Authentication, Authorisation and Security

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Grid security and trust -1

- **Providers of resources (computers, databases,..) need risks to be controlled: they are asked to trust users they do not know**
  - They trust a VO
  - The VO trusts its members
- **User’s need**
  - single sign-on: to be able to logon to a machine that can pass the user’s identity to other resources
  - To trust owners of the resources they are using

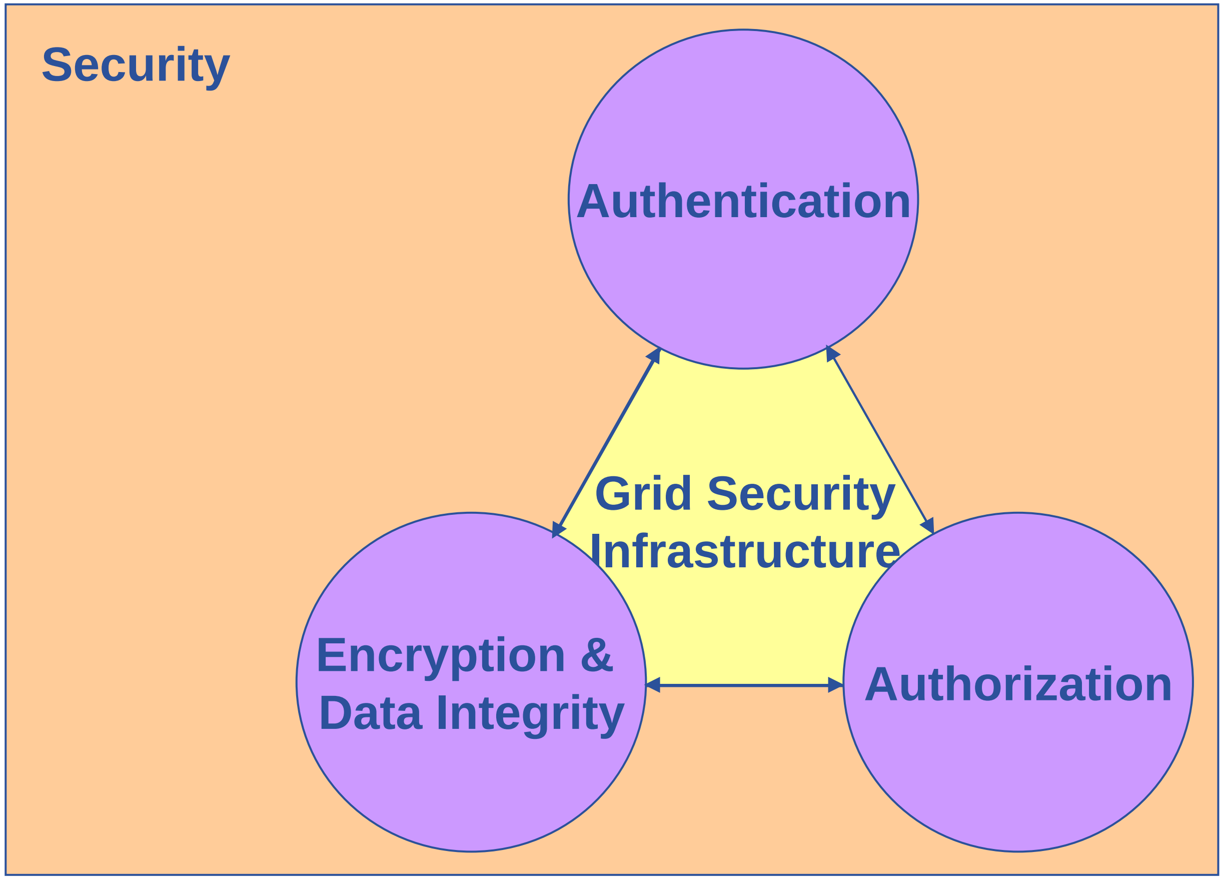
- **Build middleware on layer providing:**
  - *Authentication:* know who wants to use resource
  - *Authorisation:* know what the user is allowed to do
  - *Security:* reduce vulnerability, e.g. from outside the firewall
  - *Non-repudiation:* knowing who did what

- **The “Grid Security Infrastructure” middleware is the basis of (most) production grids**

