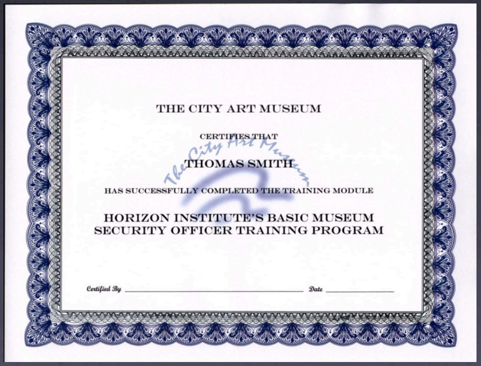
Secure Socket Layer

The University of Utah Student Computing Labs

Secure Socket Layer

- Introduction
- Overview of SSL
- What SSL is Useful For



THE CITY ART MUSEUM

CERTIFIES THAT

The City Art Museum

THOMAS SMITH

HAS SUCCESSFULLY COMPLETED THE TRAINING MODULE

HORIZON INSTITUTE'S BASIC MUSEUM
SECURITY OFFICER TRAINING PROGRAM

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Introduction

- Secure Socket Layer (SSL)

  Industry-standard method for protecting web communications.

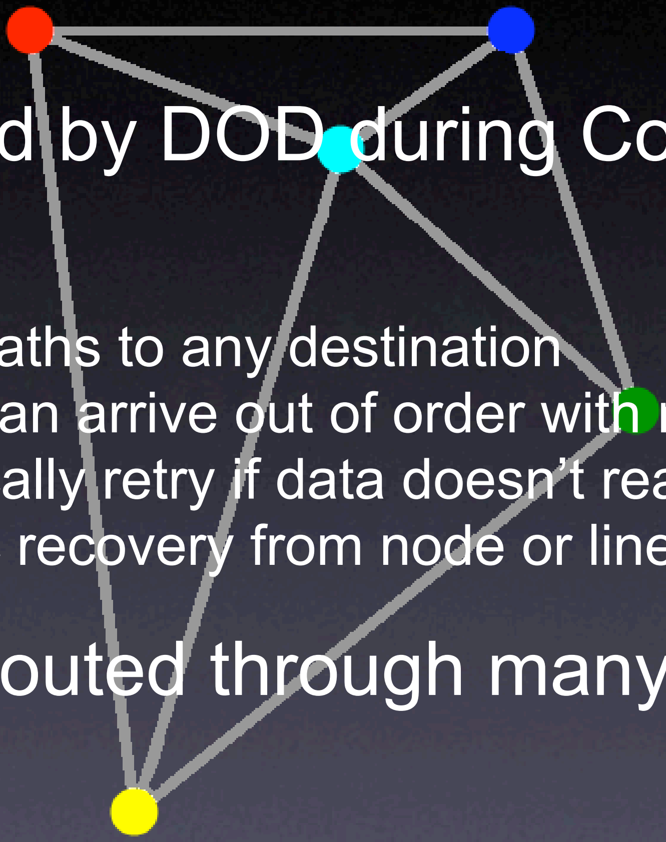
  - Data encryption

  - Server authentication

  - Message integrity

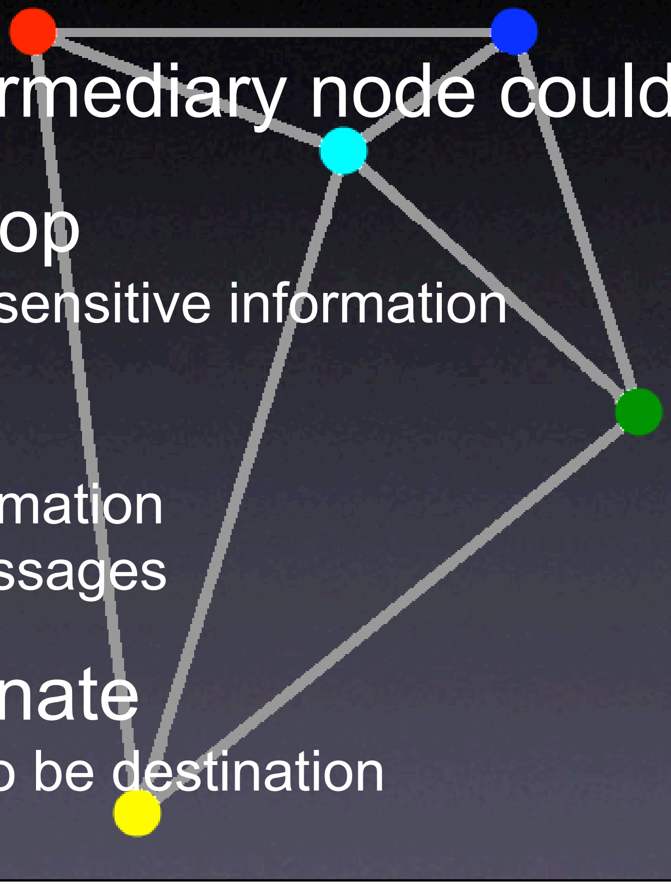
  - Optional client authentication

TCP/IP



- Designed by DOD during Cold War
- Robust
  - Multiple paths to any destination
  - Packets can arrive out of order with no problem
  - Automatically retry if data doesn't reach destination
  - Automatic recovery from node or line failure
- Data is routed through many nodes

The Problem



- Any intermediary node could:
- Eavesdrop
  - Intercept sensitive information
- Tamper
  - Alter information
  - False messages
- Impersonate
  - Pretend to be destination

The Solution

- A system that:
- Encrypts data
  - A variety of encryption methods are available
- Checks message integrity
  - Two hashing methods are used
- Authenticates participants
- https

Versions

- SSL 1.0
  - Limited to 40-bit keys (legal restriction)
- SSL 2.0
  - 168-bit keys (Triple DES)
- SSL 3.0
  - FORTEZZA support
- TLS 1.0 (Transport Layer Security)
  - Based on SSL 3.0 (internal version number is 3.1)
  - Non-interoperable with SSL, only minor differences

Overview of SSL

- SSL record protocol
  - Format to transmit data
  - Used during handshake phase and SSL session

