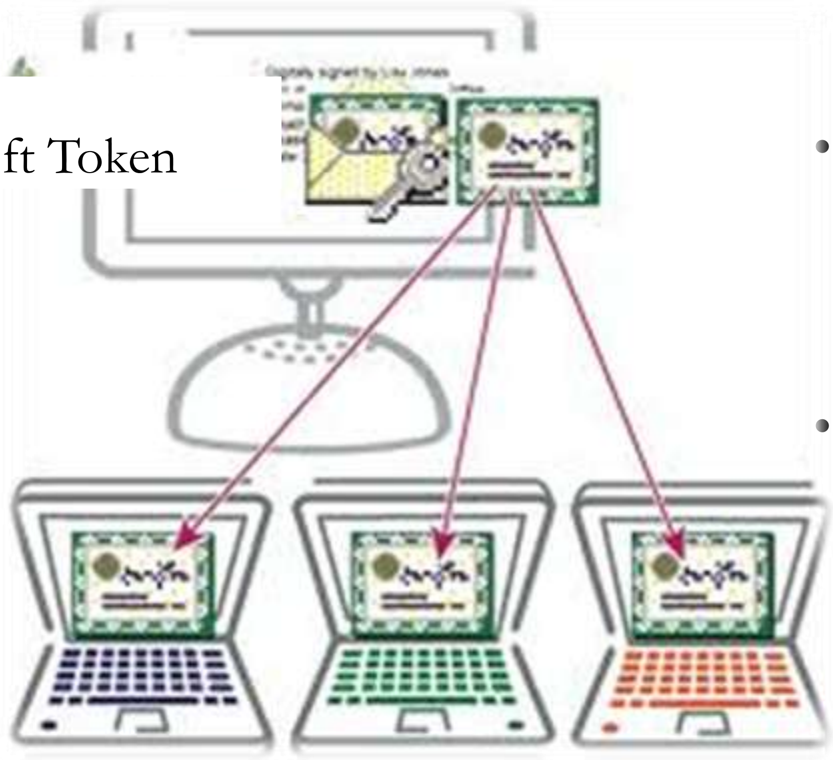
Please enter your PIN.

PIN

PIN

Click here for more information

PIN protected Soft Tokens



- The Private key is encrypted and kept on the Hard Disk in a file, this file is password protected.
- This forms the lowest level of security in protecting the key, as
  - The key is highly reachable.
  - PIN can be easily known or cracked.
- Soft tokens are not preferred because
  - The key becomes static and machine dependent.
  - The key is in a known file format.

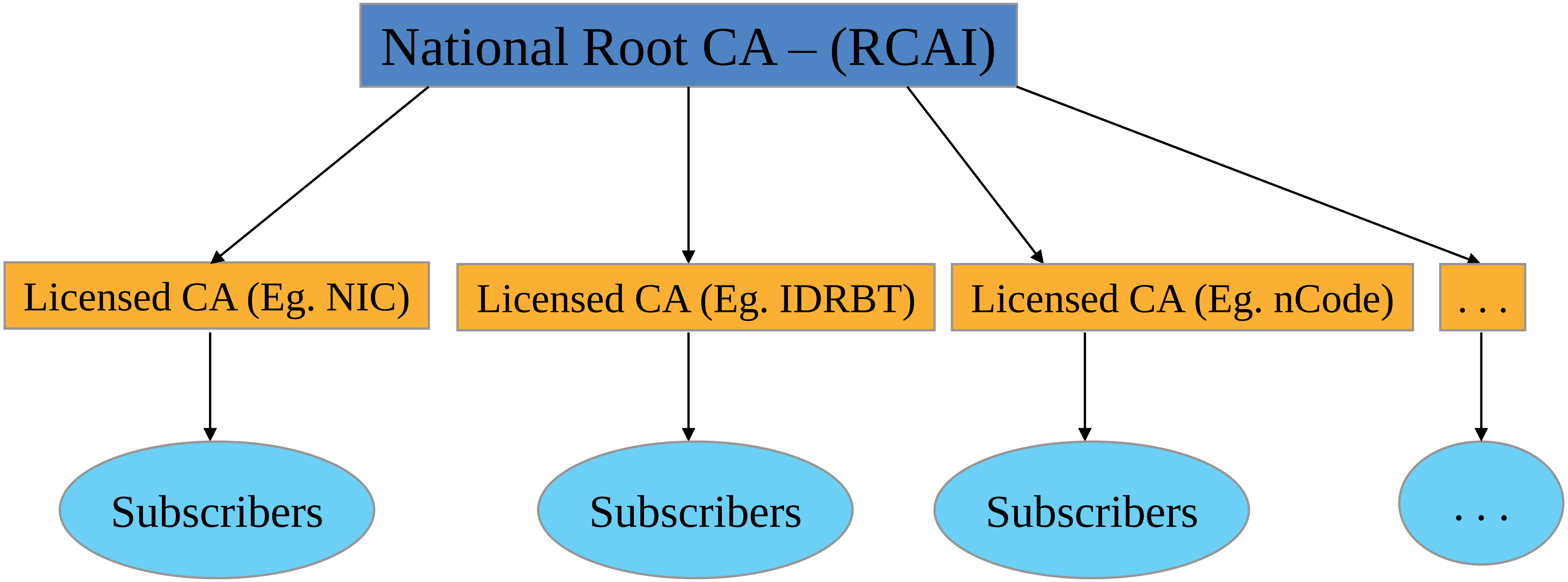
General Security Lessons

- Risks are inherent in any cryptographic system
- PKI is not a one-stop solution for all your security needs
- Any security system is only as safe as the weakest link in a security chain!

Trust Model

Hierarchical Trust Model

- For a Digital Signature to have legal validity, it must derive its trust from the Root CA certificate

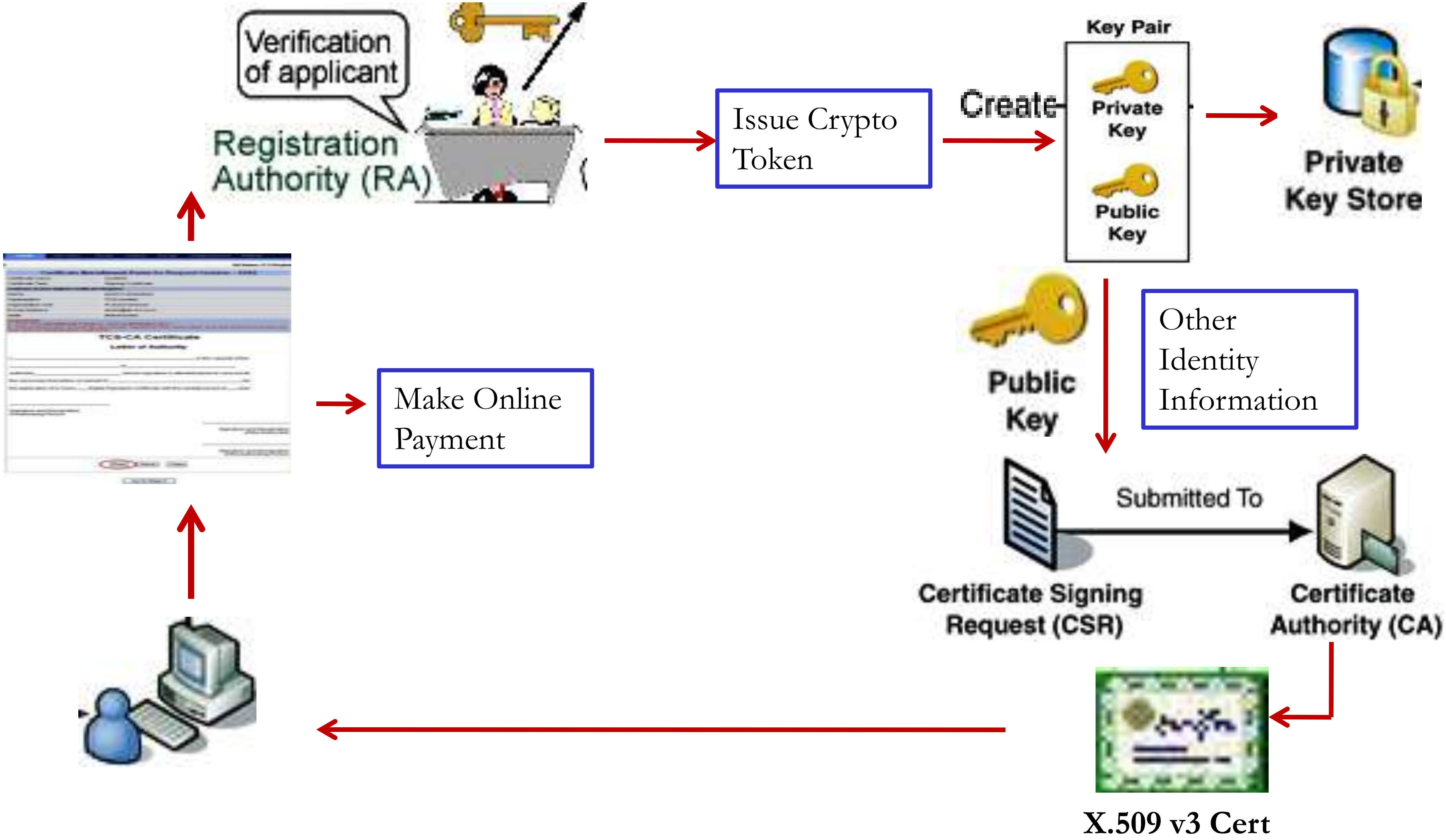


Licensed CA's in India

- National Root CA (RCAI) – operated by CCA
  - Only issues CA certificates for licensed CAs
- 6 CAs licensed under the National Root CA
  - National Informatics Centre (https://nicca.nic.in)
  - eMudhra (www.e-mudhra.com)
  - TCS (www.tcs-ca.tcs.co.in)
  - nCode Solutions CA(www.ncodesolutions.com)
  - SafeScrypt (www.safescrypt.com)
  - IDRBT CA (www.idrbtca.org.in)
- As of Sept 2014, approx. 8 Million DSCs have been issued