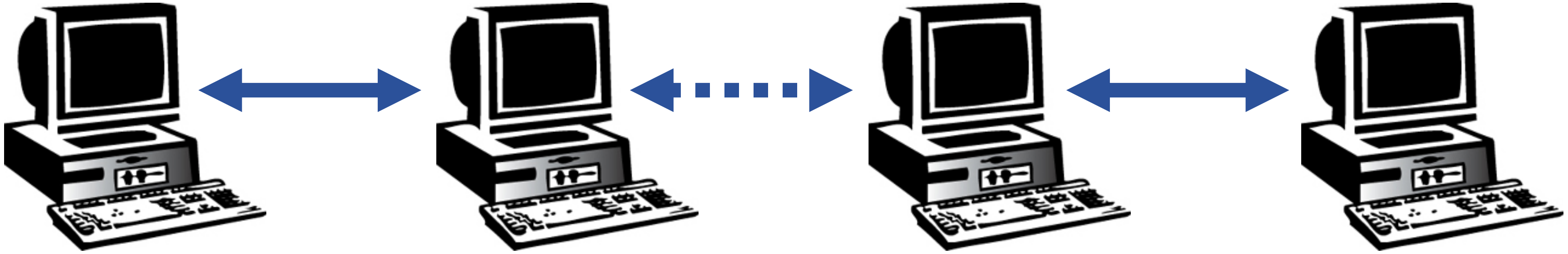
Grid security and trust -2

- **Achieved by Certification:**
  - User's identity has to be certified by one of the national *Certification Authorities* (CAs)
    - mutually recognized http://www.gridpma.org/
  - In UK go to http://www.grid-support.ac.uk/ca/ralist.htm to find CA's local "Registration Authorities"
  - Resources are also certified by CAs
- **User**
  - User joins a VO
  - Digital certificate is basis of AA
  - Identity passed to resources you use, where it is mapped to a local account
- **Virtual Organization negotiates rights to use resources**

Security Overview



The Problems - 1



- How does a user securely access the Resource without having an account on the machines in between or even on the Resource?

- How does the Resource know who a user is?
- How are rights and that they are allowed access?

Authentication: how is identity of user/site communicated?

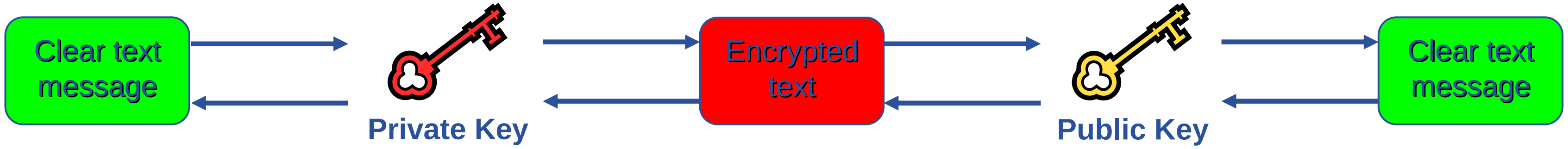
Authorisation: what can a user do?

The Problems -2: reducing vulnerability

- **Launch attacks to other sites**
  - Large distributed farms of machines, perfect for launching a Distributed Denial of Service attack.
- **Illegal or inappropriate data distribution and access sensitive information**
  - Massive distributed storage capacity ideal for example, for swapping movies.
  - Growing number of users have data that must be private – biomedical imaging for example
- **Damage caused by viruses, worms etc.**
  - Highly connected infrastructure means worms could spread faster than on the internet in general.

Basis of security & authentication

- **Asymmetric encryption…**



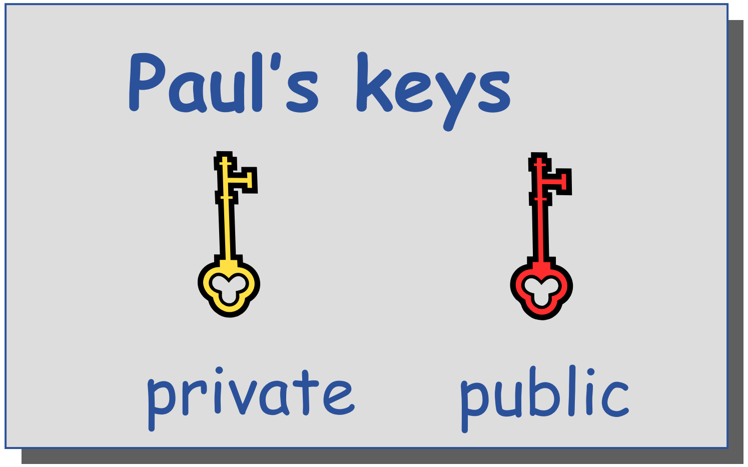
- **…. and Digital signatures …**
  - A hash derived from the message and encrypted with the signer’s private key
  - Signature is checked by decrypting with the signer’s public key

- **Are used to build trust**
  - That a user / site is who they say they are
  - And can be trusted to act in accord with agreed policies

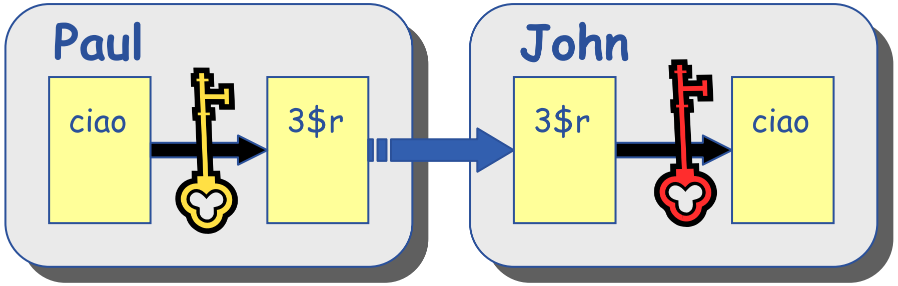
Enabling Grids for E-sciencE

Public Key Algorithms

- **Every user has two keys: one *private* and one *public*:**
  - it is *impossible* to derive the private key from the public one;
  - a message encrypted by one key can be decrypted **only** by the other one.