- SSL handshake protocol
  - Authenticate server to client
  - Negotiate cryptographic algorithms
  - Optionally authenticate client to server
  - Public-key encryption to generate shared secrets
  - Establish encrypted SSL connection

Hashes

- Used in conjunction with cipher keys
  - Cipher key encrypts/decrypts data
  - Hash comparison ensures message integrity
- MD5
  - 128-bit hash
  - Special pairs of messages with same hash
- SHA-1
  - 160-bit hash
  - Believed to be cryptographically secure

Key-Exchange Algorithms

- Algorithm determines keys used
- Algorithms
  - RSA — Rivest, Shamir, Adleman
  - KEA — Key Exchange Algorithm
  - DH — Diffie-Hellman
  - KRB5 — Kerberos 5

Ciphers

- Cryptographic algorithms
- SSL supports several ciphers
- Ciphers can be enabled/disabled
  - Part of handshake is determining which to use
  - Server admin can disable less-secure methods
- Prevent third-party interception
- Check message integrity

Cipher Keys

- Pseudo-random number
- Used during encryption and decryption
- Key length one component of strength
  - Longer: more possible keys, more work to guess key
- Symmetric Key
  - Same key to encrypt and decrypt messages
- Public Key
  - One key to encrypt, a different one to decrypt

Key Length

- 40-bit Keys
  - 1 Trillion (10^12) keys
  - Breakable in a week with average PC (1997)
  - Legal limit for exportable suites until 1999
- 256-bit Keys
  - 116 Quattuorvigintillion (10^75) keys
  - Hundreds of trillions of years with same computer

Cipher Suites

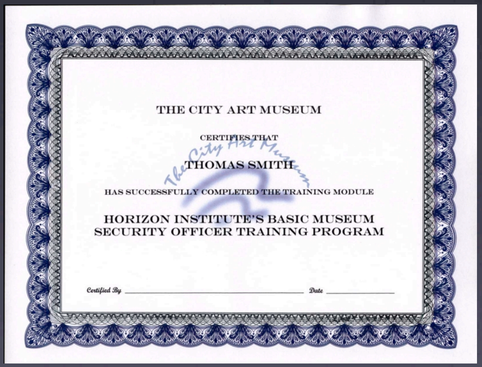
- AES
  - 128, 192, or 256-bit keys
  - Supersedes DES
  - No known, practical attacks
- DES and Triple-DES (3DES)
  - 56-bit (DES) or 168-bit (3DES) keys
  - DES Vulnerable to brute force attacks
- IDEA
  - 128-bit keys
  - No known, good attacks

