Introduction to Public Key Infrastructure

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January 13, 2005

Overview

- Why PKI?
- PKI Components
- PKI Architectures
- Path Validation

Why PKI?

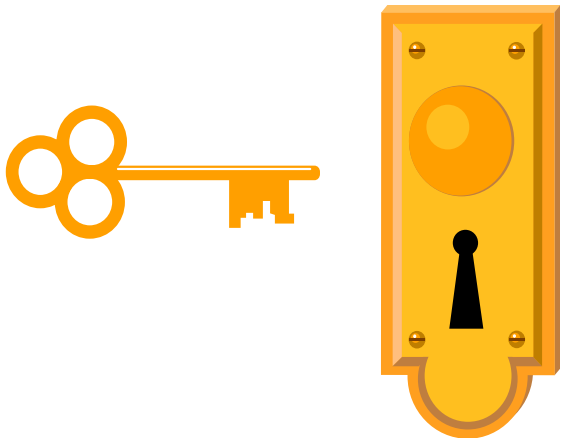
- PKI is not the goal
- Scalable security services are the goal
- PKI supports scalable security services using public key cryptography

Security Services That Can Be Supported By PKI

- Authentication - Ability to verify the identity of an entity
- Confidentiality - Protection of information from unauthorized disclosure
- Data Integrity - Protection of information from undetected modification
- Technical Nonrepudiation - Prevention of an entity from denying previous actions

Secret Key Cryptography

- Classical form of cryptography - Caesar Cipher
- Single key used to encrypt and decrypt data
- Strengths
  - Very fast relative to public key cryptography
  - Relatively short keys
- Weakness: Key must be shared among interested parties



Public Key Cryptography

- Each entity has a PAIR of mathematically related keys
  - Private Key - known by ONE
  - Public Key - known by Many
- Not feasible to determine Private Key from Public Key
- Strength – no shared private keys
- Weakness
  - Relatively slow
  - Requires longer keys for same level of security

Choosing Cryptographic Tools

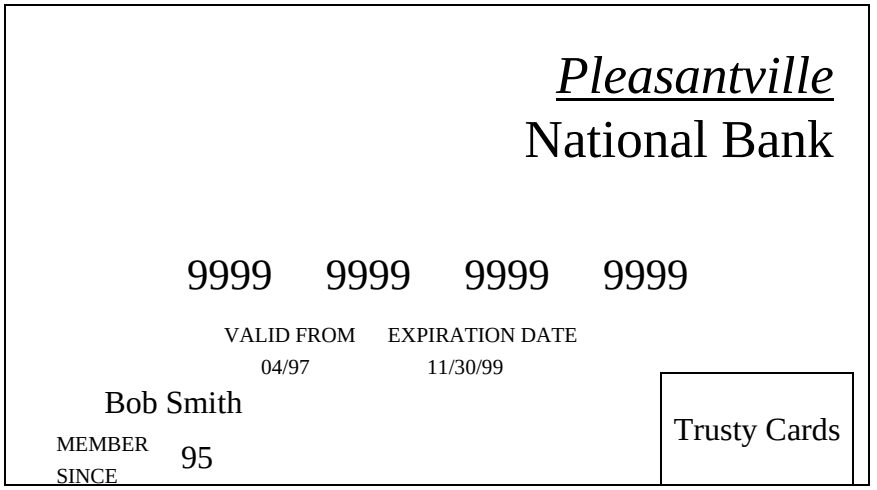
- Secret key is best
  - Bulk encryption
- Public key is best suited to
  - Digital signatures (e.g., RSA and DSA)
  - Key Management
    - Key transfer (e.g., RSA)
    - Key agreement (e.g., Diffie-Hellman)

Why Do We Need Certificates?

- Whose public key is this, anyway?
- What is this key good for?
  - Signatures or encryption?
  - < $100 or up to $10,000,000 ?
  - Secure mail, secure web, or document signing?
  - How much can I trust it?

