CNT4406/5412 Network Security

PKI (Public Key Infrastructure)

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Introduction

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  ➠ X.509 is the specification for a certificate
- a repository for retrieving certificates
- a method of revoking certificates
- a method of evaluating a chain of certificates from **trust anchors** to the **target** name

Terminology

- A **certificate** is a signed message vouching a name with a public key
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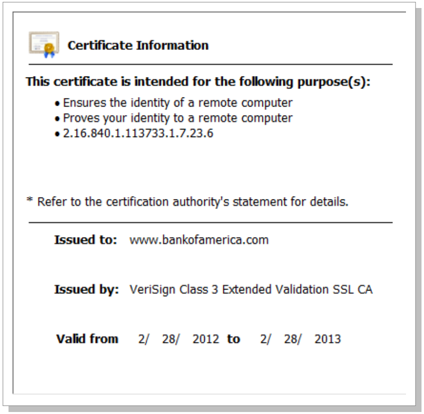
- A **trust anchor** is a public key that is trusted to sign a certificate

X.509 Certificate: Example

A certificate for Bank of America signed by VeriSign



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
- 2.16.840.1.113733.1.7.23.6

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

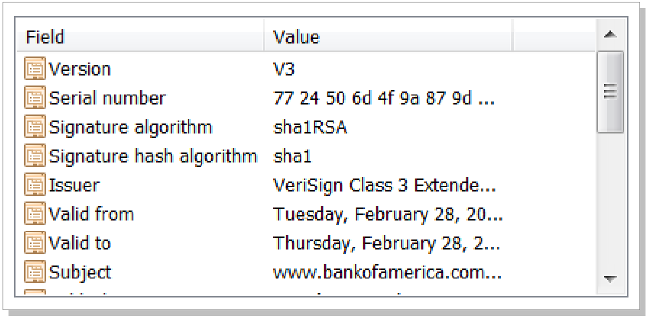
Issued to: www.bankofamerica.com

Issued by: VeriSign Class 3 Extended Validation SSL CA

Valid from 2/ 28/ 2012 **to** 2/ 28/ 2013

X.509 Certificate: Example

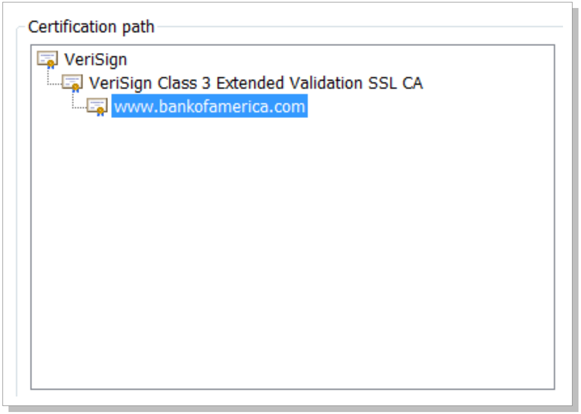
Details for the BOA certificate



Field	Value
Version	V3
Serial number	77 24 50 6d 4f 9a 87 9d ...
Signature algorithm	sha1RSA
Signature hash algorithm	sha1
Issuer	VeriSign Class 3 Extende...
Valid from	Tuesday, February 28, 20...
Valid to	Thursday, February 28, 2...
Subject	www.bankofamerica.com...

X.509 Certificate: Example

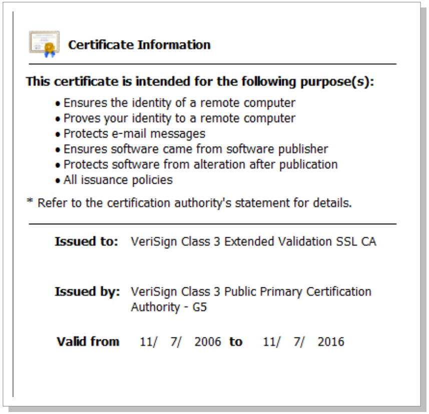
Verification path for the BOA certificate


Certification path

VeriSign
VeriSign Class 3 Extended Validation SSL CA
www.bankofamerica.com

X.509 Certificate: Example

A certificate from VeriSign signed by **VeriSign** (why?)



