Security & Privacy

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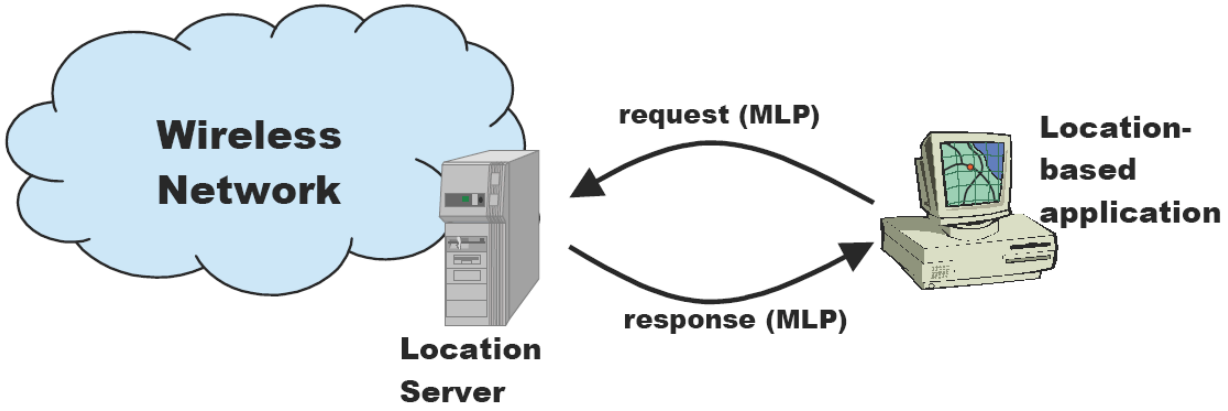
Who cares about Privacy?

- Everybody? Nobody? Criminals? Governments? Corporations?
- Privacy is the right to keep information hidden. But there is lots of information.
  - You do not have to use stuff that can be tracked, or do you?
- We in academia can have real impact here

Do we have privacy?

- Mobile Location Protocol
  - another standard



- Used to keep track of your mobile phone
  - In case you make an emergency call

Who cares about Security?

- Today, nearly everyone
  - Limit discussion to information security
- Are you allowed to use this device?
  - authorization
- Are you who you say you are?
  - authentication
- Is this device what you think it is?
  - authentication

Anonymity

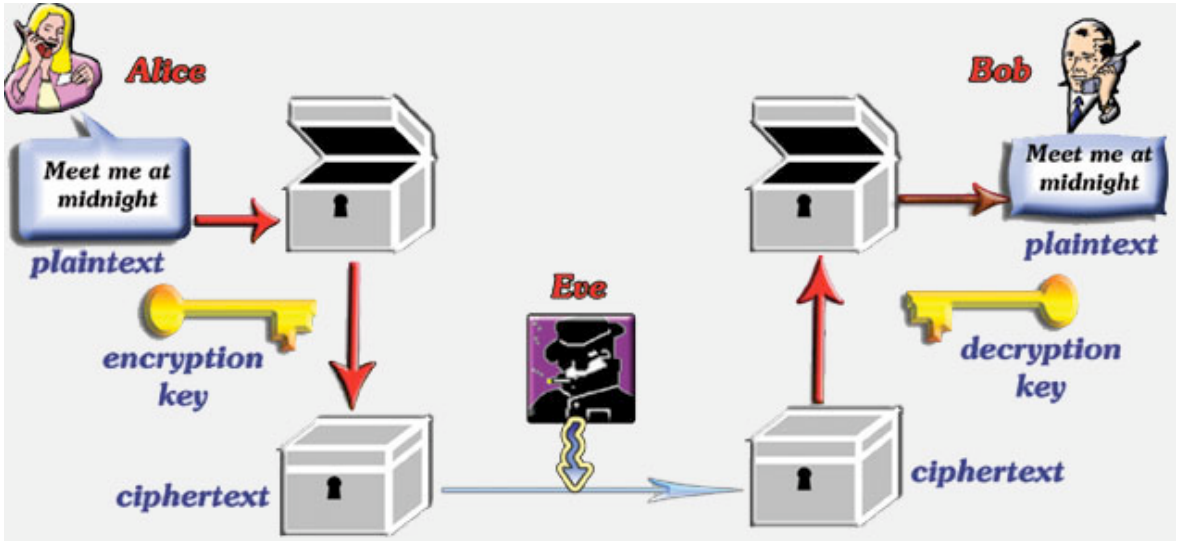
- I am having a conversation with Alice
  - Do you know we are talking?
  - Do you know what we are talking about?
  - Do you know who we are?
- Need indirection
  - but also many-to-one (so things get lost)
  - think about publish/subscribe
  - think about multiple personalities
    - multiple credit cards, cell phones, BlueTooth IDs
    - rent personality every 5 min from trusted server

