

CSE331: Introduction to Networks and Security

Lecture 11

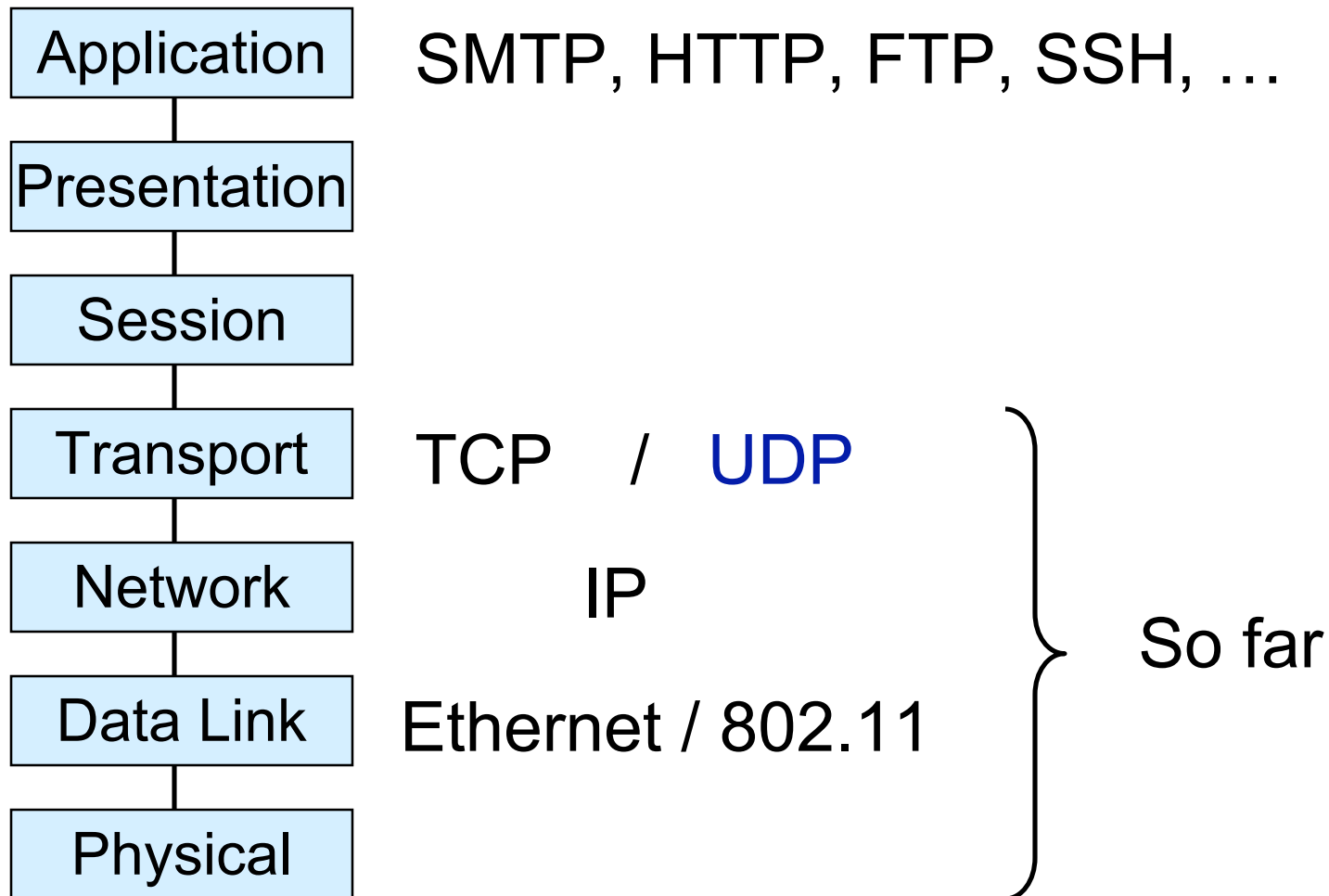
Fall 2006



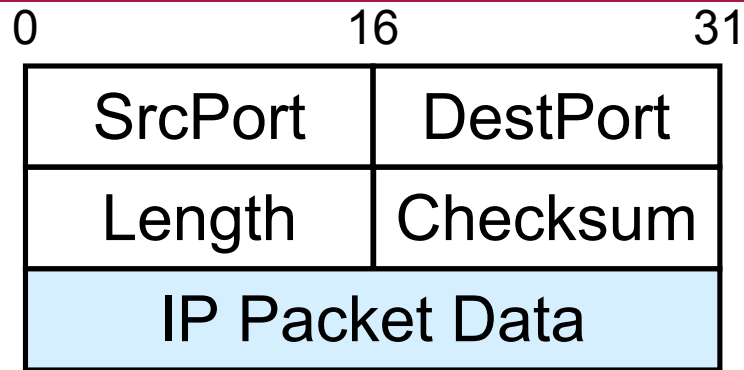
Announcements

- HW 1 Due today
- Midterm I will be held next Friday, Oct. 6th.
 - Will cover all course material up to next Weds.