Credit Card

- Features
  - Magnetic Stripe
  - Issued by trusted 3rd party (TTP)
    - issuer verifies user info
    - Issuer knows if information is current
  - Fixed expiration
- Drawbacks
  - Easy to forge
  - Partial identification



Digital Public Key Certificates

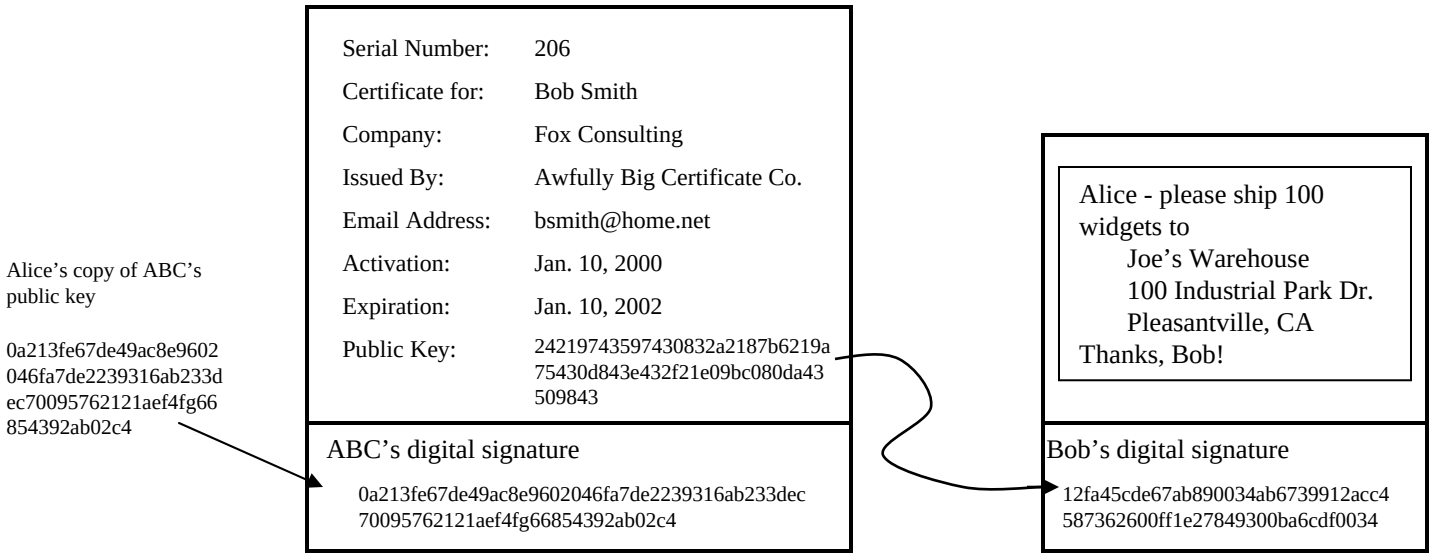
- Features
  - Digital object (no typing!)
  - Tamper-evident
  - Issued by a TTP
  - Complete user identification
  - Fixed expiration
- Drawbacks
  - Must trust issuer

Serial Number:	206
Certificate for:	Bob Smith
Company:	Fox Consulting
Issued By:	Awfully Big Certificate Co.
Email Address:	bsmith@home.net
Activation:	Jan. 10, 2000
Expiration:	Jan. 10, 2002
Public Key:	24219743597430832a2187b6219a75430d843e432f21e09bc080da43509843

ABC's digital signature

0a213fe67de49ac8e9602046fa7de2239316ab233dec70095762121aef4fg66854392ab02c4

Using Public Key certificates



Why Do We Need CRLs or Status Checking?