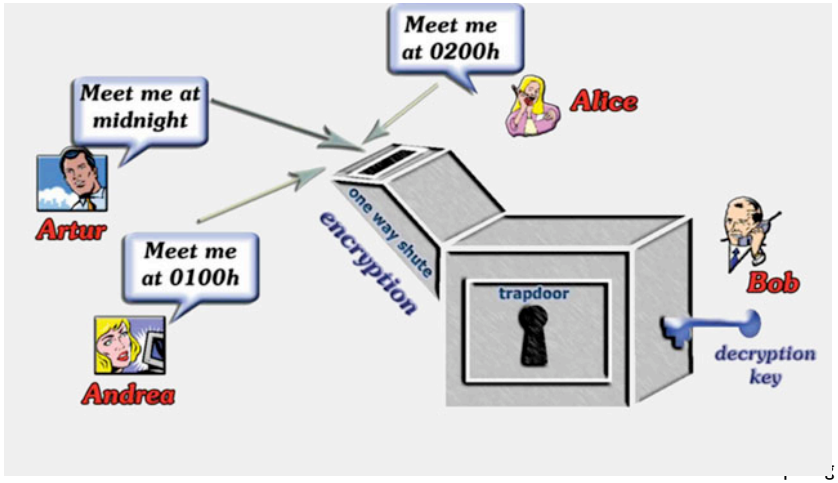
Where security?

- Communicate thru insecure area
  - Over internet
  - Through air (bluetooth, 802.11, ..)
- USB keyboard, Monitor via cable
  - Assumed to be secure
- Shared resources or devices
- RFID Tags -- very insecure
  - stand next to you and listen to your cards response and replicate it later
- Want active RFID tags
  - use radio power to drive computation

Massachusetts Institute of Technology

Public Key Crypto-system





Public Key Crypto-system

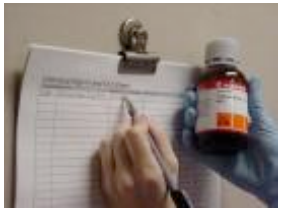
- Very quick overview
  - Ke=Public Key, Kd= Private Key
  - Encrypt message, E = Encrypt(M,Ke)
  - Decrypt message, M = Decrypt(E,Kd)

  where M = Decrypt(Encrypt(M,Ke), Kd)

  and M = Encrypt(Decrypt(M,Kd), Ke)
- Given Ke, M, Encrypt(M,Ke)
  - cannot easily compute Kd.

Signing Messages

- Alice & Bob have keys A1, A2, B1, B2
- Alice sends message M to Bob
  - Encrypt(M & Encrypt(Alice, A2) , B1)



- Bob decrypts message M using B1 and then uses Alice's public key, A1 to decrypt the name Alice.
- Does Bob know that Alice sent the msg M?

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Certification Authority

- No, it all depends on having correct public keys.
  - How did Alice know that B1 is Bob's public key?
- Use a certification authority:
  - some trusted site that associates keys with names.
- Hierarchy of CA's

Point to point communication

- Public Key scheme: many people can send messages to Alice
- But basically a one-to-one protocol:
  - With signing and with replies
- Not well suited for pervasive computing
  - Environment filled with devices

Want group keys

- Want all students in SMA 5508 and 6.883 to access course web site
- Want all SMA students to access SMA's main site, etc.
- A person belongs to many groups
- Grant access based on group
  - Add/remove people from group