Certificate Issuance Process

Certificate Issuance Process



Issue Crypto Token

Make Online Payment

Other Identity Information

Verification of applicant
Registration Authority (RA)
Create
Key Pair
Private Key
Public Key
Private Key Store
Public Key
Submitted To
Certificate Signing Request (CSR)
Certificate Authority (CA)
X.509 v3 Cert

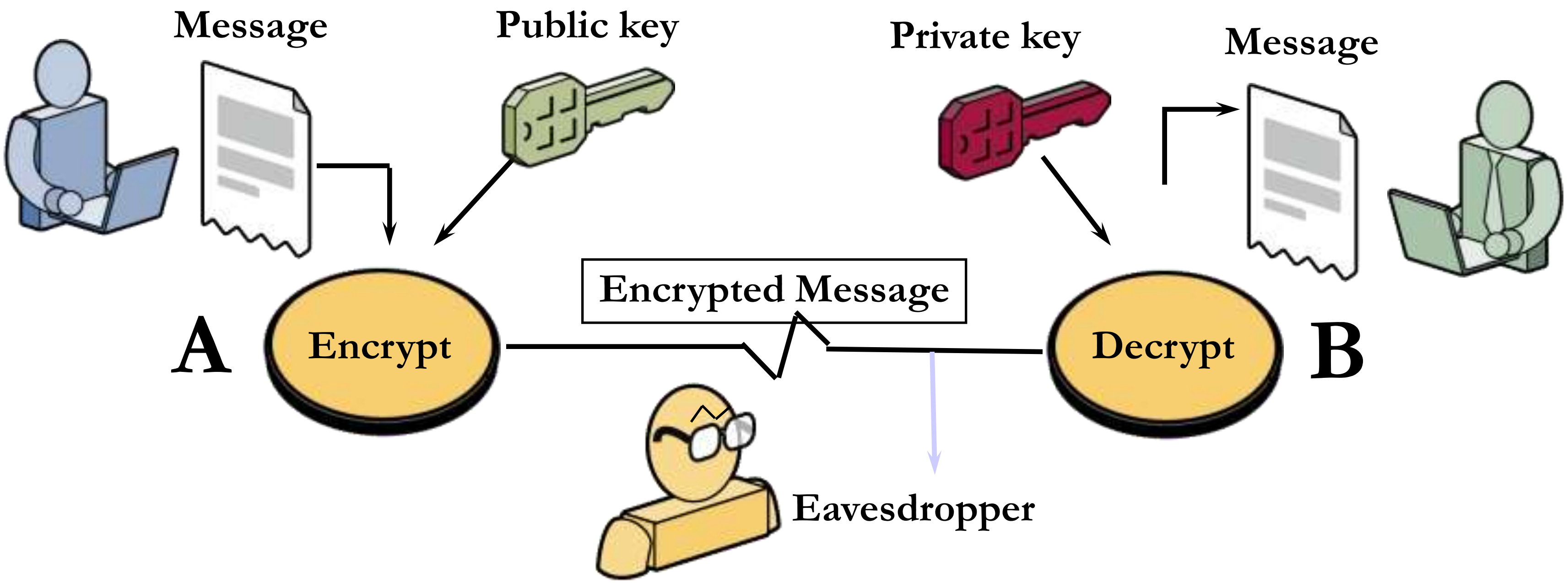
Types of Certificates

Types of Certificates

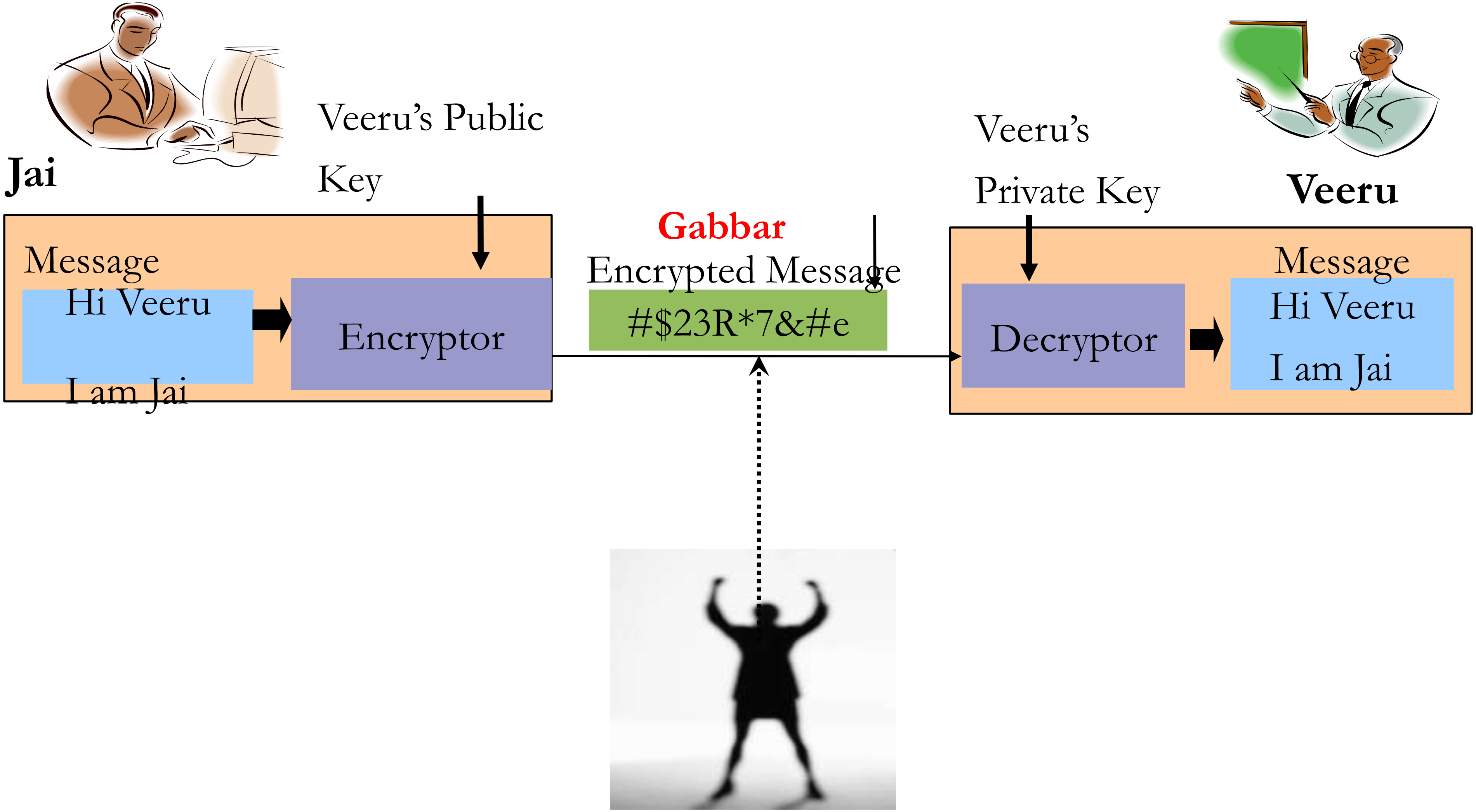
- Signing Certificate
  - Issued to a person for signing of electronic documents
- Encryption Certificate
  - Issued to a person for the purpose of Encryption;
- SSL Certificate
  - Issued to a Internet domain name (Web Servers, Email Servers etc…)

Achieving Confidentiality

Asymmetric Key Encryption - Confidentiality



Encryption & Decryption (Asymmetric)



Jai

Veeru's Public Key

Message

Hi Veeru

I am Jai

Encryptor

Gabbar

Encrypted Message

#$23R*7&#e

Veeru's Private Key

Veeru

Decryptor

Message

Hi Veeru

I am Jai

General Conventions

- Encryption – Public Key of the Receiver
- Decryption – Private Key of the Receiver

Certificate Classes

Classes of Certificates

- 3 Classes of Certificates
  - Class – 1 Certificate
    - Issued to Individuals
    - Assurance Level: **Certificate will confirm User's name and Email address**
    - Suggested Usage: **Signing certificate** primarily be used for signing personal emails and **encryption certificate** is to be used for encrypting digital emails and **SSL certificate** to establish secure communication through SSL

Classes of Certificates

- Class – 2 Certificate
  - Issued for both business personnel and private individuals use
  - Assurance Level: **Conforms the details submitted in the form including photograph and documentary proof**
  - Suggested Usage: **Signing certificate** may also be used for digital signing, code signing, authentication for VPN client, Web form signing, user authentication, Smart Card Logon, Single sign-on and signing involved in e-procurement / e-governance applications, in addition to Class-I usage