Cipher Suites

- RC2
  - Variable key length (40 to 128-bit)
  - Vulnerable to related-key attack
- RC4
  - Variable key length (40 to 256-bit)
  - Statistically, first few bytes are non-random
- SKIPJACK
  - 80-bit keys
  - Classified until 1998
  - Vulnerable to impossible differential cryptanalysis

Certificates

- Used for Identity Verification
  - Public Key
  - Serial Number
  - Validity Period (cert. valid from ___ to ___)
  - Distinguishing Name (DN)
  - Issuer's DN
  - Issuer's Digital Signature



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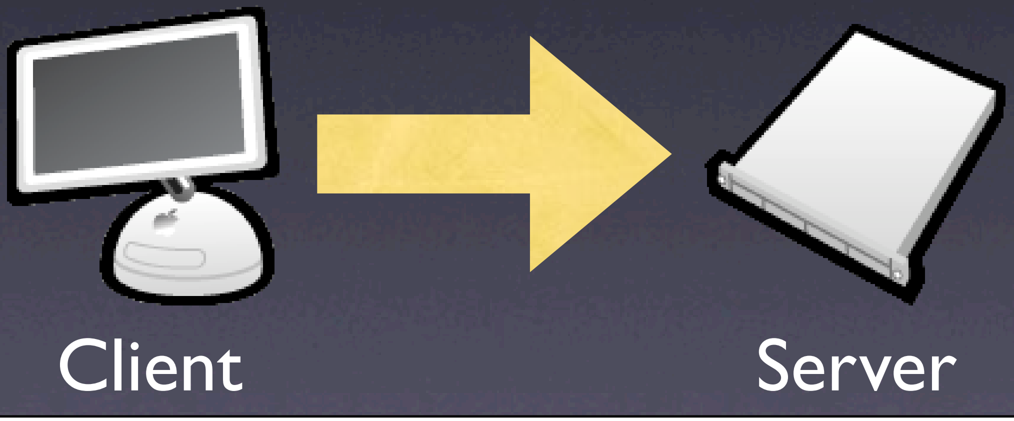
SSL Handshaking

- One of SSL's strength is extensibility
  - Range of hash/key exchange/cipher combinations
- Client and Server need to agree on one
- Server needs to prove identity
- Client might need to prove identity

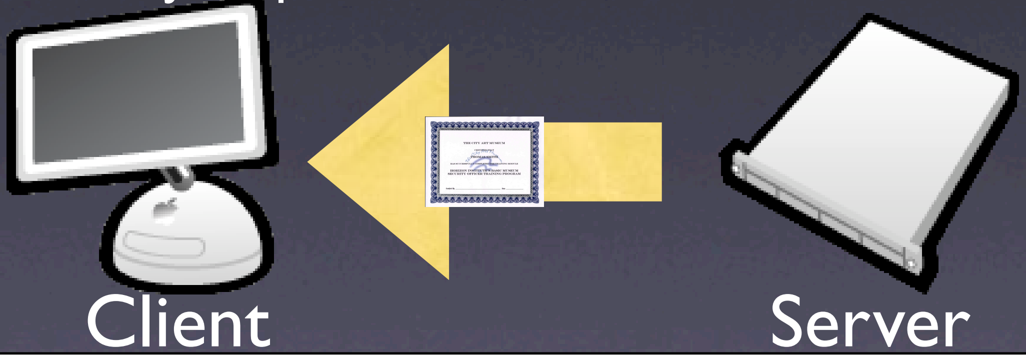
Starting Handshake

- Client initiates contact by sending:
  - SSL version (determines available cipher suites)
  - Cipher settings (further limits cipher suites)
  - Randomly generated data
  - Any other information that might be needed
  - Request for server authentication



Server Responds

- Server responds to request with:
  - Server’s SSL version
  - Server’s cipher settings
  - Another piece of randomly generated data
  - Any other information needed
  - Server’s Certificate (used to authenticate server)
  - Server may request client authentication