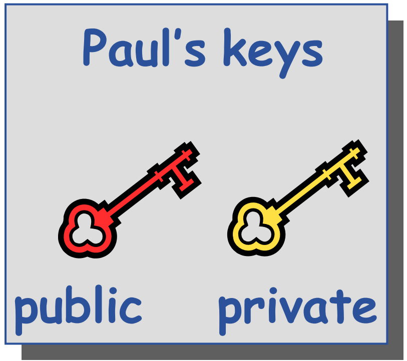


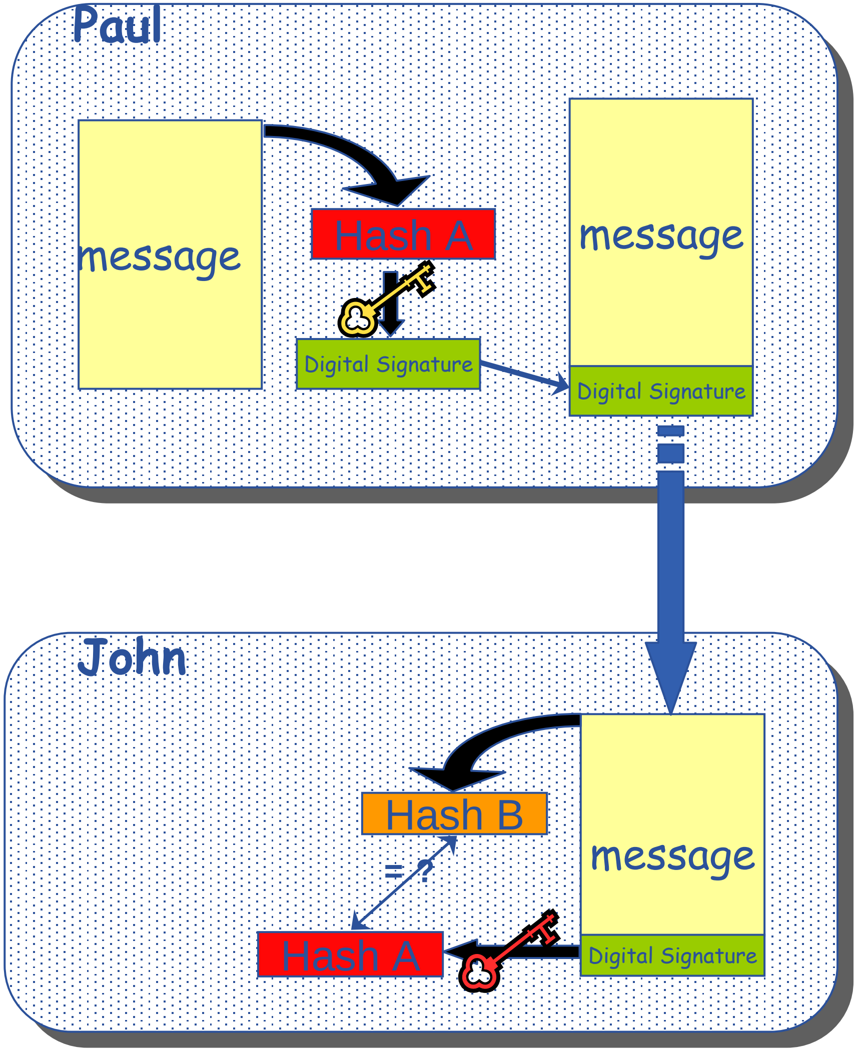
- **Public keys are exchanged**
- **The sender encrypts using his private key**
- **The receiver decrypts using senders public key;**
- **The number of keys is O(n)**



Digital Signature

- Paul **calculates the *hash* of the message**
- Paul **encrypts the hash using his *private* key: the encrypted hash is the *digital signature*.**
- Paul **sends the signed message to** John.
- John **calculates the hash of the message**
- **Decrypts signature, to get A, using Paul's *public* key.**
- **If hashes equal:**
  1. message wasn't modified;
  2. hash A is from Paul's private key