Classes of Certificates

- Class – 3 Certificate
  - Issued to Individuals and Organizations
  - Assurance Level: **Highest level of Assurance; Proves existence of name of the organization, and assures applicant's identity authorized to act on behalf of the organization.**
  - Suggested Usage: **Signing certificate** may also be used for digital signing for discharging his/her duties as per official designation and **encryption certificate** to be used for encryption requirement as per his/her official capacity

Certificate Extensions

File Formats with Extensions	Description
.CER	Contains only Public Key
.CRT	Contains only Public Key
.DER	Contains only Public Key
.P12	Contains Public and Private Key
.PFX	Contains Public and Private Key
.PEM, .KEY, .JKS	Contains Public and Private Key
.CSR	Certificate Signing Request
.CRL	Certificate Revocation List

Certificate Lifecycle Management

- A Digital Signature Certificate cannot be used for ever!
- Typical Life cycle scenario of Digital Certificates
  - Use until renewal
    - Certificates are to be reissued regularly on expiry of validity (typically 2 years)
  - Use until re-keying
    - If keys had to be changed
  - Use until revocation
    - If Certificate was revoked, typically when keys are compromised or CA discovers that certificate was issued improperly based on false documents

CRL – Certification Revocation List

- A list containing the serial number of those certificates that have been revoked
- Why they have been revoked?
  - If keys are compromised and users reports to the CA
  - If CA discovers, false information being used to obtain the certificate
- Who maintains CRLs ?
  - Typically the CA's maintain the CRL

CRL – Certification Revocation List

- How frequently the CRL is updated ?
  - Generally twice a day; based on CA’s policies
- Is there any automated system in place for accessing the CRL?
  - OCSP

Certificate Validation Methods

- Validating a certificate is typically carried out by PKI enabled application
- The validation process performs following checks
  - Digital signature of the issuer (CA)
  - Trust (Public Key verification) till root level
  - Time (Validity of the certificate)
  - Revocation (CRL verification)
  - Format

Recent Developments: e-Sign – An Online Electronic Signature Service

Electronic Signature

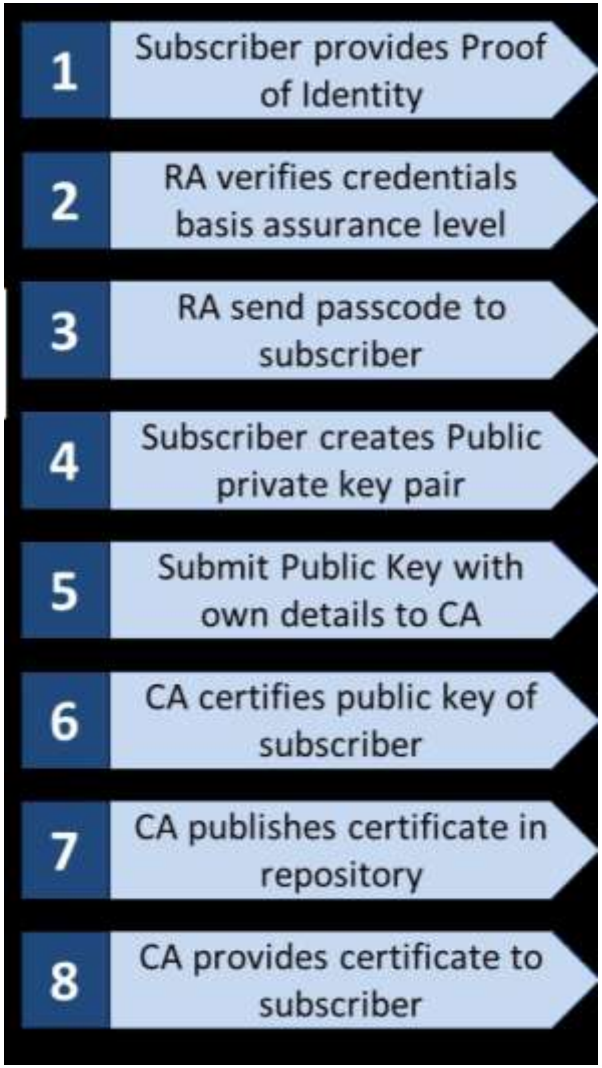
An electronic signature to be legally accepted it shall possesses the following requirements:

- **Signature Data to be Linked to Signatory**: The signature creation data or the authentication data are, within the context in which they are used, linked to signatory.
- **The signature creation data under the control of signatory:** The signature creation data or the authentication data were, at the time of signing, under the control of signatory.
- **Alteration to be detectable:** Any alteration to the electronic signature made after affixing such signature is detectable. and
- **Modification to be detectable:** Any modification to the information made after its authentication by electronic signature is detectable.

Challenges in Present Digital Signature

- Currently personal digital signature requires
  - Person’s identity verification
  - Current scheme of physical verification, document based identity validation, and issuance of physical dongles does not scale to a billion people.
  - Certifying Authorities engage Registration Authorities to carry out the verification of credentials prior to issuance of certificate.
  - Issuance of USB dongle having private key, secured with a password/pin.
  - The major cost of the DSC is found to be the verification cost and cost of USB dongle.

Current Scenario of Certificate Issuance



1 Subscriber provides Proof of Identity

2 RA verifies credentials basis assurance level

3 RA send passcode to subscriber

4 Subscriber creates Public private key pair

5 Submit Public Key with own details to CA

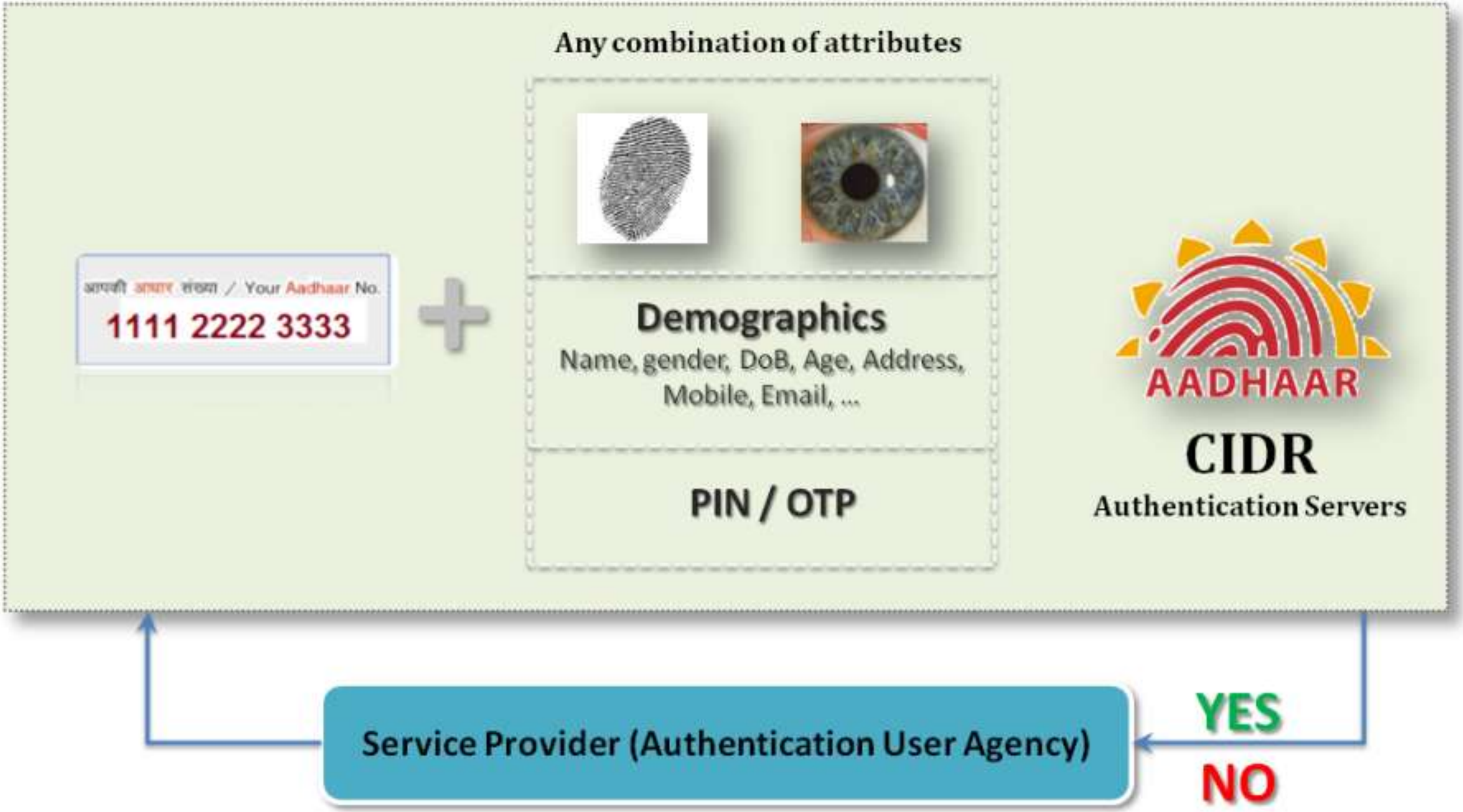
6 CA certifies public key of subscriber

7 CA publishes certificate in repository

8 CA provides certificate to subscriber

Aadhaar Authentication EcoSystem

A Typical Aadhaar Authentication



आपकी आधार संख्या / Your Aadhaar No.