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
- All issuance policies

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Issued to: VeriSign Class 3 Extended Validation SSL CA

Issued by: VeriSign Class 3 Public Primary Certification Authority - G5

Valid from 11/ 7/ 2006 **to** 11/ 7/ 2016

X.509 Certificate Format

- Basic fields:

Field	Description	Example
version	X.509 certificate version	V3
serial number	unique id for the certificate in the CA	`77 24 50 6d...`
signature	algorithm used to signed the certificate	sha1 RSA
issuer	X.500 name of the issuer	VeriSign Class 3 ...
validity from	starting date of the certificate	02/28/2012 8:00:00 PM
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- Optional fields: basic constrains, key usage, CRL distribution points, authority key identifier*, subject key identifier...

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1. Monopoly model
2. Monopoly + RAs
3. Delegated CAs
4. Oligarchy model
5. Anarchy model
6. Top-down with name constraints
7. Bottom-up with name constraints

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- The CA's public key is embedded in all software and hardware
  ➠ the only trust anchor

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  ➠ infeasible to change the CA's key everywhere if compromised
- It is expensive and insecure for the CA to remotely certify a public key

Monopoly + Registration Authorities (RAs)

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  ➠ Firefox (ver 15.0.1): hundreds of root certificates from 86 organizations around the world, none revoked

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  ➠ encrypted does not mean secure
- Some software (browsers) accept expired certificates
  ➠ Google Chrome includes a certificate from Microsoft which has expired since 12/30/1999

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- User searches through the database to verify a public key
  ➠ a path from one of his trust anchors to the target $\rightarrow$trusted

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- The database would be unworkably large if deployed on Internet scale
- It's hard to verify the trustworthiness of every certificate on the chain
  ➠ no problem for a small community where everyone is trustworthy
  ➠ can we trust a certificate if there are multiple chains?

Models with Name Constraints

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  - ➠ FSU CA certifies FSU students
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- Name constraints defines they way to verify (search) a target
  - ➠ top-down or bottom-up

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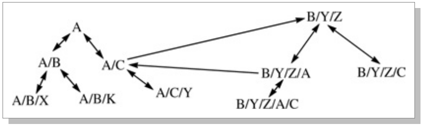
- It has the other problems of the monopoly model

Bottom-up with Name Constraints

- The model assumes a hierarchical namespace (like DNS)



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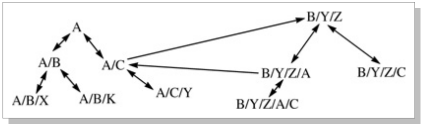

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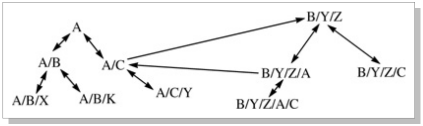
- The namespace can be traversed starting from any node
  - ➠ follow up-links and/or one cross-link to an ancestor of the target
  - ➠ follow donw-links (only) from there



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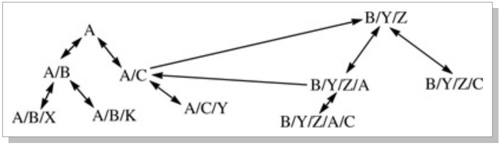

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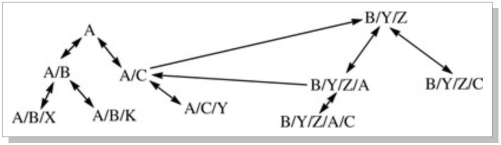

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  - ➠ Authentication between users in the same organization stays within
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- No monopoly is possible
- Replacing any key is reasonably easy

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- Each transaction is checked against the CRL

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Certificate Revocation List

- Why are CRL issued periodically even if no certificates are revoked?
- How frequent should CRL be issued?
- If a CRL is maintained, why set an expiration time for certificates?

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- CRL may be very large and needs to be downloaded frequently
- A delta CRL lists changes from the last complete CRL
  ➠ not from the last delta CRL
- Delta CRLs can be issued very frequently
  ➠ full CRLs are issued less frequently

On-line Revocation Servers (OLRS)

- OLRS is a online system to query the revocation status of certificates
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  - ➠ Alice can obtain a (timestamped) certificate from OLRS
    "Alice's certificate was not revoked as of ..."
  - ➠ Bob can query OLRS in advance and cache the result

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  ➠ solution: use hashes of the certificates

Summary

- X.509 certificate
- PKI trust models
- Certificate revocation

- Next lecture: IPSec