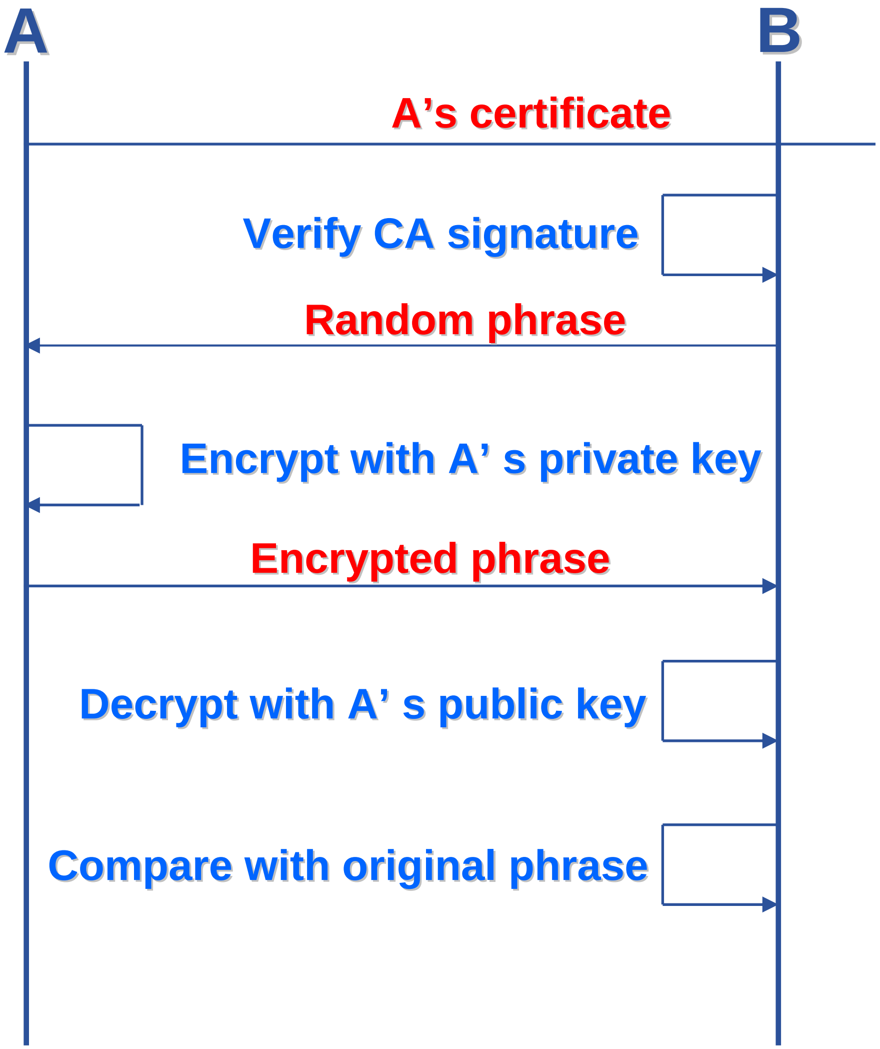




The Grid Security Infrastructure (GSI)

Based on X.509 PKI:

- **every Grid transaction is mutually authenticated:**
  1. A sends his certificate;
  2. B verifies signature in A's certificate using CA public certificate;
  3. B sends to A a challenge string;
  4. A encrypts the challenge string with his private key;
  5. A sends encrypted challenge to B
  6. B uses A's public key to decrypt the challenge.
  7. B compares the decrypted string with the original challenge
  8. If they match, B verified A's identity and A can not repudiate it.
  9. Repeat for A to verify B's identity


A
B
A's certificate
Verify CA signature
Random phrase
Encrypt with A' s private key
Encrypted phrase
Decrypt with A' s public key
Compare with original phrase

The Grid Security Infrastructure (GSI) - continued

After A and B authenticated each other,
for A to send a message to B:

- **Default: message integrity checking**
  - Not private – a test for tampering

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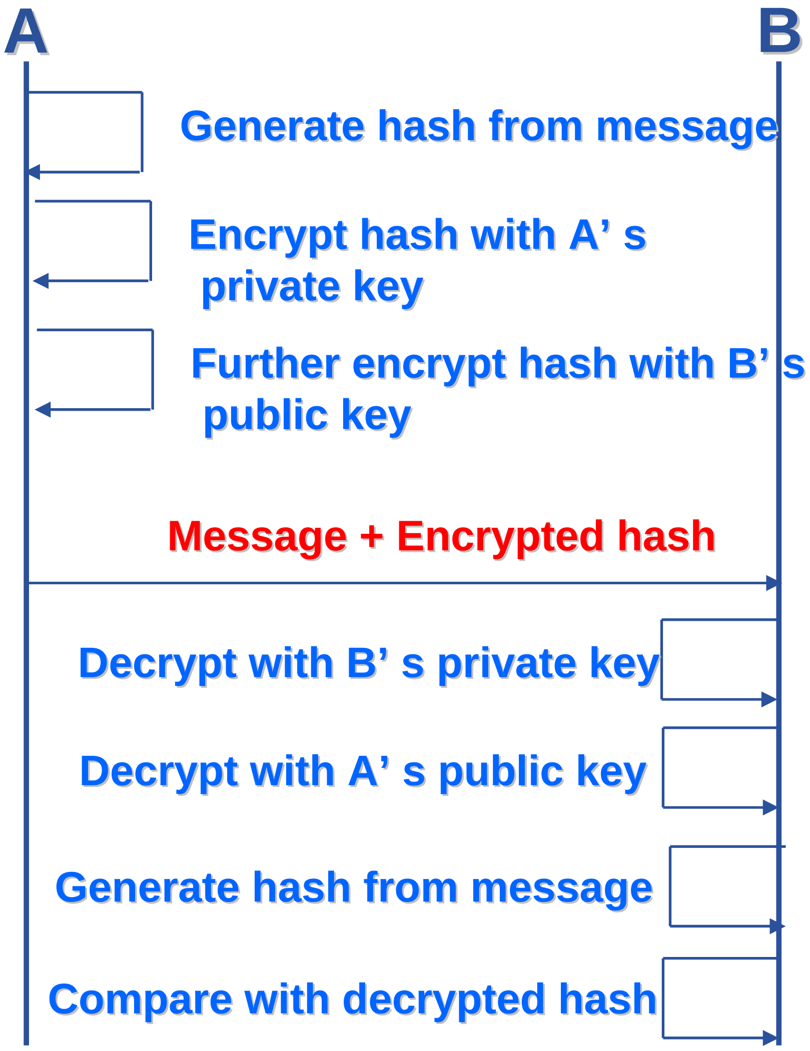
- **For private communication:**
  - Encrypt all the message (not just hash) - Slower