1111 2222 3333

+

Any combination of attributes

Demographics

Name, gender, DoB, Age, Address, Mobile, Email, ...

PIN / OTP

AADHAAR

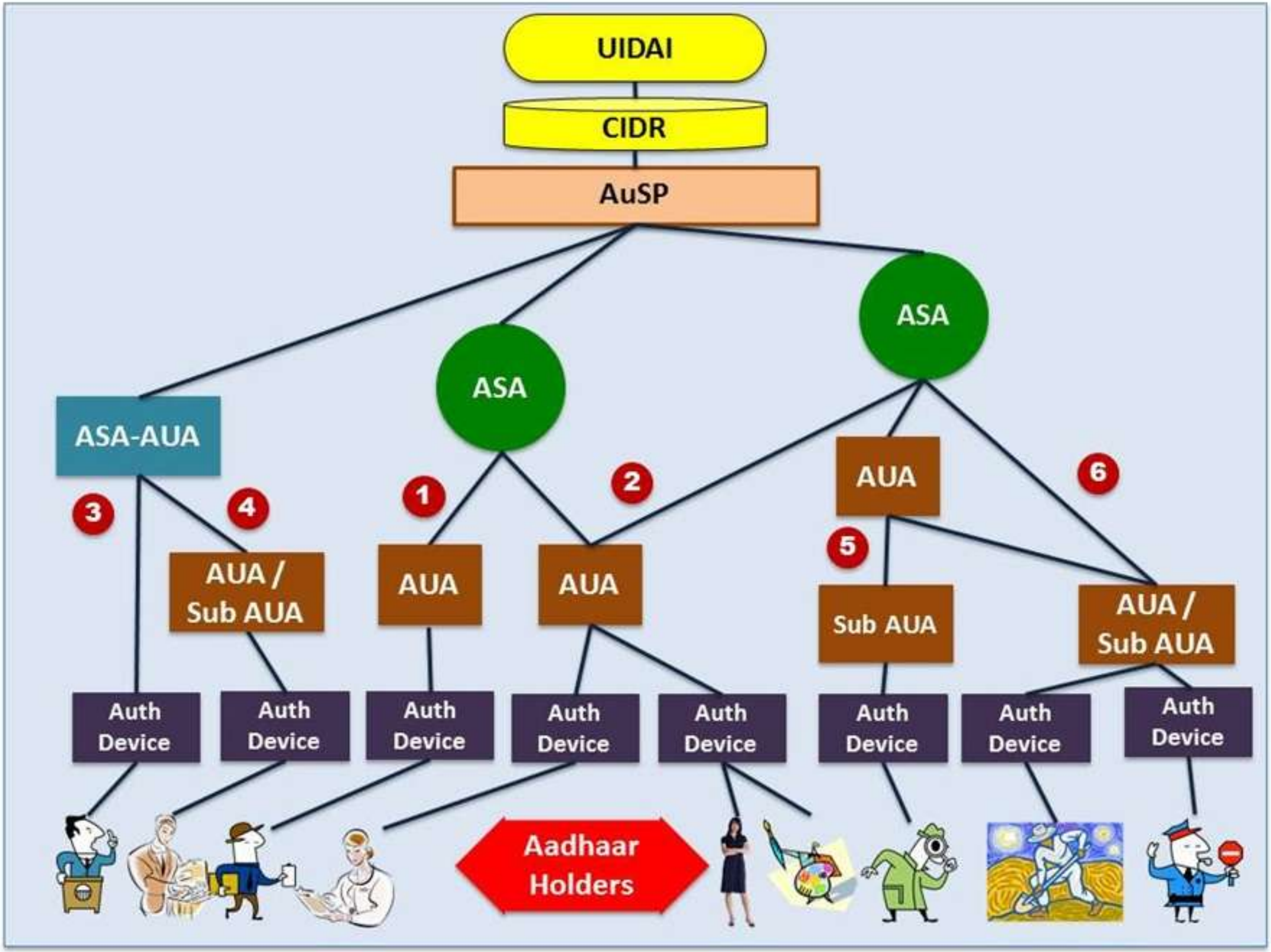
CIDR

Authentication Servers

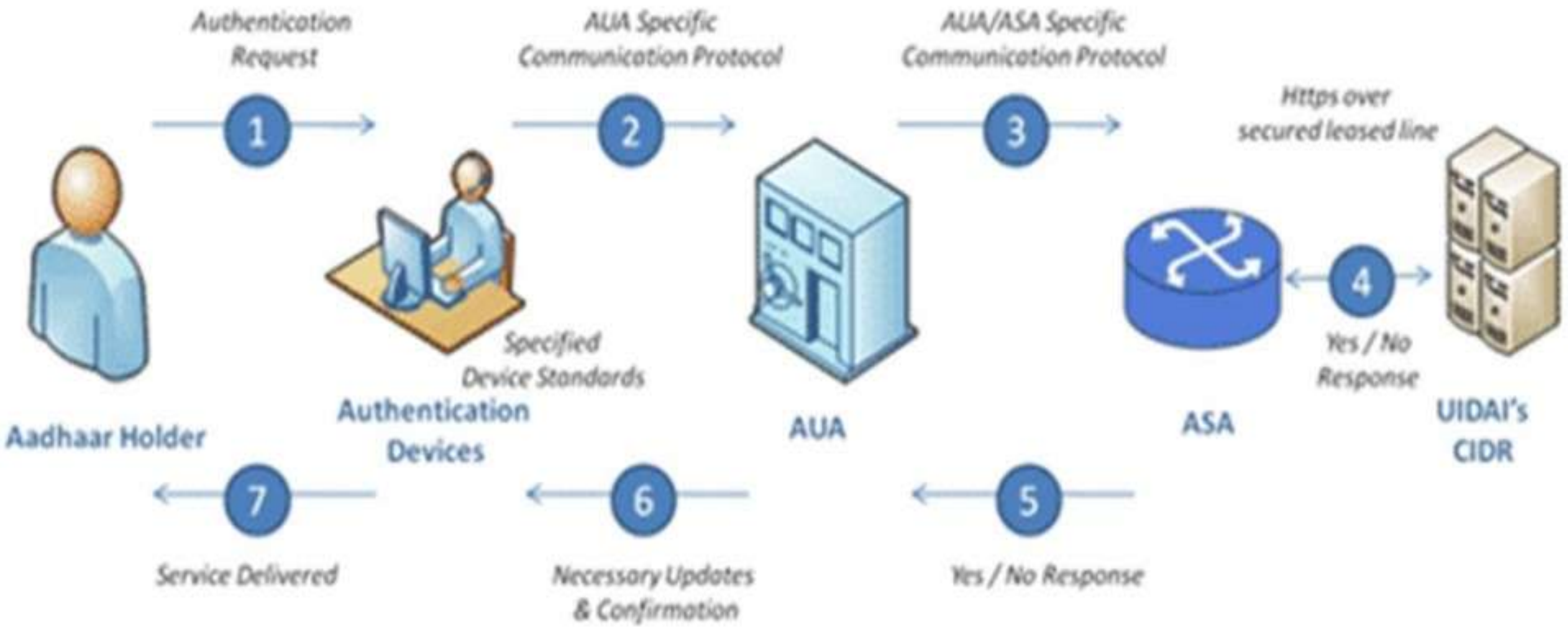
Service Provider (Authentication User Agency)

YES

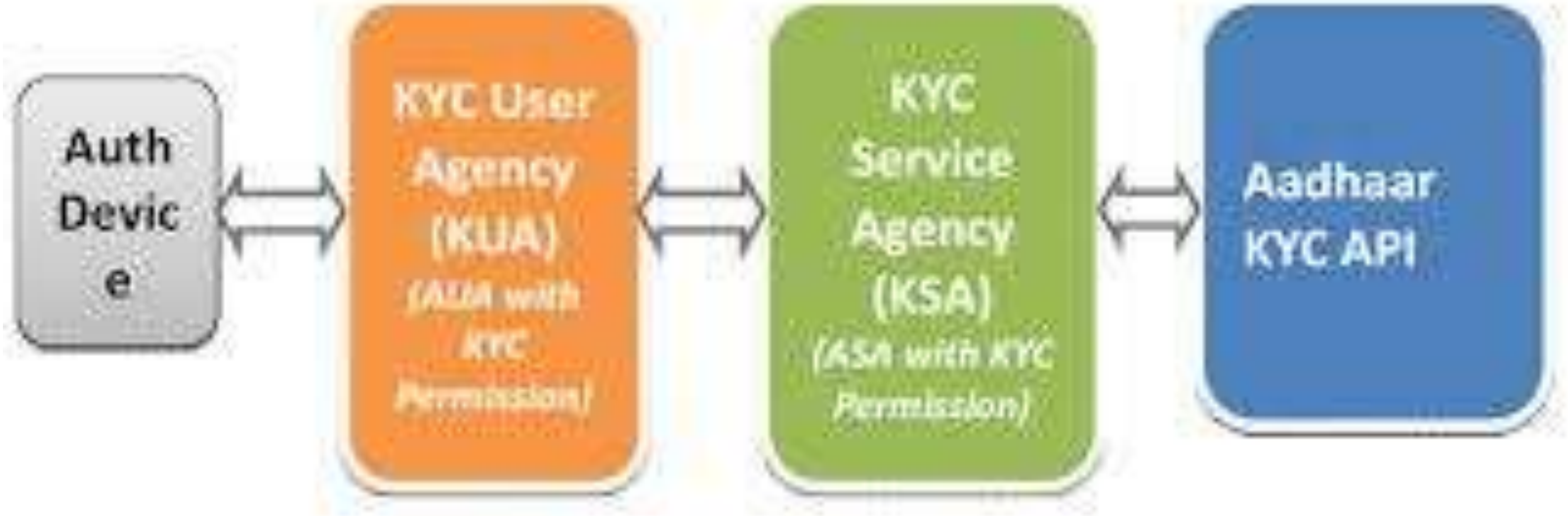
NO


UIDAI
CIDR
AuSP
ASA
ASA
ASA-AUA
1
2
3
4
5
6
AUA
AUA / Sub AUA
AUA
AUA
Sub AUA
AUA / Sub AUA
Auth Device
Auth Device
Auth Device
Auth Device
Auth Device
Auth Device
Auth Device
Auth Device
Aadhaar Holders