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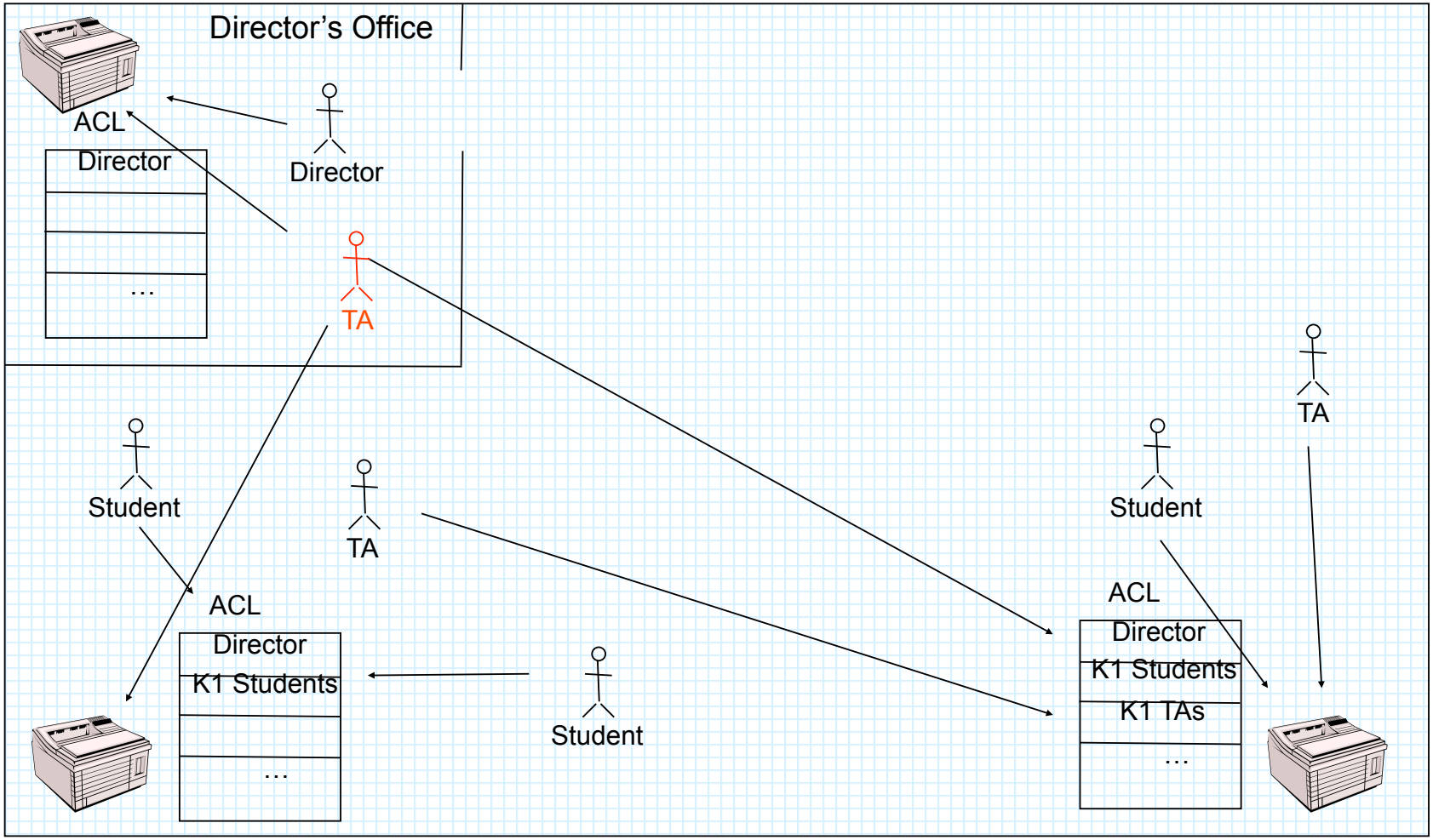
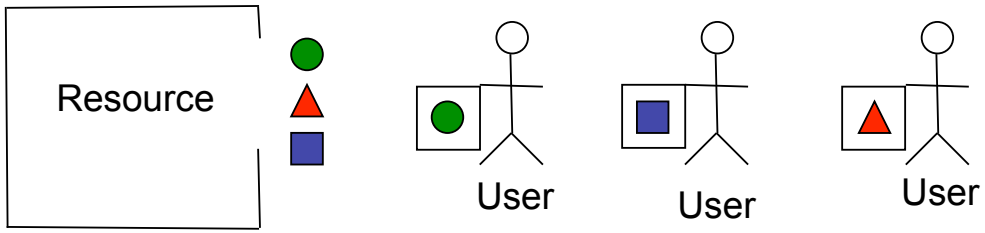
Usage Scenario



Access Control

- Security Model
- Useful mechanism in guarding access to resources
- Suitable for dynamic environments
- Each resource maintains a list referencing a set of valid keys
  - Granting, delegating, revoking access
  - user/application does not know accessibility of resource without explicitly attempting access