A

B

Generate hash from message

Encrypt hash with A’ s private key

Further encrypt hash with B’ s public key

Message + Encrypted hash

Decrypt with B’ s private key

Decrypt with A’ s public key

Generate hash from message

Compare with decrypted hash

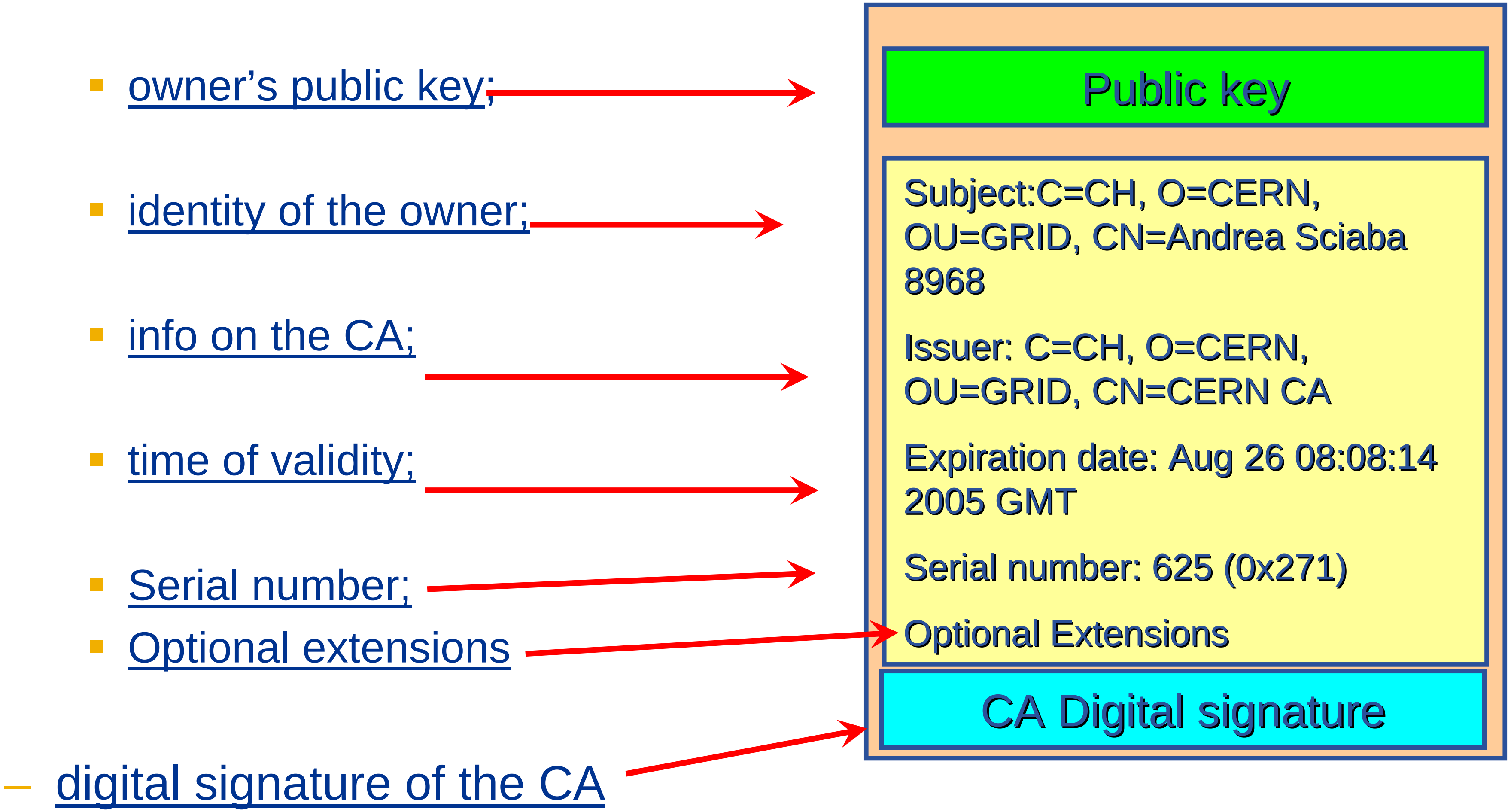
Digital Certificates

- **How can John be sure that Paul’s public key is really <u>Paul’s</u> public key and not someone else’s?**
  - A *third party* certifies correspondence between the public key and Paul’s identity.
  - Both John and Paul trust this third party

The “third party” is called a *<u>Certification Authority</u>* (CA).

