

Public Key Infrastructure

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Integrates:

1. Digital certificates
2. Public key cryptography
3. Certification authorities

for enterprise-wide network security architecture

Public Key Infrastructure

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- verifies user requests for a digital certificate and tells the CA to issue it

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- database of active digital certificates for a CA
- provide data that allows users to confirm the status of digital certificates for individuals and businesses that receive digitally signed messages

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5. Certificates

- includes public key, information about the identity of the party holding the corresponding private key, the operational period for the certificate, and the CA's own digital signature
- may contain other information about the signing party or information about the recommended uses for the public key

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 - issues certificates (creates and signs them)
 - maintains certificate status information and issues CRLs
 - publishes its current (e.g., unexpired) certificates and CRLs, so users can obtain the information they need to implement security services
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6. May assert that certificates issued by other CAs are trustworthy
7. Signs every certificate
8. CA *must* provide adequate protection for its own private key

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7. RAs must provide adequate protection for their private keys

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4. Lightweight Directory Access Protocol (LDAP) for client-server communications
5. Directory servers need to be *interoperable* to be able to retrieve CRLs and certificates from remote sites for signature verification

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6. This permits the verification of signatures on old documents (such as wills) at a later date.

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Trust Models:

Monopoly model: One organization is trusted by all others to issue certificates. All software contains public key of that CA

Monopoly + Registration Authorities: Use other organizations to check identities and vouch for public keys

Delegated CAs: Trust anchor issues certificates to other CAs. Users can get a certificate from one of the other CAs.

Oligarchy (Browsers): Many trust anchors, certificate from one is sufficient

Anarchy (PGP): Each user responsible for configuring TAs.

Public Key Infrastructure

Monopoly:

There is no one universally trusted organization

Infeasible to change the key in all software if it is compromised

CA could charge whatever it wants to issue certificates

Monopoly + RAs:

More convenient than above

Delegated CAs:

Does recipient see one certificate or a chain of them?

Oligarchy (e.g. browsers):

Worse than monopoly since *any* of trust anchors could be comp.

Trust anchors may be trusted by vendor but not user!

It is easy to trick a naive user into accepting a bogus trust anchor

Users do not understand what's up: ex: use of public terminal

Unlikely a user will check trust anchor list to see if it's tampered

Anarchy (PGP): Could become unworkable on large scale

Public Key Infrastructure

Name Constraints:

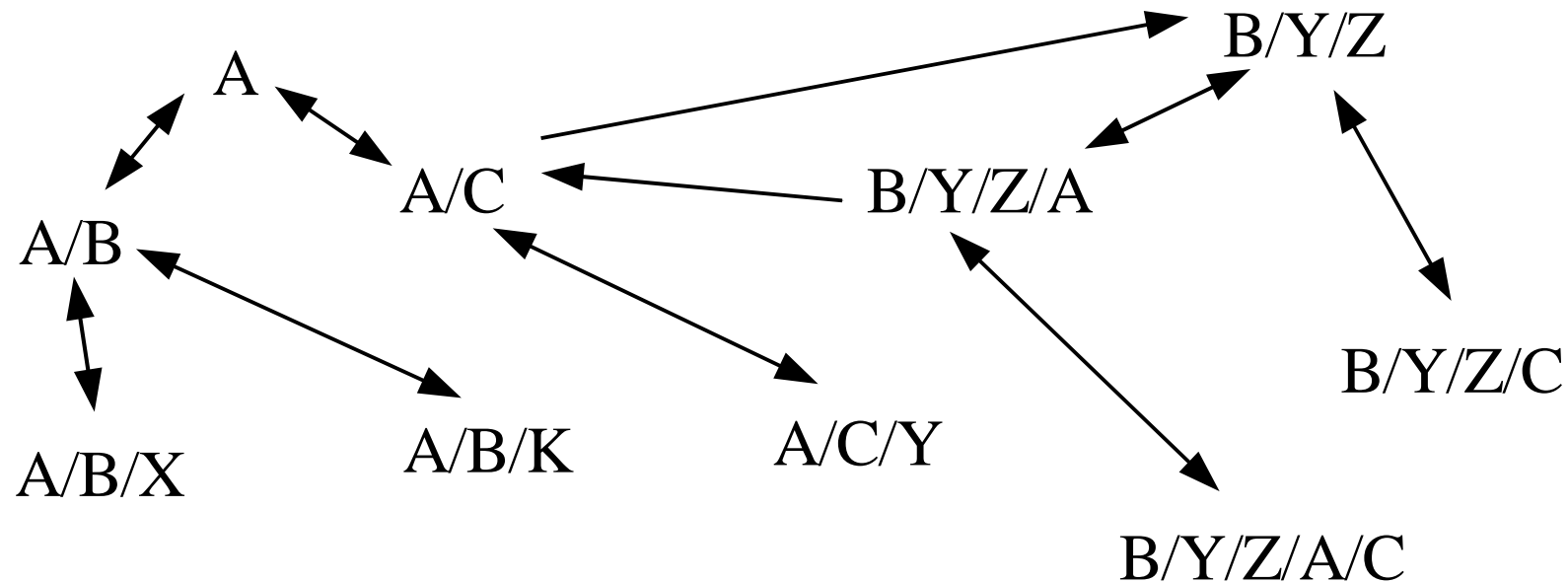
Assume CA trusted to issue certs for only some users or domains

Top-Down with Name Constraints:

Tree of CAs, each can only issue certs in their domain.

Bottom-Up with Name Constraints:

Each org creates its own PKI and links to the WWW of PKIs



Public Key Infrastructure

Bottom-Up with Name Constraints:

1. Easy to determine whether path exists
2. Hierarchy corresponding to the name of the principal is intuitive
3. PKI can be deployed in any org, no need to pay someone to do it
Can have a PKI in your org even if lots of other orgs do not
4. Damage due to compromised CA is limited to that org
No one can impersonate you from a compromised CA outside of your org
5. Configuration is easy: all CAs can be reached beginning with your key pair - new employee gets a key just like a badge

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Relative Names:

Certificates carry relative names, not absolute names

e.g. Use *ececs* instead of *ececs.uc.edu*

If an entire subtree of names has to be moved, no certificates need to be reissued

Do not use name A/B/C/D but only D on certificates from A/B/C - then if that moves to H/Y, say, only certificates between H/Y and ancestors need be reissued.

Name Constraints in Certificates:

Field in certificate stating names

Allows issuer to specify names that subject is trusted to certify

Can also disallow names.

In Bottom-Up model

child says “allow only names below yours”

parent says "allow any names except myself and below"

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Policies in Certificates:

Statement of how carefully the identity of requestor is checked.

If not obeyed, no certificate is issued.

Can deny certificates to users not at high level of security.

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Expiration and Revocation:

Revocation important – someone may realize their key is stolen.

Expiration important – many orgs do not bother with revocation
companies collecting money for issueing certs want to issue
lots of them

If certificates of web service providers expire or are revoked, then
new ones have to be issued - thus, down time

So, browsers typically do not check certificates

Verisign demands are so high, people do not get new certificates
from them - depending on browsers not to check

Hence, security is down the tubes.

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Certificate Revocation Lists (CRL):

CA periodically issues a timestamped, signed list of revoked certs

Delta CRL – just the changes since a particular time/day

On-Line Revocation Server (OLRS):

System that can be queried over the net

Can this service be trusted?

Worst thing is to claim an invalid cert is still valid

– damage from this is limited