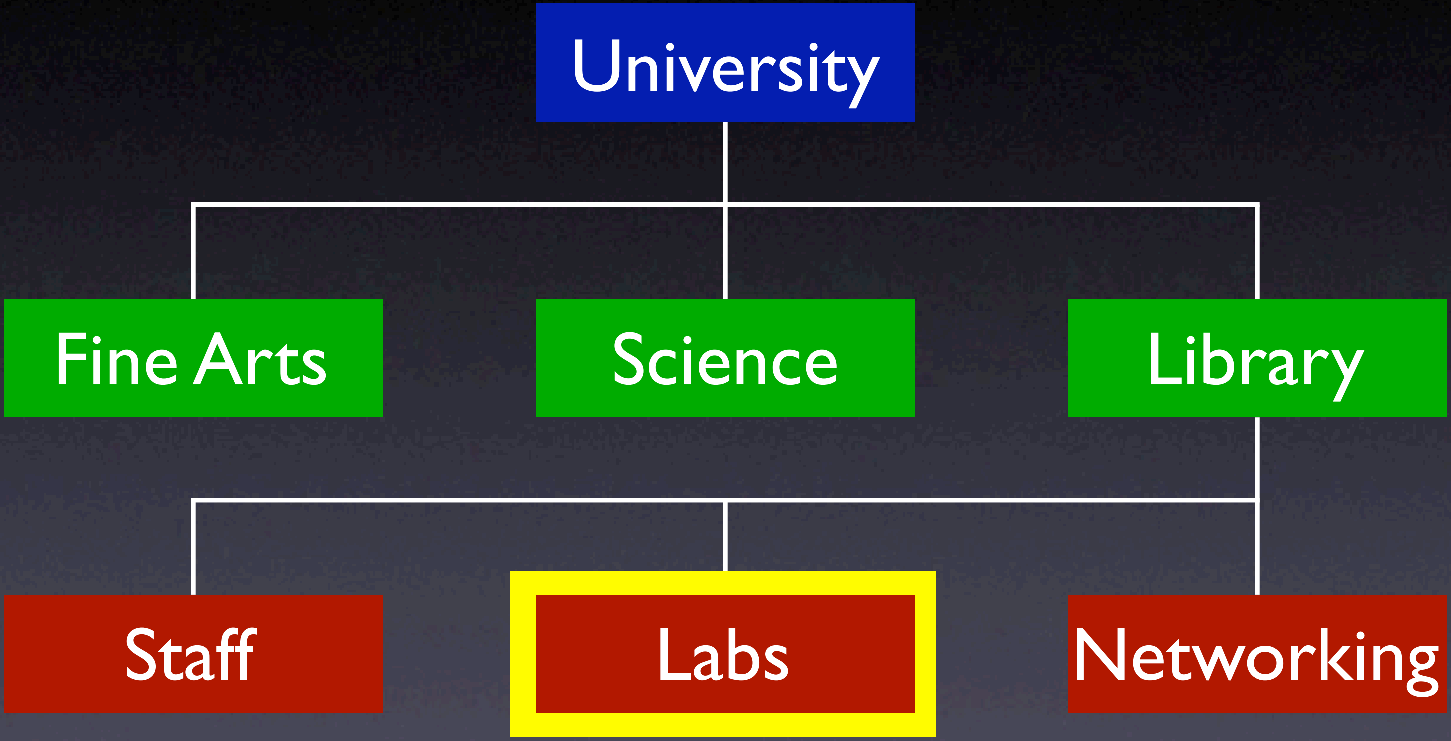
Server Authentication

- Is today’s date within the validity period?
- Is the Issuer trusted?
  - List of trusted Certificate Authorities (CA)
  - Issuer’s DN
  - Issuer’s public key
  - Issuer’s digital signature
- CA’s public key validate digital sig.?
- Does server’s DN match cert.’s DN?