SPKI/SDSI Introduction

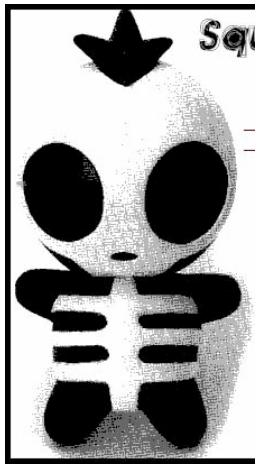
(Simple Public-Key Infrastructure/Simple Distributed Security Infrastructure)

- A group key infrastructure
- Build secure, scalable distributed computing systems
- Fine-grained access control over an untrusted network

SPKI/SDSI Introduction

(Simple Public-Key Infrastructure/Simple Distributed Security Infrastructure)

- Designed by Ron Rivest, Butler Lampson and Carl Ellison
- Each public key is a CA
- Name certificate: defines a name in issuer's name space
- Authorization certificate: grants a specific authorization from issuer to subject



SPKI/SDSI: Name Certificates

Traditional:

$\{\text{MIT Larry}, K_L\}_{Kmit}$

- Local name spaces
- Groups

SPKI/SDSI:

$\{K_c \text{ friends}, K_d c\}_K$

$\{K_c \text{ friends}, K_e c\}_K$

$\{K_c \text{ friends}, K_f c\}_K$

If 'K_c friends' is on an ACL, K_d, K_e and K_f are allowed to access the object.

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SPKI/SDSI: Name Certificate

```
(cert
  (issuer
    (name
      (public-key
        (rsa-pkcs1-md5
          (e #23#)
          (n
            |AMMgMuKpqK13pHMhC8kuxaSeCo+yt8TadcgnG8bEo+erdrSBveY3C
            MBkkZqrM0St4KkmMuHMXhsp5FX71XBiVW1+JGCBLfI7hxWDZCxGTMg
            bR4Fk+ctyUxIv3CQ93uYVkg9ca6awCxtS0EI7sLuEB+HKuOLjzTsH+
            +Txw9NAHq4r|)))
      friends))
  (subject
    (public-key
      (rsa-pkcs1-md5
        (e #23#)
        (n
          |AKg3tOzoJ5PGQ5q9jzxzwxE8o6bIZ6/cE8gEL+1xJa23viE3bz68ru
          hpD5muqJ+uyDCNxgAZ0JVXJazmX1QjiGudj9kEmuni8gJRLZRu0T5E3
          K7OU2dodu0kdDg32kym7+ooZNe/F0zWGekfESeezyQ25kvNO3XQvMHX
          afWcYjRw|)))))
```

SPKI/SDSI: Authorization Model

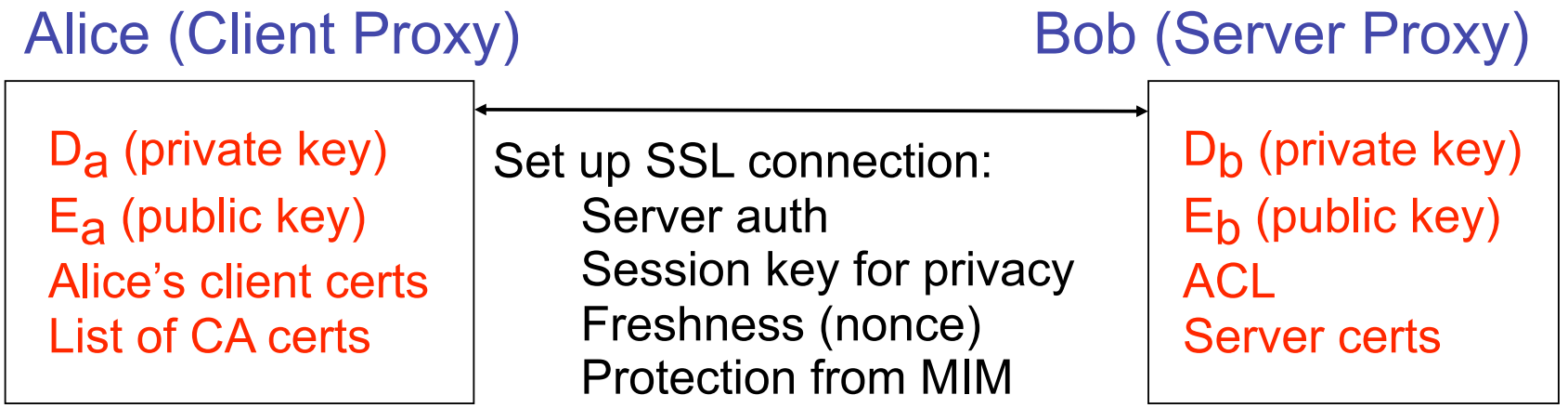
- Simple trust policy model
- Authorizations specified in flexible, user-defined tags
- Authorizations can be defined as specific or as general as desired
- Delegation (specific)