Authentication Flow (AUA & ASA)


Authentication Request
1
AUA Specific Communication Protocol
2
AUA/ASA Specific Communication Protocol
3
Https over secured leased line
4
Yes / No Response
Specified Device Standards
Aadhaar Holder
Authentication Devices
AUA
ASA
UIDAI's CIDR
7
Service Delivered
6
Necessary Updates & Confirmation
5
Yes / No Response

Aadhaar eKYC – KUA & KSA



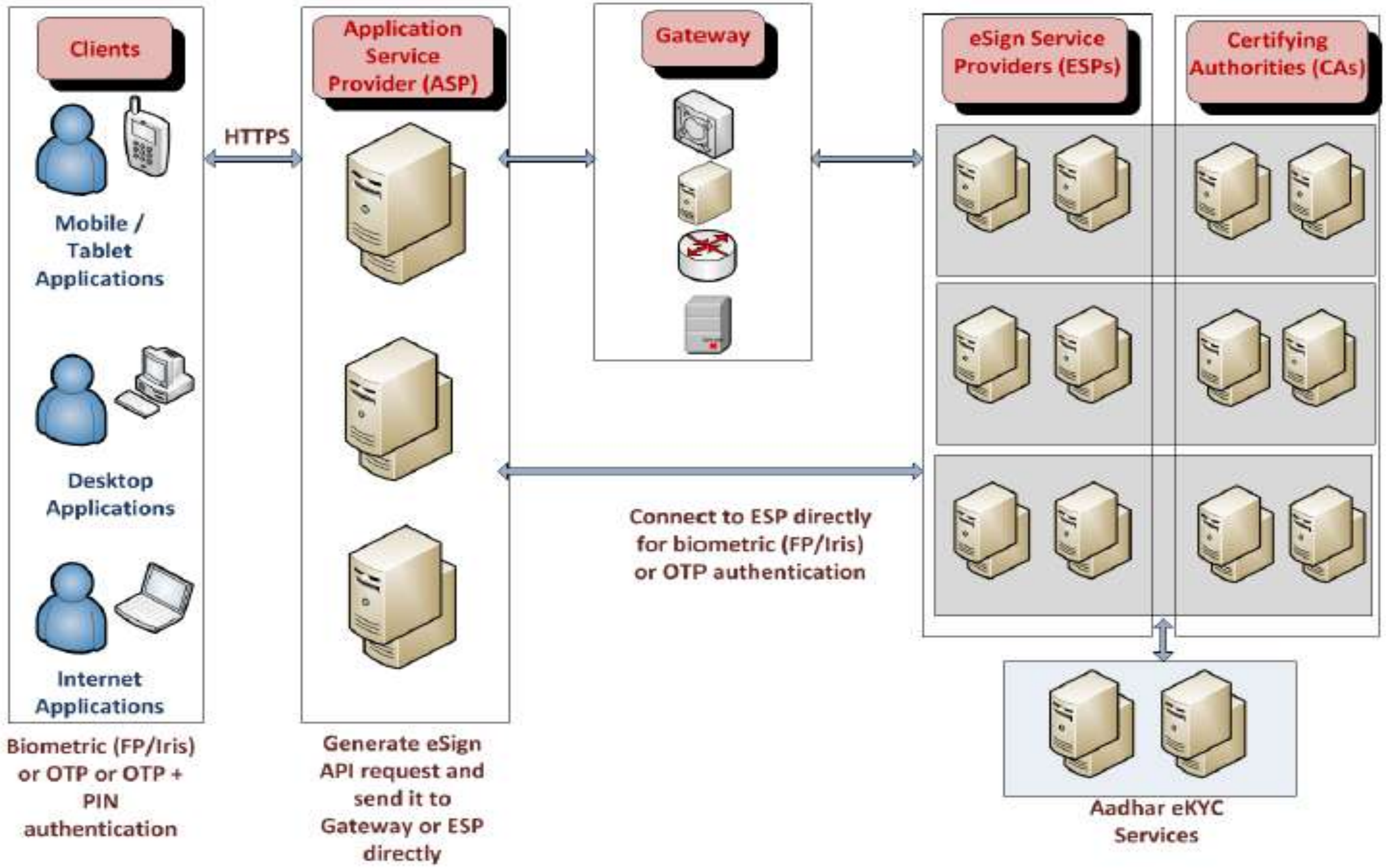
- Auth Device captures Aadhaar No. & Biometric; forwards encrypted packet to KUA
- KUA creates KYC XML and passes to KSA
- KSA forwards KYC XML to Aadhaar eKYC API
  - If Biometric Auth is successful, demographic data and photo is given to KSA in encrypted format
  - KSA then sends the packet to KUA, which formats for user

e-Sign – Electronic Signature

- An innovative initiative for allowing easy, efficient, and secure signing of electronic documents by authenticating signer using Aadhaar eKYC services.
- Any Aadhaar holder can digitally sign an electronic document **without having to obtain a hardware dongle**.
- Application Service Providers (ASPs) can integrate this service within their application to offer Aadhaar holders a way to sign electronic forms and documents.
- The need to obtain DSC through a printed paper application form with ink signature and supporting documents will not be required.

E-Sign: Online Electronic Signature

Stakeholders in e-Sign Service



Clients

Mobile / Tablet Applications

Desktop Applications

Internet Applications

Biometric (FP/Iris) or OTP or OTP + PIN authentication

HTTPS

Application Service Provider (ASP)

Generate eSign API request and send it to Gateway or ESP directly

Gateway

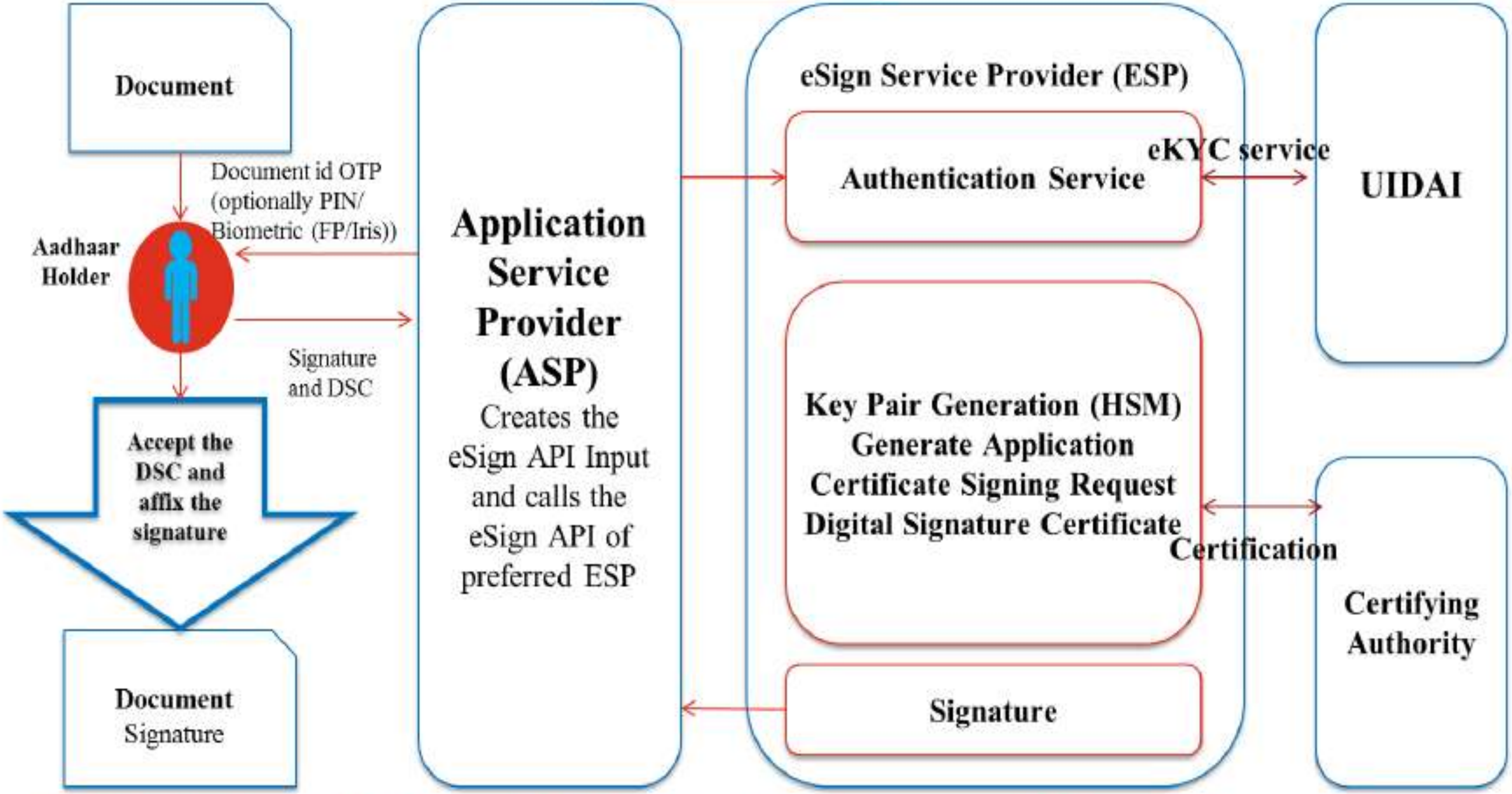
eSign Service Providers (ESPs)