Trusted CA List

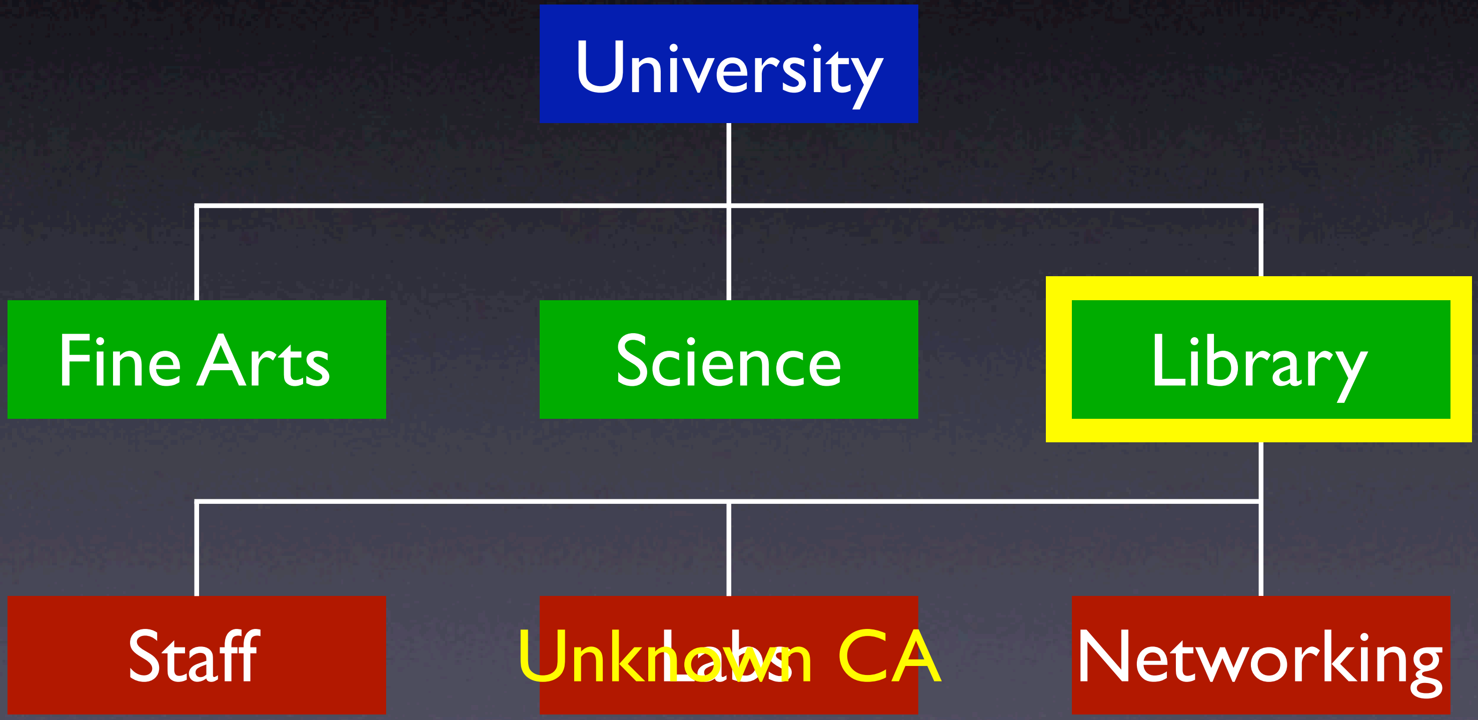
- Clients keep list of trusted CAs
  - Issuer’s DN
  - Issuer’s public key
  - Issuer’s digital signature
- If Issuer’s DN in list all is good
- If not, check certificate chain
  - CA Hierarchies

CA Hierarchy



CA Hierarchies

- Labs Group not in list of trusted CAs
  - Labs Group is subordinate to Library, check Library