SPKI/SDSI: Authorization Certificate

```
(cert
  (issuer
    (public-key
      (rsa-pkcs1-md5
        (e #23#)
        (n
          |AMMgMuKpqK13pHMhC8kuxaSeCo+yt8TadcgnG8bEo+erdrSBveY3C
          MBkkZqrM0St4KkmMuHMXhsp5FX71XBiVW1+JGCBLfI7hxWDZCxGTMg
          bR4Fk+ctyUxIv3CQ93uYVkg9ca6awCxtS0EI7sLuEB+HKuOLjzTsH+
          +Txw9NAHq4r|))))
  (subject
    (public-key
      (rsa-pkcs1-md5
        (e #23#)
        (n
          |AKg3tOzoJ5PGQ5q9jzxzwxE8o6bIZ6/cE8gEL+1xJa23viE3bz68ru
          hpD5muqJ+uyDCNxgAZ0JVXJazmX1QjiGudj9kEmuni8gJRLZRu0T5E3
          K7OU2dodu0kdDg32kym7+ooZNe/F0zWGekfESeezyQ25kvNO3XQvMHX
          afWcYjRw|))))
  (tag
    (http
      (* set GET POST)
      (* prefix http://ostrich.lcs.mit.edu/demo/)))
  (propagate))
```