Certifying Authorities (CAs)

Connect to ESP directly for biometric (FP/Iris) or OTP authentication

Aadhar eKYC Services

e-sign Overview



HSM – Hardware Security Module

OTP – One Time Password

ESP – eSign Service Provider

ASP – Application Service Provider

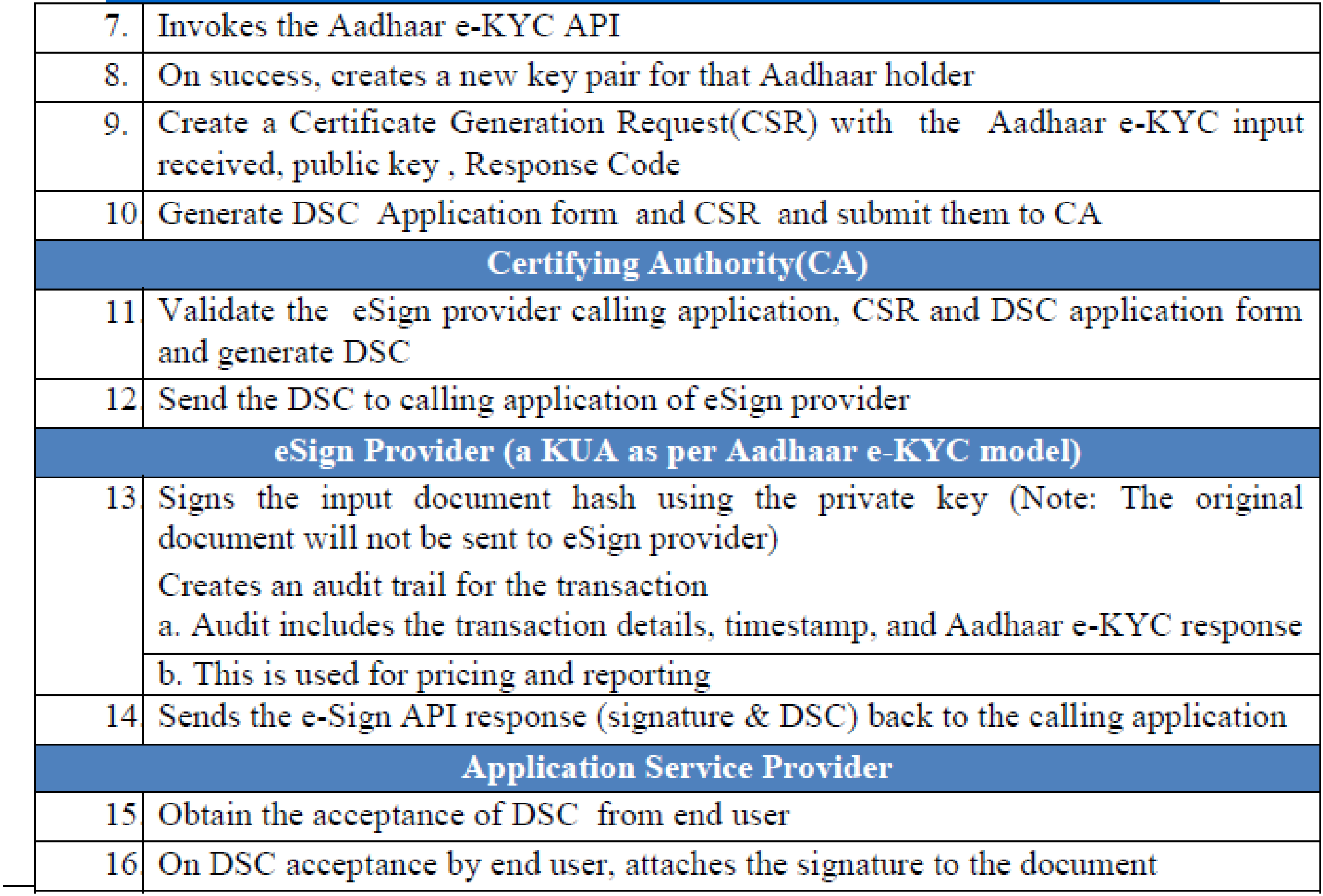
eKYC – electronic Know Your Customer

DSC – Digital Signature Certificate

FP – Finger Print

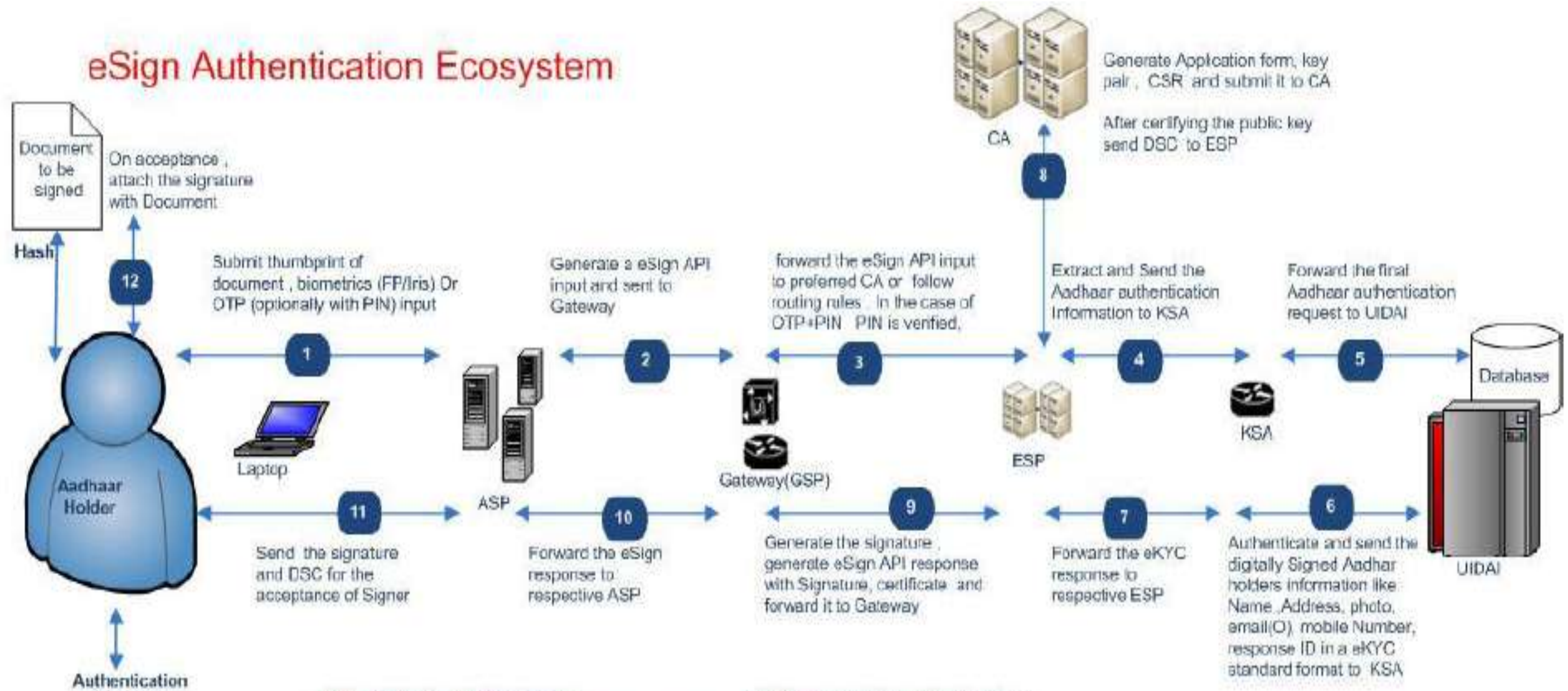
UIDAI – Unique Identification Authority of India