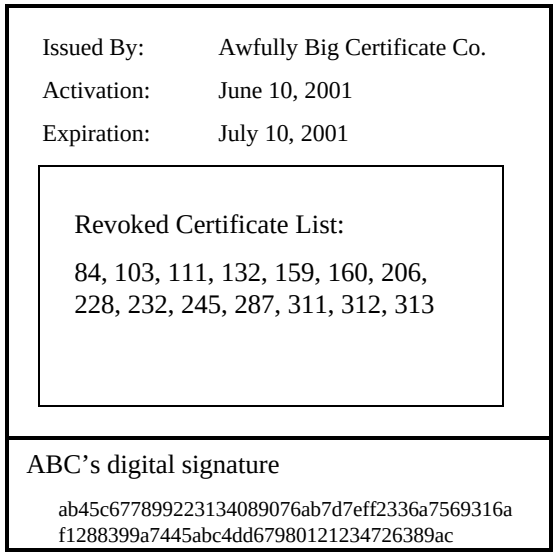
- Credit cards are revoked if the card holder
  - Dies
  - Loses the card
  - Cancels the card
  - Doesn’t pay
- Certificates may be revoked if the subject
  - Dies
  - Loses their crypto module
  - Leaves the company

Credit Card Verification

- Two mechanisms for handling credit card revocation
  - The “hot list”
    - Paper booklet listing hot cards
  - Calling the issuer
    - Providing the card number AND the $ amount
    - Received an authorization number OR a denial

CRLs & Status Checking

- CRLs are analogous to the "hot list"
- Status checking is analogous to calling the issuer to obtain information on a credit card



Certification Authority (CA)

- An entity that is trusted by PKI users to issue and revoke public key certificates
- A CA is a collection of personnel and computer systems
  - Highly secured (e.g., a guarded facility, with firewalls on the network) against external threats
  - Strong management controls (separation of duties, n of m control) to protect against internal threats

Registration Authority (RA)

- An entity that is trusted by the CA to vouch for the identity of users to a CA
  - This entity is only trusted by the CA
  - Generally relies on operational controls and cryptographic security rather than physical security

Repository

- An electronic site that holds certificates and certificate status information
  - Need not be a trusted system since all information is tamper-evident
  - Most commonly accessed via LDAP
  - Theoretically could be accessed using HTTP, FTP, or even electronic mail

PKI Architectures

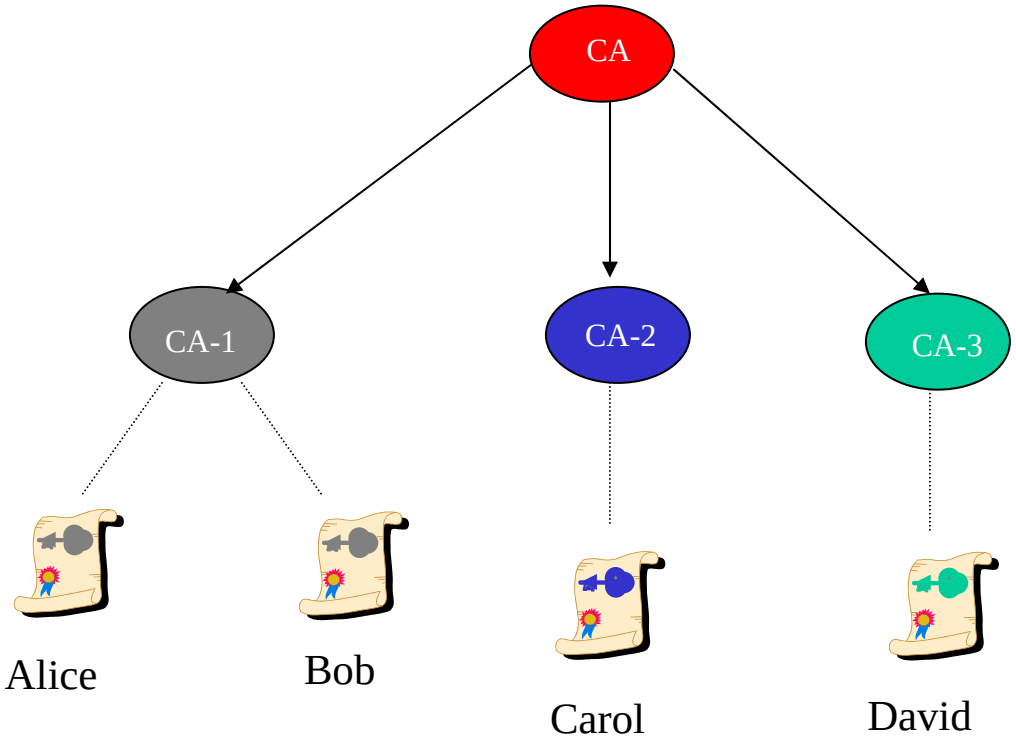
- Single CA
- Hierarchical PKI
- Mesh PKI
- Trust lists (Browser model)
- Bridge CAs