University

Fine Arts

Science

Library

Staff

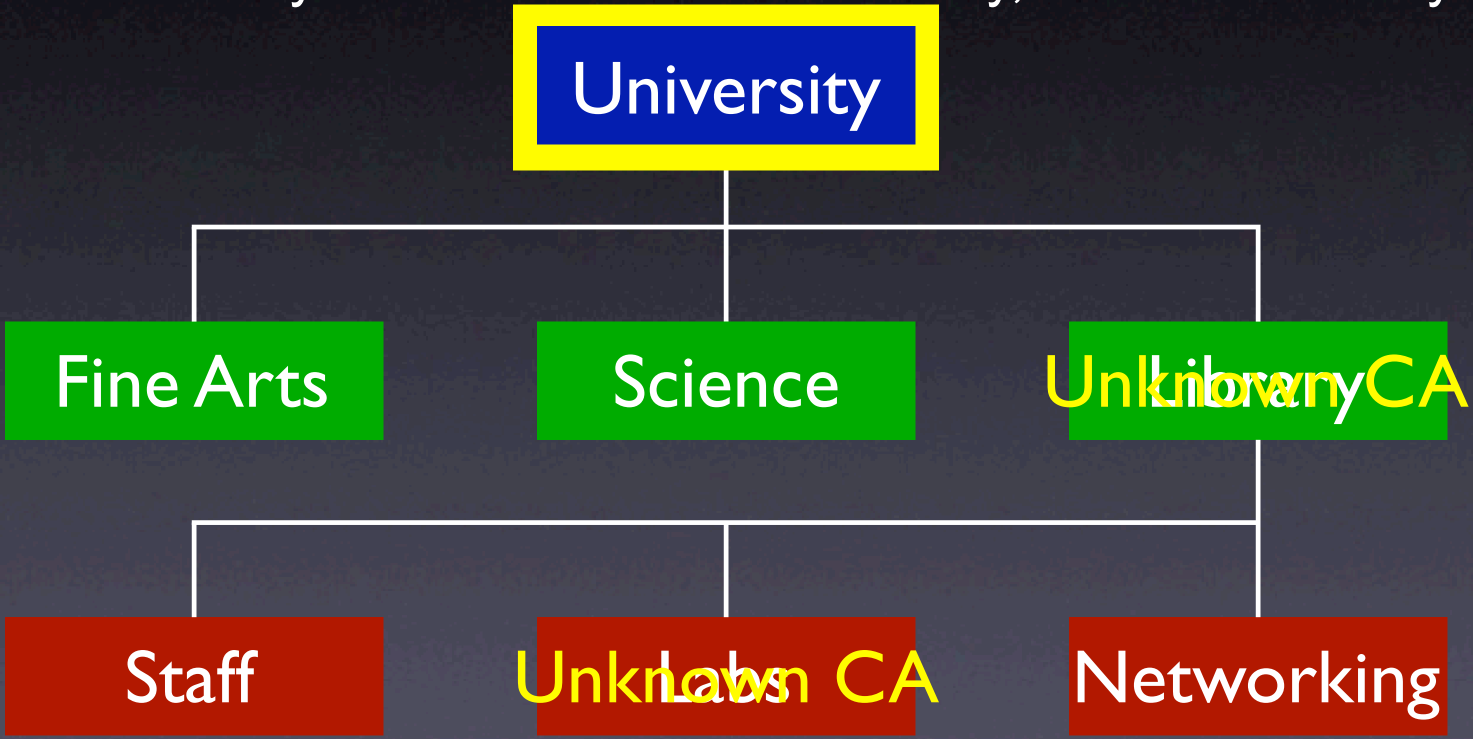
Labs

Unknown CA

Networking

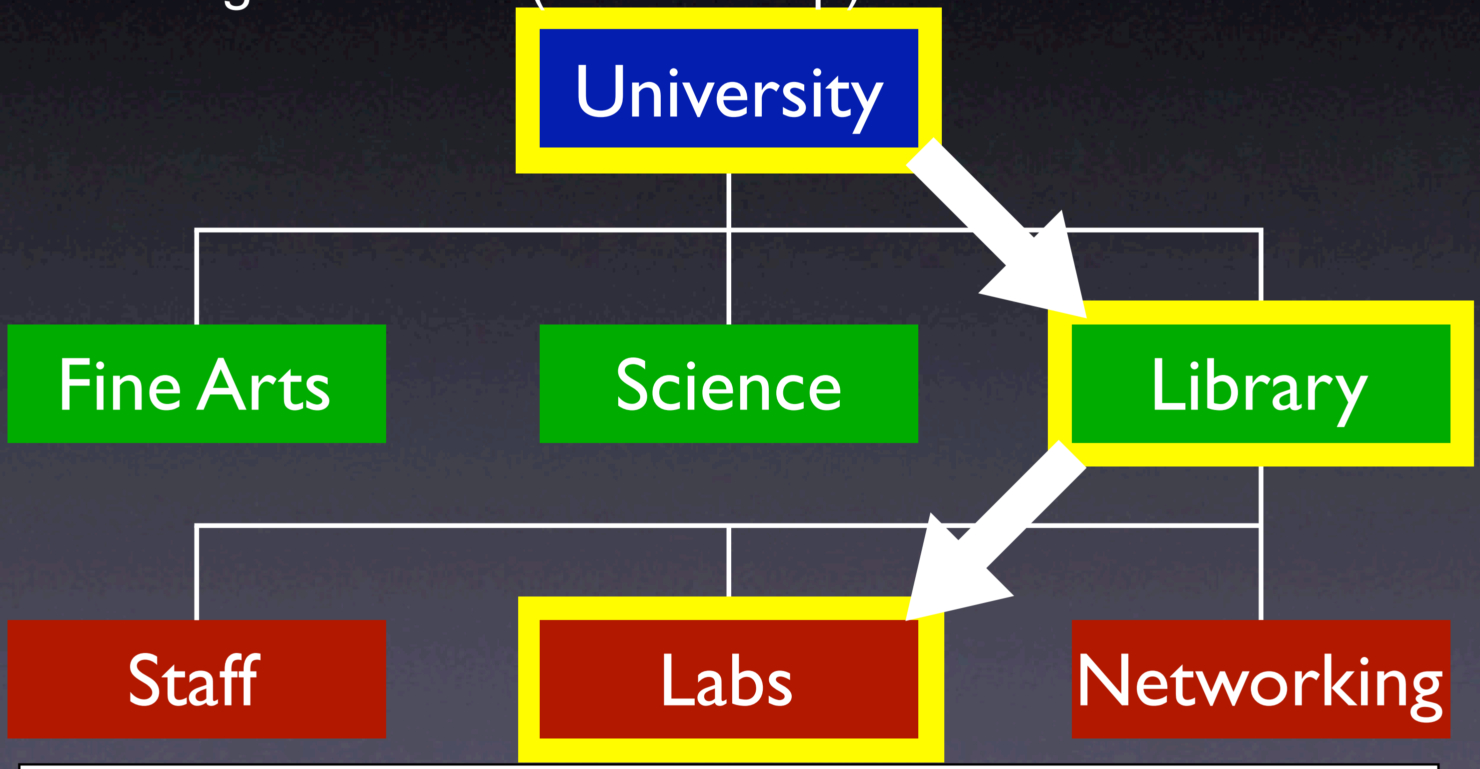
CA Hierarchies

- Library is also not in list of trusted CAs
  - Library is subordinate to University, check University



CA Hierarchies

- University **is** in list of trusted CAs
  - Original Issuer (Labs Group) checks out



Authentication

- Everything checks out
  - Server is who it says it is, continue
- Something’s wrong
  - Warn the user that authenticated and encrypted connection cannot be established

Premaster Secret

- Client generates Premaster Secret
  - 2 bytes is the SSL version, other 46 are random
- Encrypt P.S. with server’s public key
- Send encrypted P.S. to server
- If client authentication was requested
  - Sign a hash of all SSL messages so far
  - Send signed data and client certificate with P.S.

Client Authentication

- Optional
- Does client’s public key validate sig.?
- Is today’s date within validity period?
- Is issuing CA trusted?
- Does CA’s public key validate sig.?
- Is user’s certificate listed in LDAP entry?
  - Optional
- Is client authorized for the service?
  - Access Control Lists (ACLs)

Master Secret

- Premaster Secret
  - Server decrypts with private key
- Server & Client generate Master Secret
  - Same P.S.
  - Same steps
  - Independent of each other

Session Keys

- Server & Client generate session keys
  - Use master secret
  - Symmetric keys to encrypt and decrypt data
- Why Symmetric cryptography?
  - Faster than Public Key cryptography
  - Since Server & Client don’t transmit actual key it is secure enough