X.509 Certificates

- **An X.509 Certificate contains:**



  - owner's public key;
  - identity of the owner;
  - info on the CA;
  - time of validity;
  - Serial number;
  - Optional extensions

  – digital signature of the CA

Public key

Subject:C=CH, O=CERN, OU=GRID, CN=Andrea Sciaba 8968

Issuer: C=CH, O=CERN, OU=GRID, CN=CERN CA

Expiration date: Aug 26 08:08:14 2005 GMT

Serial number: 625 (0x271)

Optional Extensions

CA Digital signature

Certification Authorities

- User’s identity has to be certified by one of the national *Certification Authorities* (CAs)

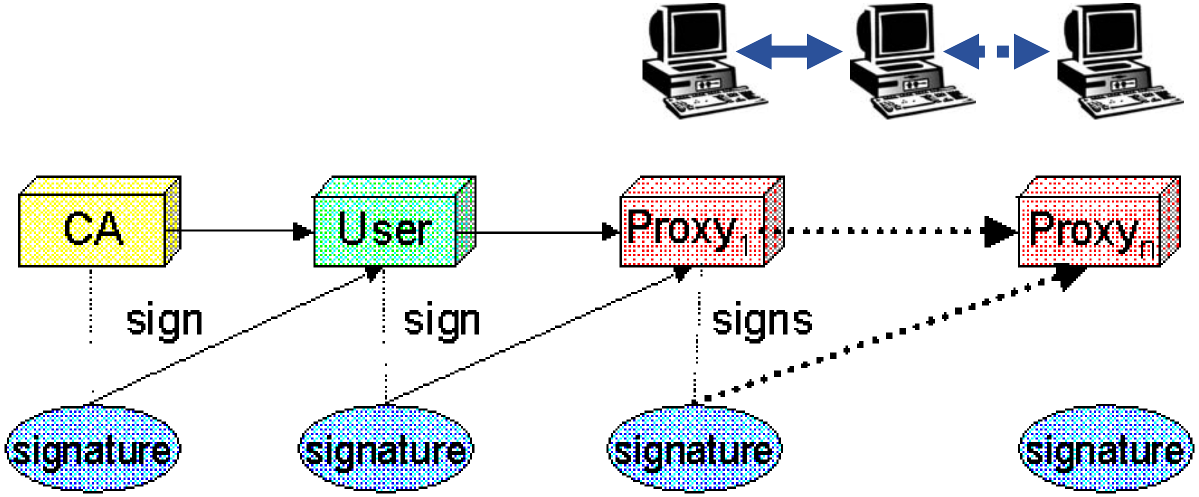
- Resources are also certified by CAs

- CAs are mutually recognized http://www.gridpma.org/

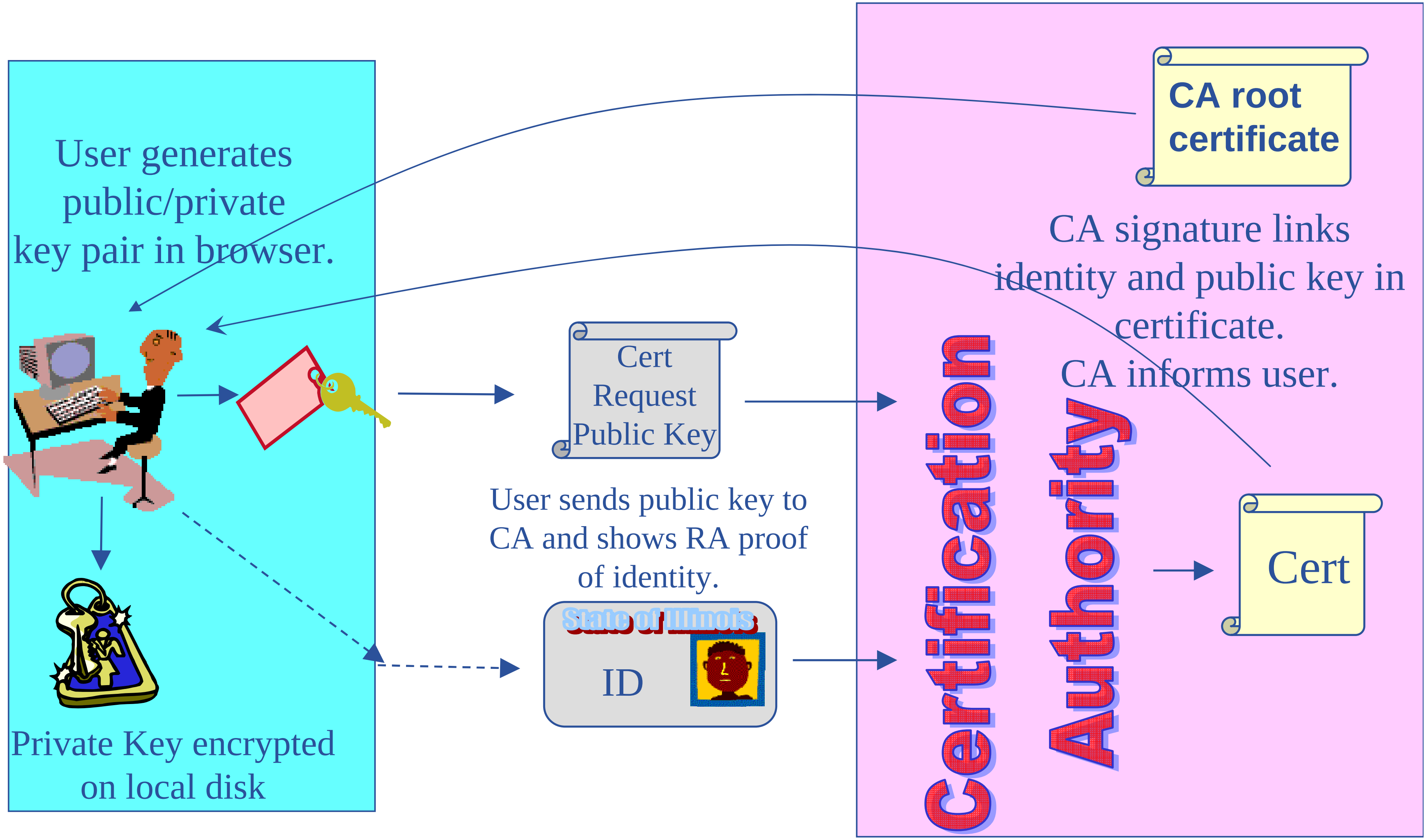
- CAs each establish a number of people “registration authorities” RAs