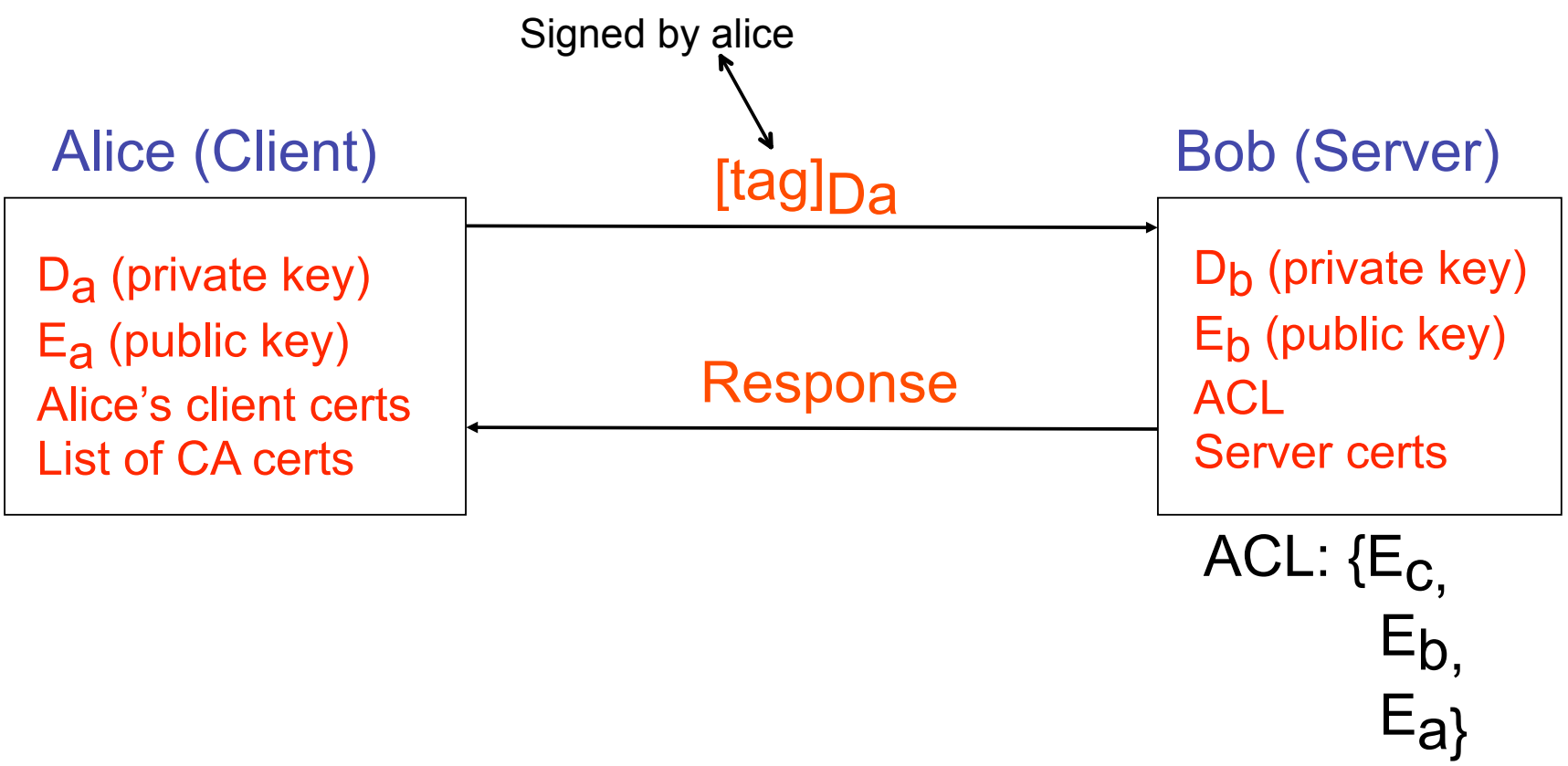
Proxy to Proxy

Initialization:



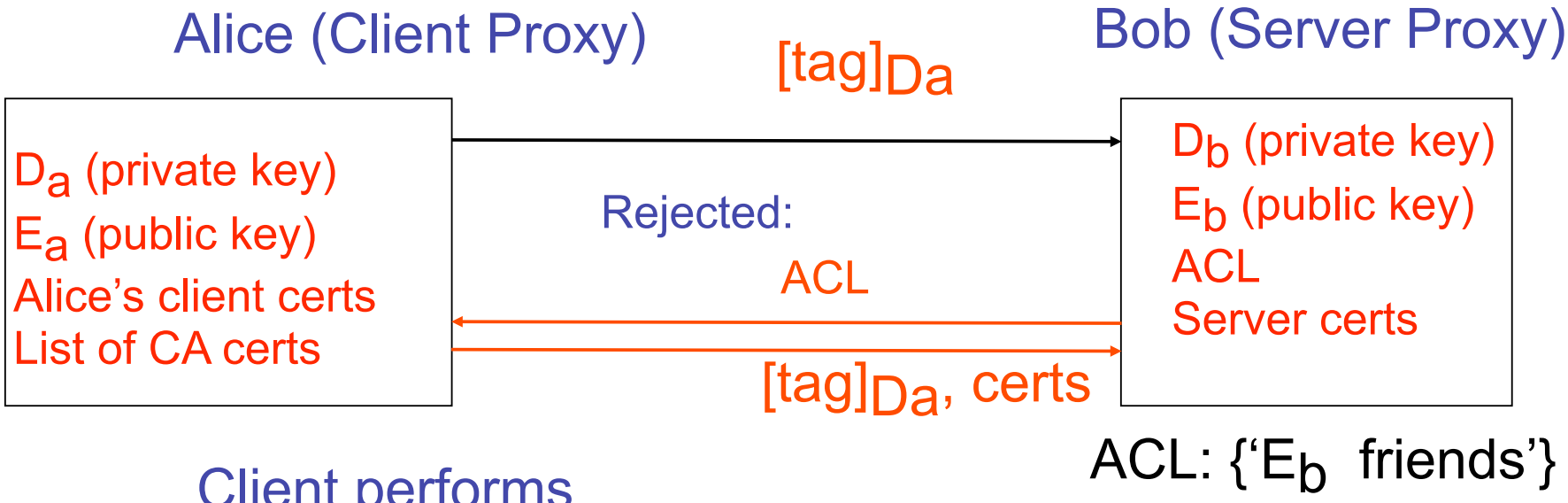
Proxy to Proxy

Case 1: user's key is directly on the ACL



Proxy to Proxy

Case 2: user's key is "indirectly" on the ACL



Certificate Chaining Example

- Bob's ACL says only **MIT faculty** are allowed to access his server.
- Alice's first request is simply signed with Alice's key, and Bob rejects this request.
- Alice's second request contains a chain consisting of the following certificates:
  - A certificate saying she is an **CSAIL Professor**
  - A second certificate saying **CSAIL Professors** are **MIT faculty**

Certificate Chain Discovery (Client Proxy)

- Derive certificate chains
- Input: device's ACL, requestor's public key, requestor's set of signed certificates, tag
- Output: a chain of certificates leading from an entry on the ACL to the requestor's public key.