Single CA

- A CA that issues certificates to users and systems, but not other CAs
  - Easy to build
  - Easy to maintain
  - All users trust this CA
  - Paths have one certificate and one CRL
  - Doesn’t scale particularly well

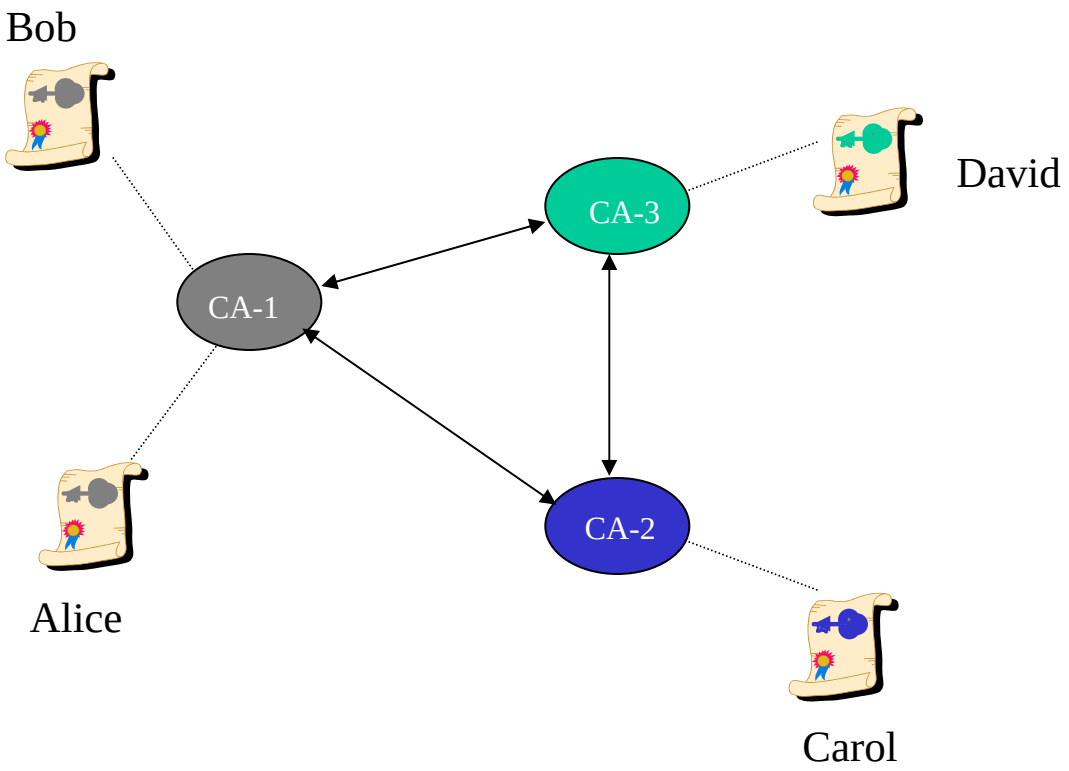
Hierarchical PKI

- CAs have superior-subordinate relationships
- Users trust the root CA



Mesh PKI

- CAs have peer-to-peer relationships
- Users trust the CA that issued their certificates