Grid Security Infrastructure - proxies

- **To support delegation: A delegates to B the right to act on behalf of A**
- **proxy certificates *extend X.509 certificates***
  - Short-lived certificates signed by the user's certificate or a proxy
  - Reduces security risk, enables delegation



Certificate Request



User generates public/private key pair in browser.

Private Key encrypted on local disk

Cert Request Public Key

User sends public key to CA and shows RA proof of identity.

ID

Certification Authority

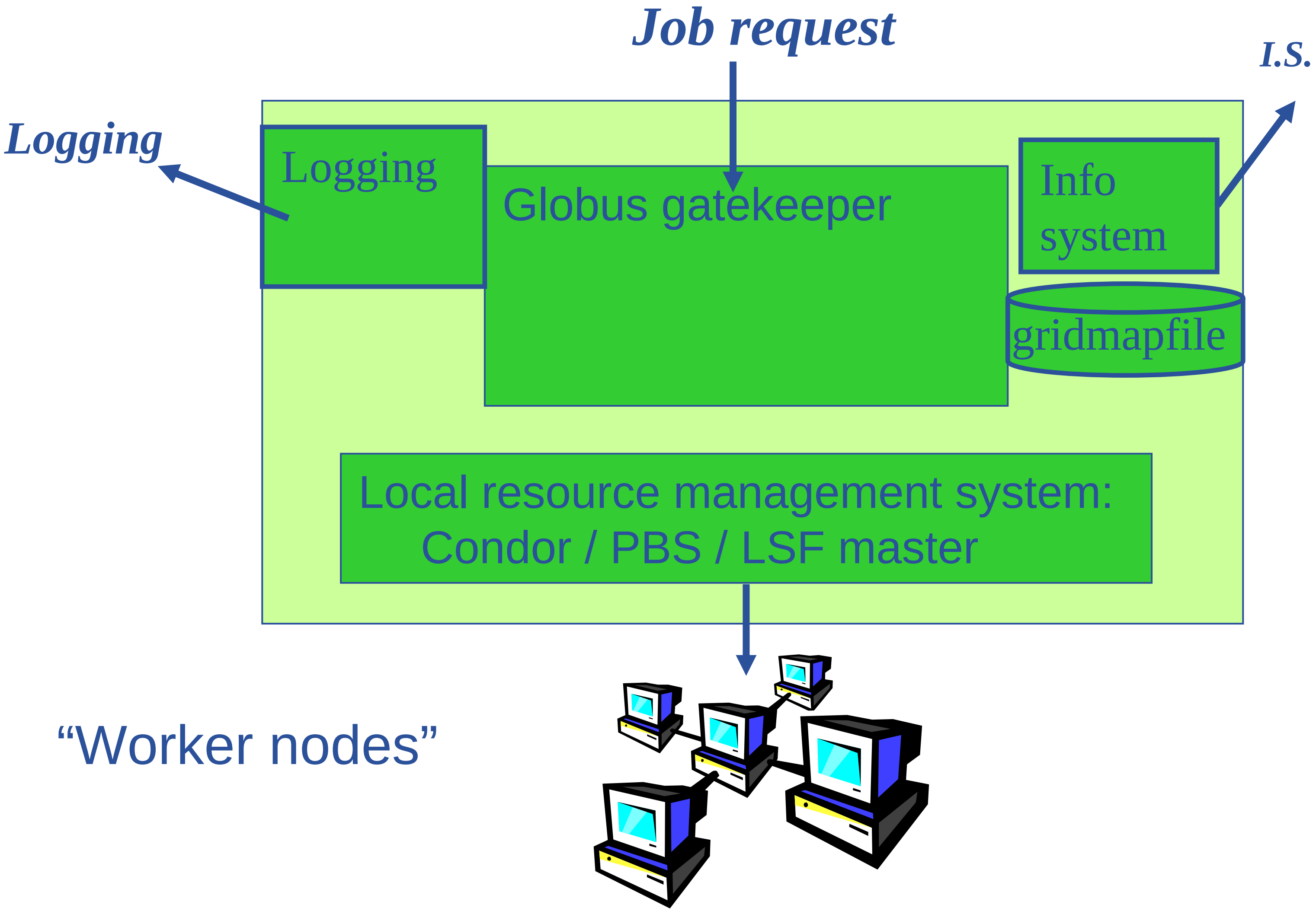
CA root certificate

CA signature links identity and public key in certificate.