Finishing Handshake

- Client done
  - Message that all future messages will be encrypted
  - Sends encrypted message that handshake is done
- Server done
  - Message that all future messages will be encrypted
  - Sends encrypted message that handshake is done
- SSL Session begins
  - Session keys used to encrypt and decrypt data
  - Session keys also used to validate messages

Uses of SSL/TLS

- eCommerce
  - Banking
  - Online stores
- secure mail (U.CC)
- secure news
- radmind
  - DHCP
  - Three levels of security (0, 1, 2)

Campus Resources

- University Internal CA
  - Managed by ISO
- Uses
  - Available for servers/applications
  - Radius
  - Time
  - VPN
  - SSL Web Servers
  - No certificates for individuals at this time

Campus Certificate

- Public certificate
  - ITAC web site (available in handout)
  - Adds U to list of trusted CAs
- Generating a certificate
  - email ca@utah.edu
  - Contact information
  - Application to use the certificate
  - Either FQDN of host or a certificate request file

Best Practices

- Hosts must meet ISO requirements
  - Vulnerability scans run before cert is issued
  - Periodic scans afterwards
- Currently no best practice document
  - ISO is accepting recommendations
- Do not use PEAP
  - Plain text password storage

Issues

- Self-Signed Certificates and Mac OS X
  - Does not automatically accept self-signed certificates
  - Security feature
  - Manually install certificate to KeyChain
  - Requires that cert be available for download

- To Add a Self-Signed Certificate
  - Download
  - Make sure the cert names ends in “.cer” or “.dem”
  - Double-Click on the certificate
  - Add to Keychain