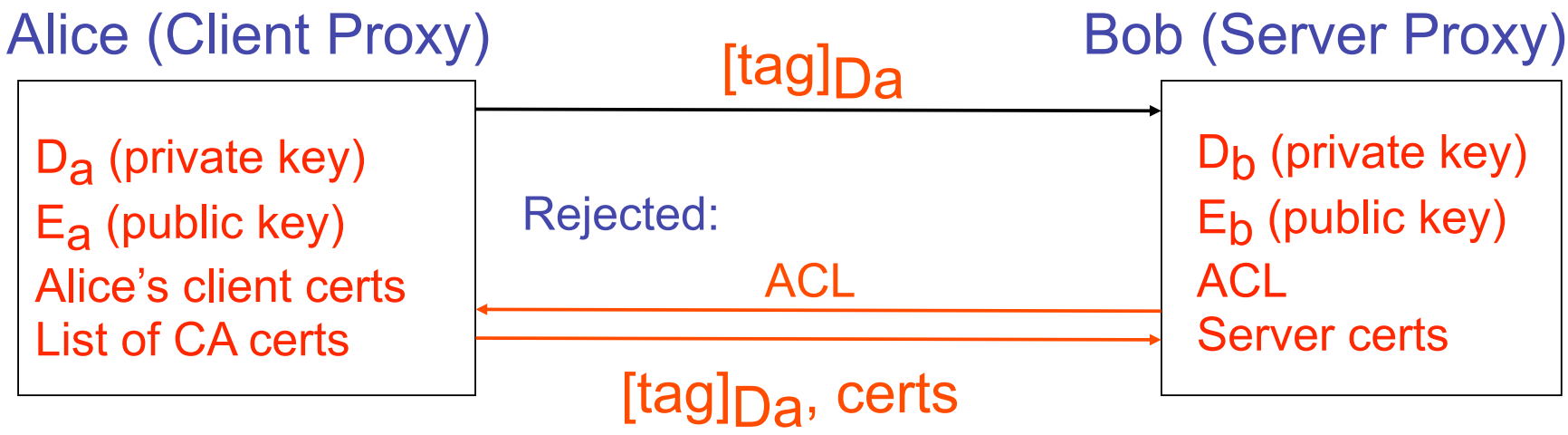
(The certificate chain consists of signed certificates. It proves that the requestor is authorized to perform the tag's operations on the device.)

* Recall, intuitively, a tag is a set of requests.

Certificate Chain Verification (Server Proxy)

- Verify certificate chains
- Input: device's ACL, requestor's public key, requestor's certificate chain, tag
- Output: 1 if certificate chain proves that the public key is authorized to perform the tag's operations on the device; 0 otherwise.

Proxy to Proxy
Case 2 revisited
user's key is "indirectly" on the ACL



- Signed request provides proof of authenticity of the request
- Certificate chain provides proof that the request is authorized

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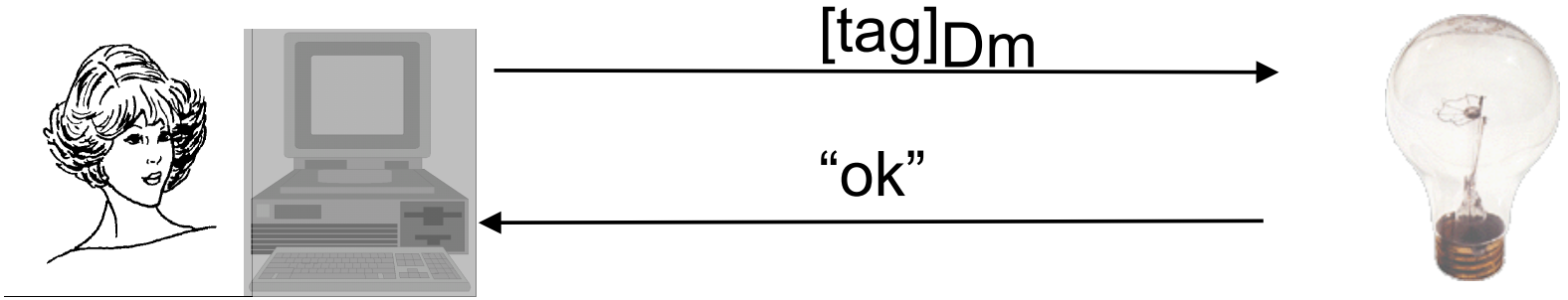
Example: Public resource