CA informs user.

Cert

“Compute element”: a local job queue



User Responsibilities

- Keep your private key secure – *on USB drive only*
- Do not loan your certificate to anyone.
- Report to your local/regional contact if your certificate has been compromised.
- Do not launch a delegation service for longer than your current task needs.

If your certificate or delegated service is used by someone other than you, it cannot be proven that it was not you.

Evolution of VO management

Before VOMS

- User is authorised as a member of a single VO
- All VO members have same rights
- Gridmapfiles are updated by VO management software: map the user’s DN to a local account
- grid-proxy-init

VOMS

- User can be in multiple VOs
  - Aggregate rights
- VO can have groups
  - Different rights for each
    - Different groups of experimentalists
    - …
  - Nested groups
- VO has roles
  - Assigned to specific purposes
    - E,g. system admin
    - When assume this role
- Proxy certificate carries the additional attributes
- voms-proxy-init

VOMS – now in use on EGEE grid

Summary of AA - 1

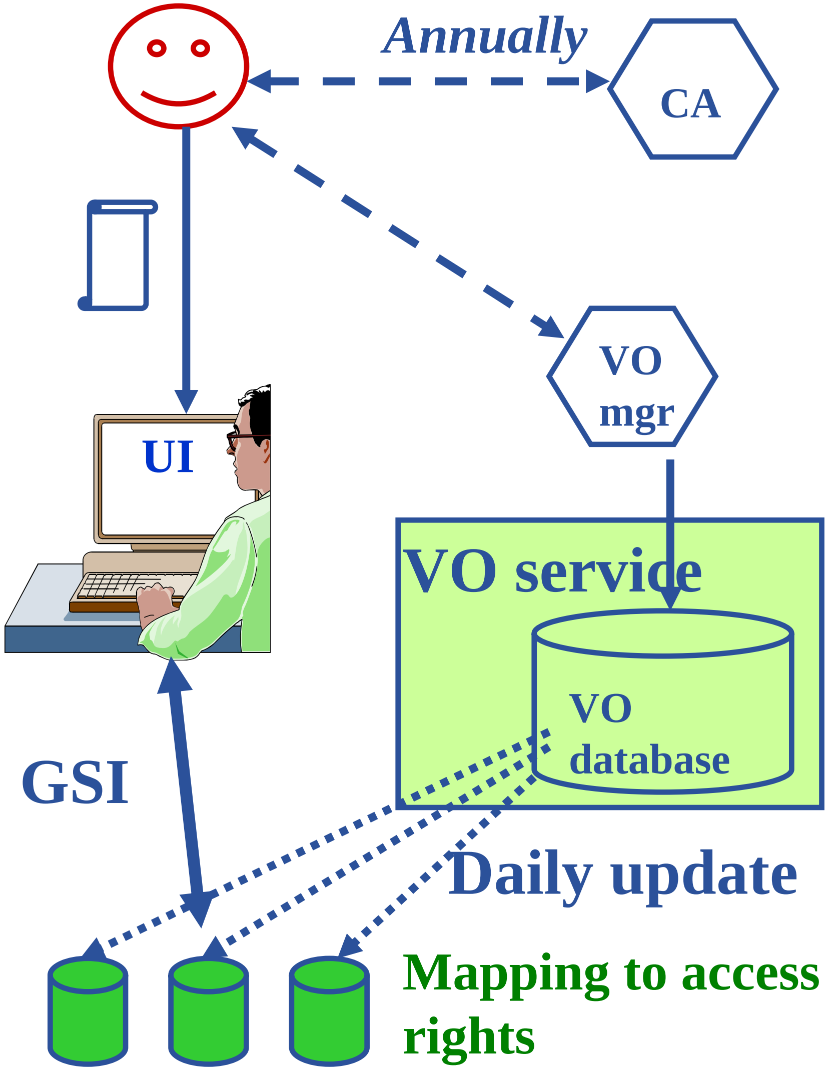
- **Authentication based on X.509 PKI infrastructure**
  - Trust between Certificate Authorities (CA) and sites, CAs and users is established (offline)
  - CAs issue (long lived) certificates identifying sites and individuals (much like a passport)
    - Commonly used in web browsers to authenticate to sites
  - In order to reduce vulnerability, on the Grid user identification is done by using (short lived) proxies of their certificates
- **Proxies can**
  - Be delegated to a service such that it can act on the user's behalf
  - Include additional attributes (like VO information via the VO Membership Service VOMS)
  - Be stored in an external proxy store (myProxy)
  - Be renewed (in case they are about to expire)

Summary of AA - 2

- **Authentication**
  - User obtains certificate from Certificate Authority
  - Connects to UI by ssh (UI is the user's interface to Grid)
  - Uploads certificate to UI
  - Single logon – to UI - create proxy
  - **Grid Security Infrastructure**

- **Authorisation**
  - User joins Virtual Organisation
  - VO negotiates access to Grid nodes and resources
  - Authorisation tested by resource:

  Credentials in proxy determine user's rights


Annually
CA
UI
VO mgr
VO service
VO database
GSI
Daily update
Mapping to access rights