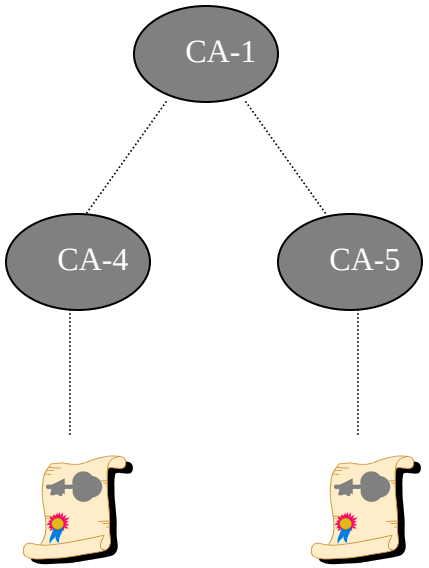
Trust lists (Browser model)

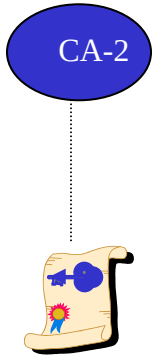
- User trusts more than one CA
- Each CA could be a single CA or part of a PKI
  - For hierarchies, should be the root
  - For mesh PKIs, could be any CA

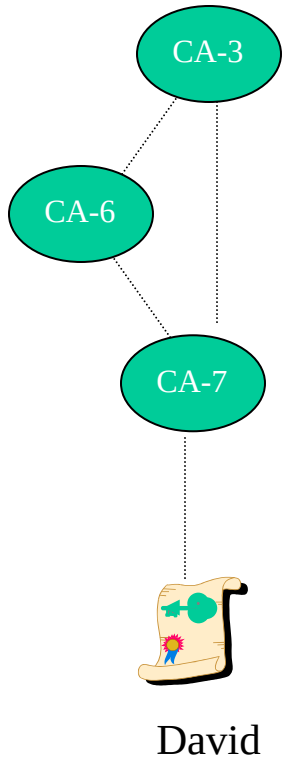
Trust List Example

Alice's Trust List

CA-1
CA-2
CA-3





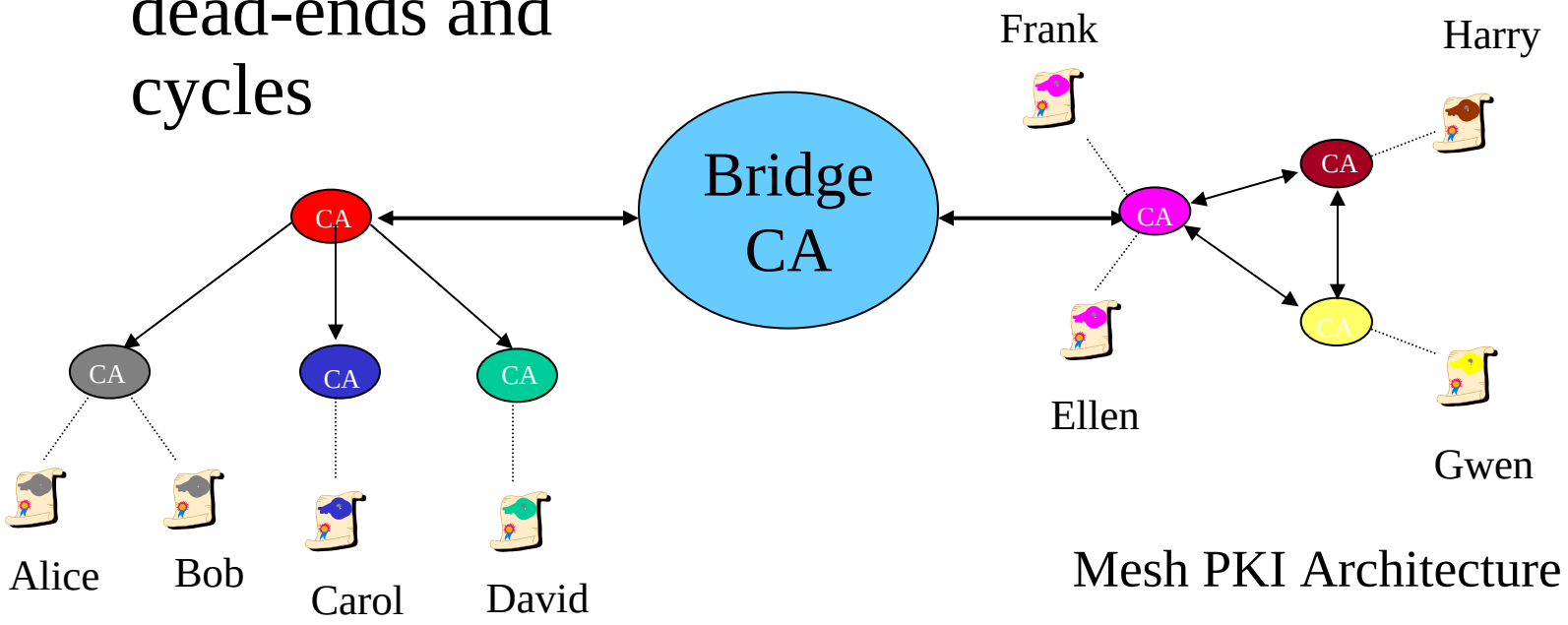


Bridge CAs

- Designed to unify many PKIs into a single PKI
- Designed to translate trust information into a single entity