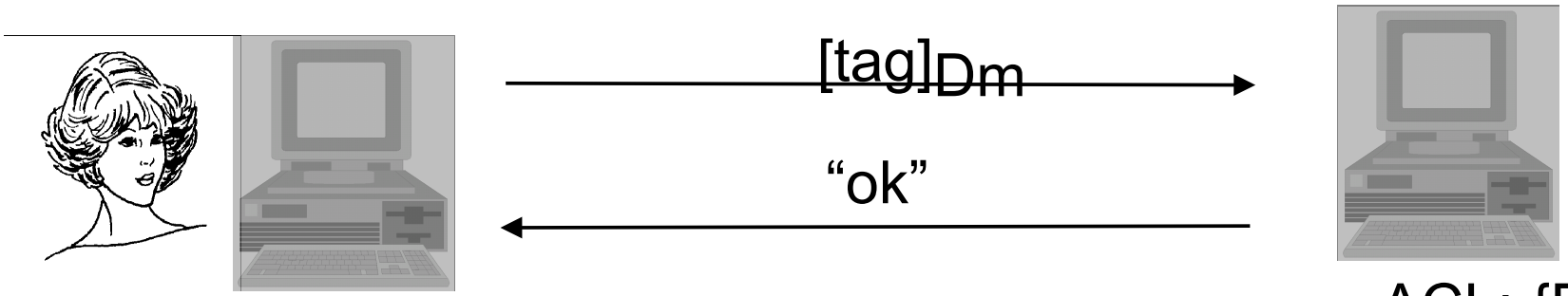
Mary wants to turn on/off a public light switch.



1. Mary sends request (either signed or unsigned) via her proxy to the light switch’s proxy.
2. Light switch’s proxy has no ACL. It honors Mary’s request.
   Light switch’s proxy may require requests to be signed for auditing purposes.

User's key directly on ACL

Mary wants to log into an account on a dialup machine.



1. Mary sends signed request via her proxy to the dialup's proxy.

1. Dialup's proxy has an ACL which contains Mary's public-key. It checks the signature on Mary's request, and honors Mary's request to login if the signature verifies.

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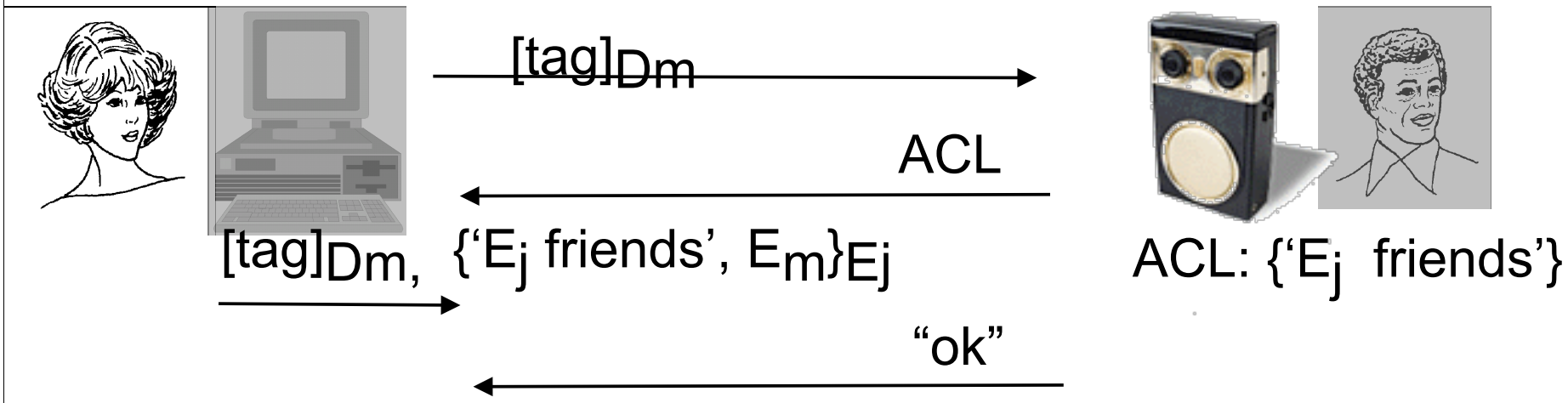
Example:user's key is indirectly on ACL

Mary wants to play music on John's speaker.



1. Mary sends signed request via her proxy to John's speaker's proxy.
2. John's speaker's proxy rejects first request, and returns the ACL.
   1. Mary's proxy derives a chain of certificates and sends second request to John's speaker's proxy.
4. John's speaker's proxy verifies second request.

More “fun”

- Integrating access control with name lookup services
- Trusting untrusting devices
  - Using public terminals in Startbucks as a cache for handheld