Application Service Provider	
1.	Asks the end user to sign the document
2.	Creates the document hash (to be signed) on the client side
3.	Capture Aadhaar number and authentication factor (OTP/OTP+PIN/Biometric)
4.	Creates the input API for eSign
5.	Calls the e-Sign API of the eSign provider
eSign Provider (a KUA as per Aadhaar e-KYC model)	
6.	Validates the calling application, input, and then creates the Aadhaar e-KYC input based on Aadhaar e-KYC API specification



7.	Invokes the Aadhaar e-KYC API
8.	On success, creates a new key pair for that Aadhaar holder
9.	Create a Certificate Generation Request(CSR) with the Aadhaar e-KYC input received, public key , Response Code
10	Generate DSC Application form and CSR and submit them to CA
Certifying Authority(CA)	
11	Validate the eSign provider calling application, CSR and DSC application form and generate DSC
12	Send the DSC to calling application of eSign provider
eSign Provider (a KUA as per Aadhaar e-KYC model)	
13	Signs the input document hash using the private key (Note: The original document will not be sent to eSign provider) Creates an audit trail for the transaction a. Audit includes the transaction details, timestamp, and Aadhaar e-KYC response
	b. This is used for pricing and reporting
14	Sends the e-Sign API response (signature & DSC) back to the calling application
Application Service Provider	
15	Obtain the acceptance of DSC from end user
16	On DSC acceptance by end user, attaches the signature to the document

e-Sign Authentication Ecosystem



1 Submit thumbprint of document , biometrics (FP/Iris) Or OTP (optionally with PIN) input

2 Generate a eSign API input and sent to Gateway

3 forward the eSign API input to preferred CA or follow routing rules . In the case of OTP+PIN PIN is verified.

4 Extract and Send the Aadhaar authentication Information to KSA

5 Forward the final Aadhaar authentication request to UIDAI

6 Authenticate and send the digitally Signed Adhar holders information like Name ,Address, photo, email(O), mobile Number, response ID in a eKYC standard format to KSA

7 Forward the eKYC response to respective ESP

8 Generate Application form, key pair , CSR and submit it to CA

After certifying the public key send DSC to ESP

9 Generate the signature , generate eSign API response with Signature, certificate and forward it to Gateway

10 Forward the eSign response to respective ASP

11 Send the signature and DSC for the acceptance of Signer

12 On acceptance , attach the signature with Document

ASP- Application Service Provider
ESP- eSign Service Provider(KUA for Aadhaar e-KYC)
HSM -Hardware Security Module
GSP- Gateway Service Provider(PIN Management)
CA- Certifying Authority
OTP-One Time Password

eKYC- electronic Know Your Customer
KSA -KYC Service Agency
UIDAI-Unique Identification Authority of India
FP-Finger Print
DSC-Digital Signature Certificate
CSR-certificate Generation Request

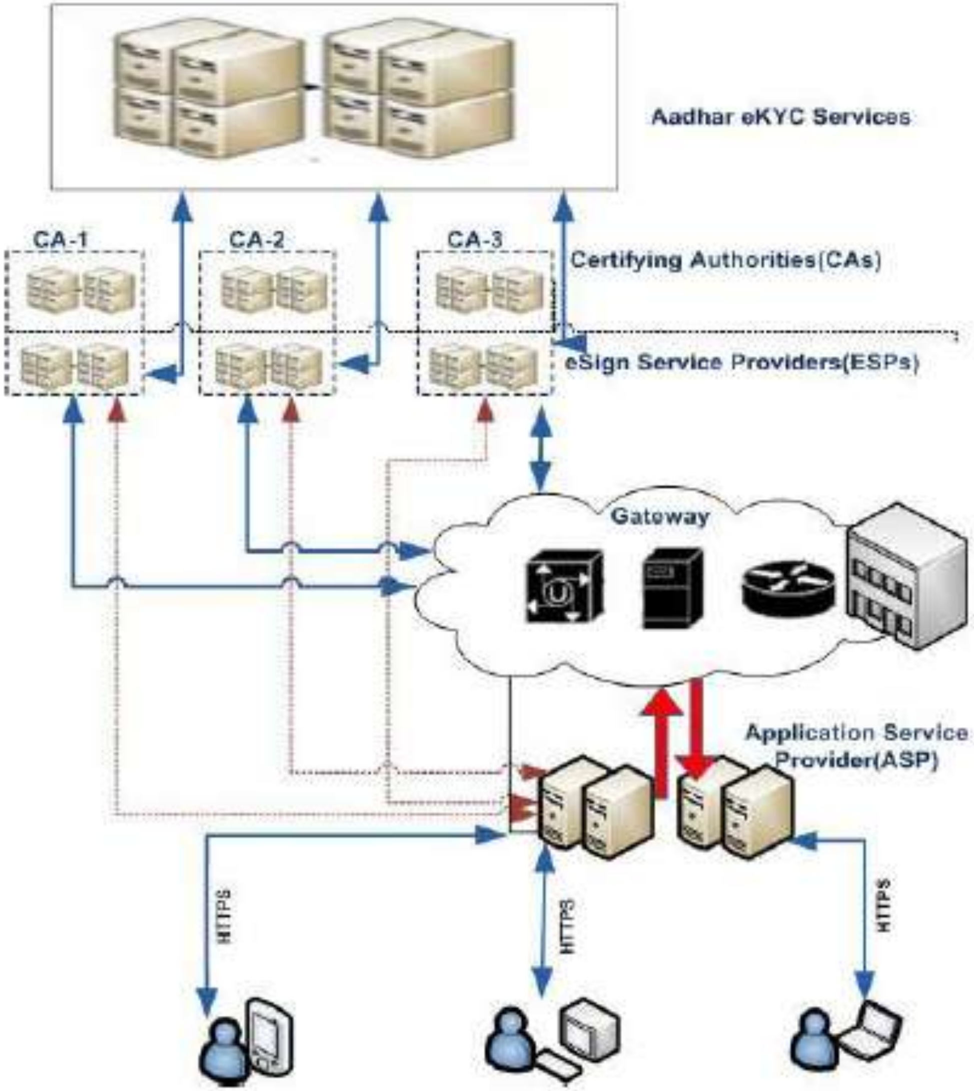
Certificate Assurance Levels

- Following classes of Certificates are issued.
- Aadhaar-eKYC – **OTP**:
  - This class of certificates shall be issued for **individuals use** based on OTP authentication of subscriber through Aadhaar e-KYC.
    - These certificates will confirm that the information in Digital Signature certificate provided by the subscriber is same as information retained in the Aadhaar databases pertaining to the subscriber as Aadhaar holder.

Certificate Assurance Levels

- Aadhaar-eKYC – **Biometric (FP/Iris)**:
  - This class of certificate shall be issued based on biometric authentication of subscriber through Aadhaar e-KYC service.
    - These certificates will confirm that the information in Digital Signature certificate provided by the subscriber is same as information retained in the Aadhaar databases pertaining to the subscriber as Aadhaar holder.

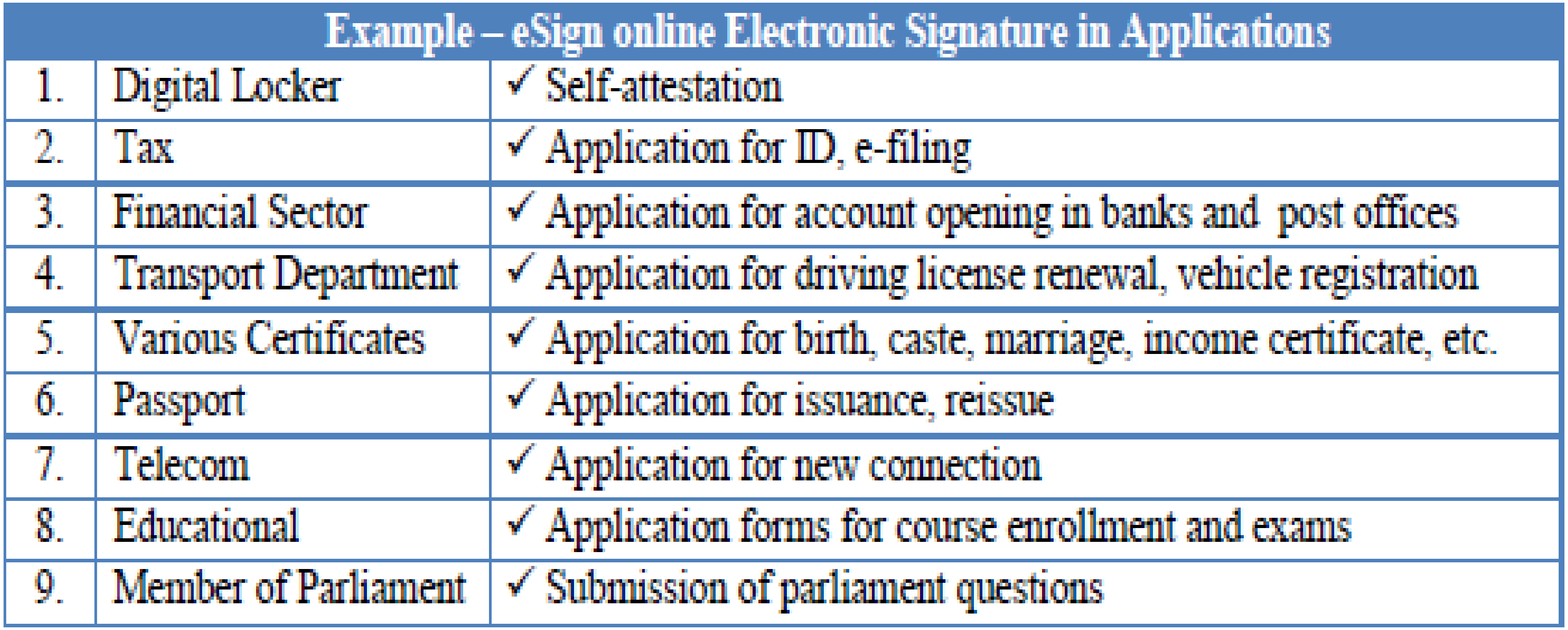
e-Sign Services (Operational Scenario)