Bridge CA Example

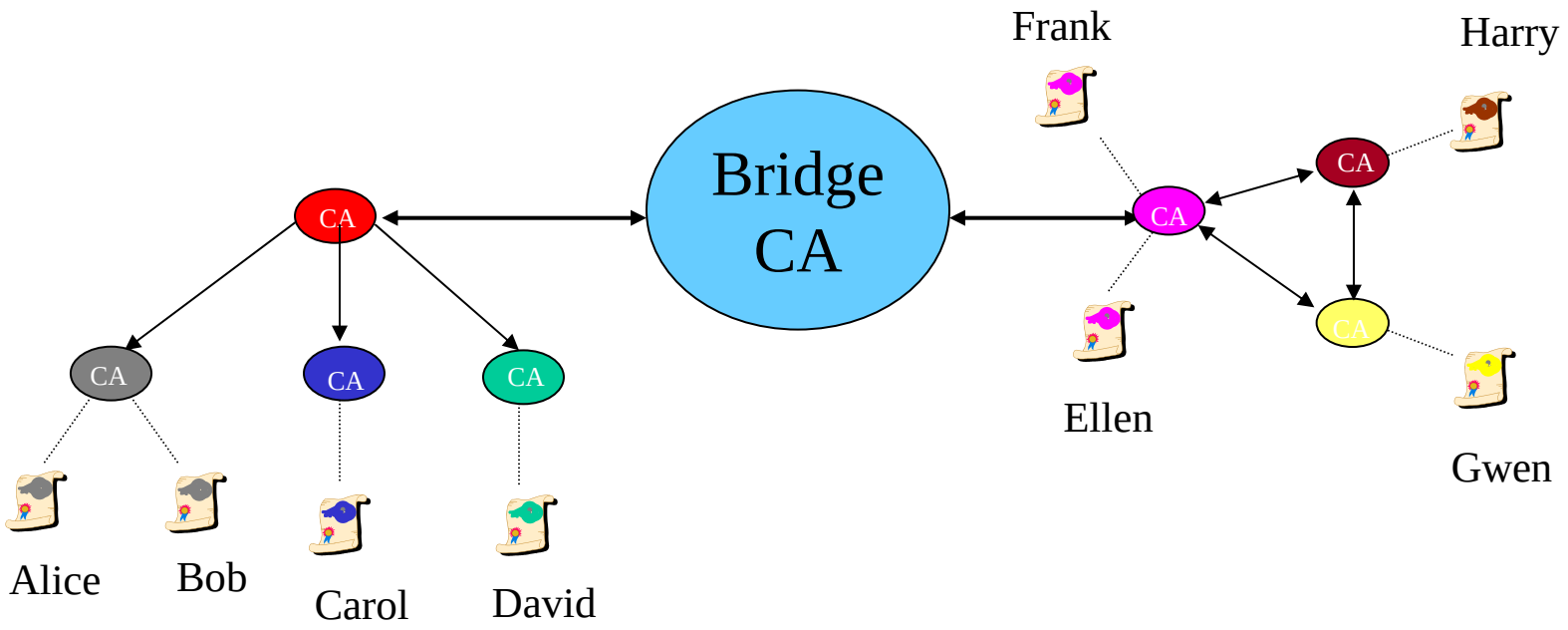
- There may be dead-ends and cycles



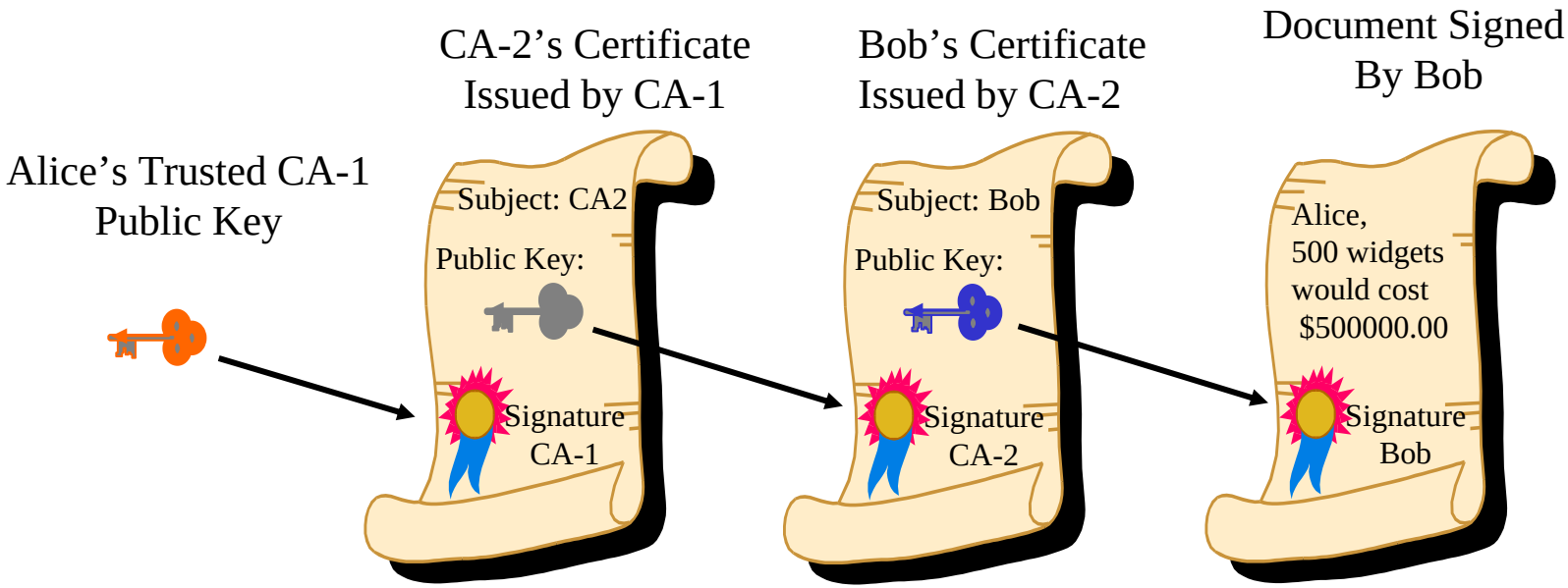
Hierarchical PKI Architecture

Mesh PKI Architecture

The Path Development Problem



Path Validation



- Also need to check the status of each certificate!