Aadhar eKYC Services
CA-1
CA-2
CA-3
Certifying Authorities(CAs)
eSign Service Providers(ESPs)
Gateway
Application Service Provider(ASP)
HTTPS
HTTPS
HTTPS

Two Options for Operating e-Sign Services

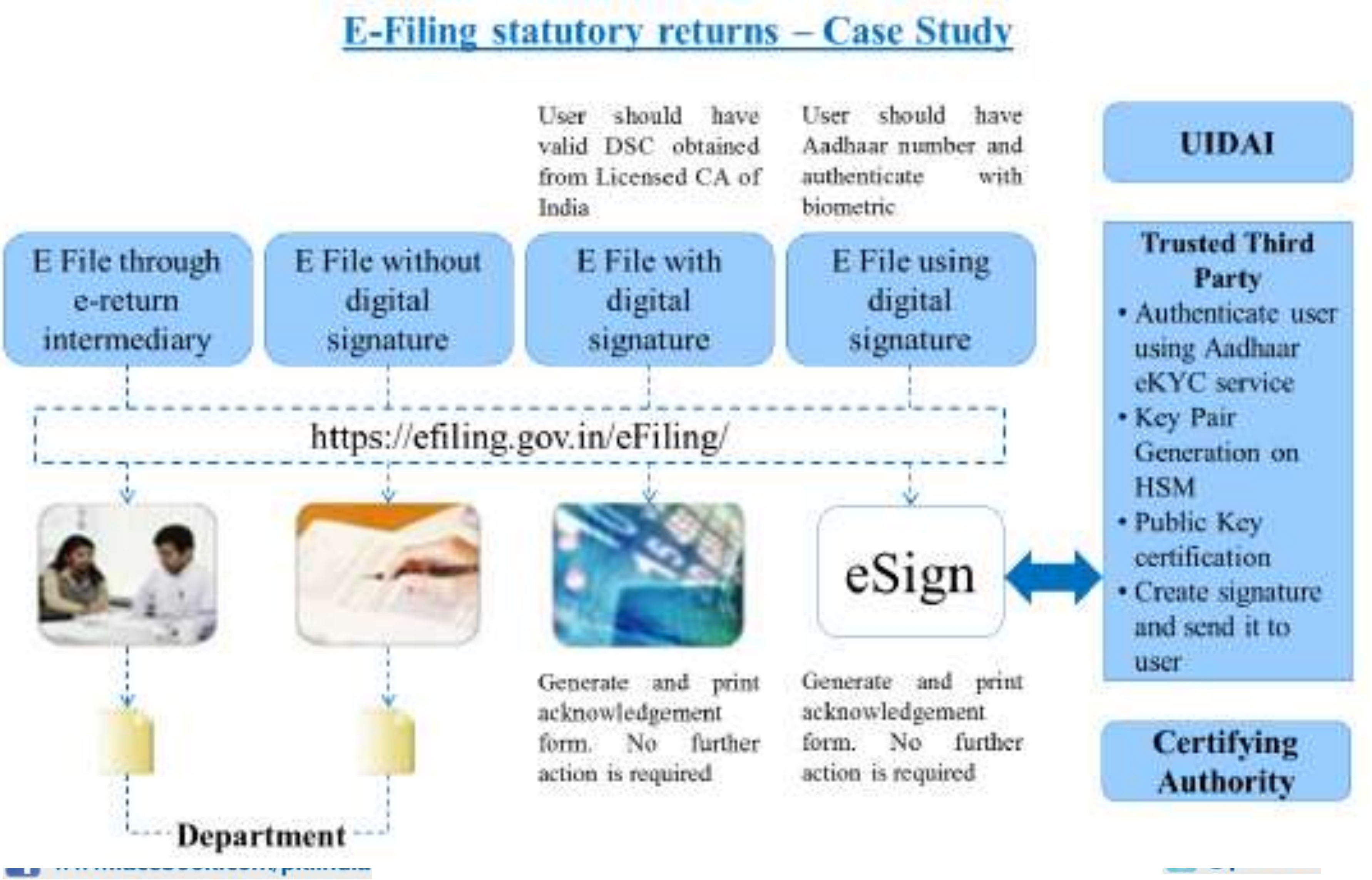
1) Directly Connecting to ESP
2) Using a Gateway Service Provider

Use Cases of e-Sign Services



Example – eSign online Electronic Signature in Applications		
1.	Digital Locker	✓ Self-attestation
2.	Tax	✓ Application for ID, e-filing
3.	Financial Sector	✓ Application for account opening in banks and post offices
4.	Transport Department	✓ Application for driving license renewal, vehicle registration
5.	Various Certificates	✓ Application for birth, caste, marriage, income certificate, etc.
6.	Passport	✓ Application for issuance, reissue
7.	Telecom	✓ Application for new connection
8.	Educational	✓ Application forms for course enrollment and exams
9.	Member of Parliament	✓ Submission of parliament questions

Case Study : e-Filing



E-Filing statutory returns – Case Study

User should have valid DSC obtained from Licensed CA of India

User should have Aadhaar number and authenticate with biometric

UIDAI

E File through e-return intermediary

E File without digital signature

E File with digital signature

E File using digital signature

https://efiling.gov.in/eFiling/

Trusted Third Party

- Authenticate user using Aadhaar eKYC service
- Key Pair Generation on HSM
- Public Key certification
- Create signature and send it to user

Generate and print acknowledgement form. No further action is required

Generate and print acknowledgement form. No further action is required

Certifying Authority

Department

Present Digital Signature & PKI Implementations in India

PKI enabled Applications

1	**e-Invoice**	**(B2C)**
2	**e-Tax Filing**	**(G2C)**
3	**e-Customs**	**(G2B)**
4	**e-Passport**	**(G2C) -** Presently in India, the Ministry of External Affairs has started issuing e-Passports in Karnataka state with the fingerprints and the digital photo of applicant
5	**e-Governance**	**Bhoomi (G2C)** a PKI enabled registration and Land Records Services offered by Govt. of Karnataka to the people. All the land records and certificates issued are digitally signed by the respective officer
6	**e-Payment**	**(B2B) -** In India, currently between banks fund transfers are done using PKI enabled applications whereas between customers and vendors such as online shopping vendor the payment is done through SSL thereby requiring the vendor to hold DSC)

PKI enabled Applications

7	**e-Billing**	**(B2C)** -The electronic delivery and presentation of financial statement, bills, invoices, and related information sent by a company to its customers)
8	**e-Procurement**	**G2B , B2B**
9	**e-Insurance Service**	**(B2C) -** Presently the users are getting the E-Premium Receipts etc. which is digitally signed by the provider
10	**Treasury Operations**	**(G2C)** ***Khajanae – II*** of Govt. of Karnataka uses Digital Signatures to automate and speed up the treasury operations

Other Implementations

- DGFT - Clearance of goods are now initiated by exporters through push of a button and in their offices;
  - Previously it used to take days; and requests are now cleared within 6 hours
- Indian Patent office has implemented e-filing of patents and allows only use of Class-3 Certificates
  - Around 30% of e-filing of patents is happening now, among the total filings.

Summary

- PKI is an ecosystem comprising of Technology, Policy and Implementations
  - Digital Signatures provide **A**uthenticity, **I**ntegrity, and **N**on-Repudiation for electronic documents & transactions
  - Asymmetric Key system enables **C**onfidentiality
- General Conventions
  - Signing – Private Key of the Signer
  - Verification – Public Key of the Signer
  - Encryption – Public Key of the Receiver
  - Decryption – Private Key of the Receiver

Conclusion

- PKI and Digital Signatures have been transforming the way traditional transactions happen
- PKI Ecosystem has the potential to usher
  - Transparency
  - Accountability
  - Time, Cost & Effort-savings
  - Speed of execution and to be an integral part of
  - **Digital India and bring in Digital Identity**

References

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- FAQ on Digital Signatures and PKI in India - http://www.cca.gov.in/cca/?q=faq-page
- Controller of Certifying Authorities – www.cca.gov.in
- e-Sign: http://www.cca.gov.in/cca/?q=eSign.html
- More Web Resources
  - For events, slides and Discussions: www.seekha.in/event/pki
  - Social Media:

www.facebook.com/pkiindia @pkiindia

C-DAC Activities in PKI Domain

- PKI Knowledge Dissemination Program
  - An effort to spread awareness and build competencies in the domain across the country
- PKI Body of Knowledge
  - To develop a BoK with inputs from various sections of users
    - Researchers – Algorithms and new directions in PKI
    - Developers – PKI Administration and implementation issues
    - Policy Makers - Laws
    - End Users and Applications

Thank You

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