Protocol Stack Revisited



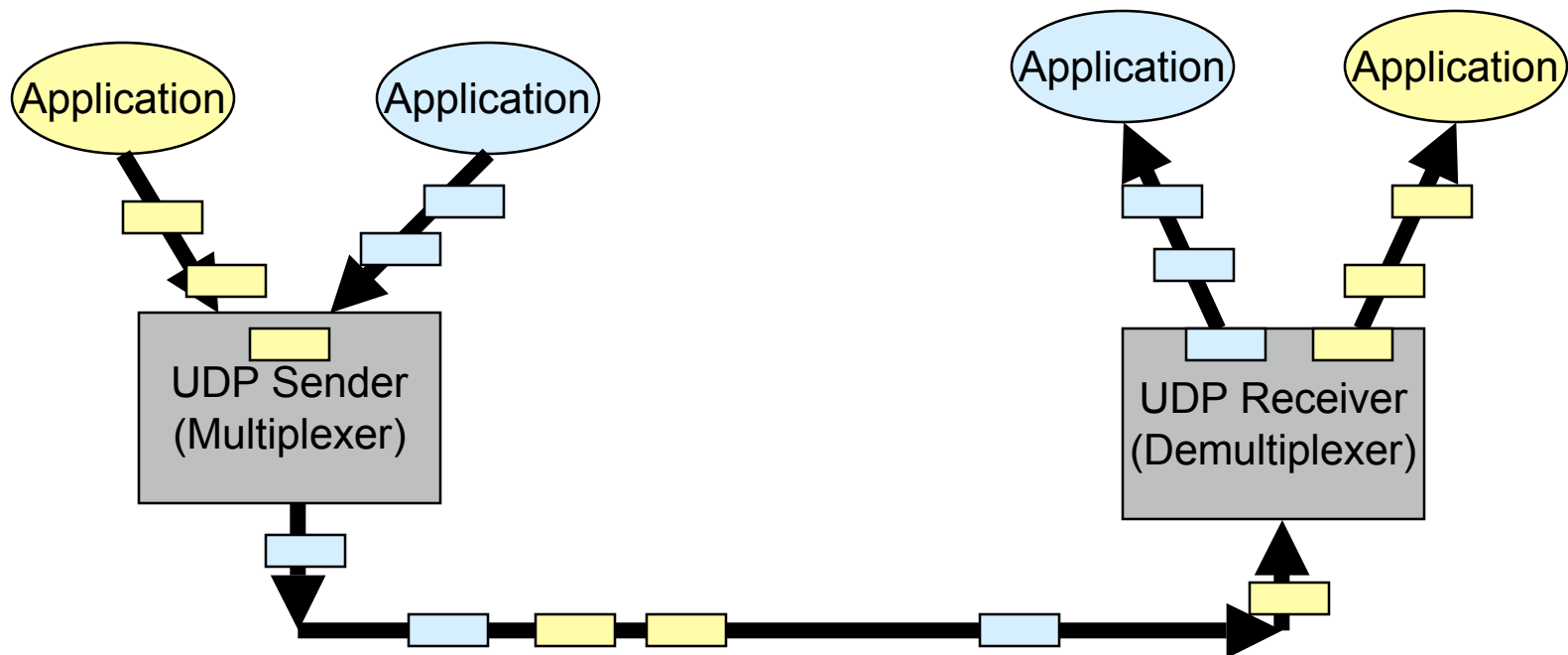
User Datagram Protocol (UDP)



- Simplest transport-layer protocol
- Just exposes IP packet functionality to application level
- *Ports* identify sending/receiving process
 - Demultiplexing information
 - (port, host) pair identifies a network process

UDP End-to-End Model

- Multiplexing/Demultiplexing with Port number



Application Layer Protocols

- SMTP, HTTP, SNMP, FTP, ...
 - Request/Reply protocols built on TCP or UDP
 - Designed to handle a fixed set of messages
 - Often have a companion *data format*
 - Many applications

| Protocol | Data Format | Programs |
|----------|------------------|------------------------------------|
| SMTP | RFC 822 and MIME | Pine, NSMail, Eudora, Outlook, ... |
| HTTP | HTML | Explorer, Netscape, Opera, ... |
| SNMP | MIB | snmpget, snmpset, ... |

SMTP: Simple Mail Transfer Protocol

- Data format RFC822
 - Adopted around 1982, extended 1993, 1996
 - <http://www.faqs.org/rfcs/rfc822.html>
 - ASCII text
 - Header and Body
- MIME: Multipurpose Internet Mail Extensions
 - Mail systems assume ASCII
 - Only 64 valid characters A-Z, a-z, 0-9, +, /
 - Some datatypes include arbitrary binary data (e.g. JPEG)
 - Base64 encoding
 - 3 bytes of data map to 4 ASCII Characters
 - A=0,B=1,...

RFC822 Headers

- <CRLF>-terminated lines containing pairs of form **type: value**
- Many valid Header types
- Some headers filled out by client
 - **To: stevez@cis.upenn.edu**
 - **Subject: CSE331**
- Others filled out by mail delivery system
 - **Date:**
 - **Received:**
 - **From:**

From: Steve Zdancewic <stevez@cis.upenn.edu>

MIME-Version: 1.0

To: stevez@cis.upenn.edu

Subject: Example Mail

Content-Type: **multipart/mixed**; boundary="-----020307000708030506070607"

This is a multi-part message in MIME format.

-----020307000708030506070607

Content-Type: text/plain; charset=us-ascii; format=flowed

Content-Transfer-Encoding: **7bit**

This is the body.

-----020307000708030506070607

Content-Type: **text/plain**; name="example.txt"

Content-Transfer-Encoding: **7bit**

Content-Disposition: inline; filename="example.txt"

Hello

-----020307000708030506070607

Content-Type: **image/jpeg**; name="doc.jpg"

Content-Transfer-Encoding: **base64**

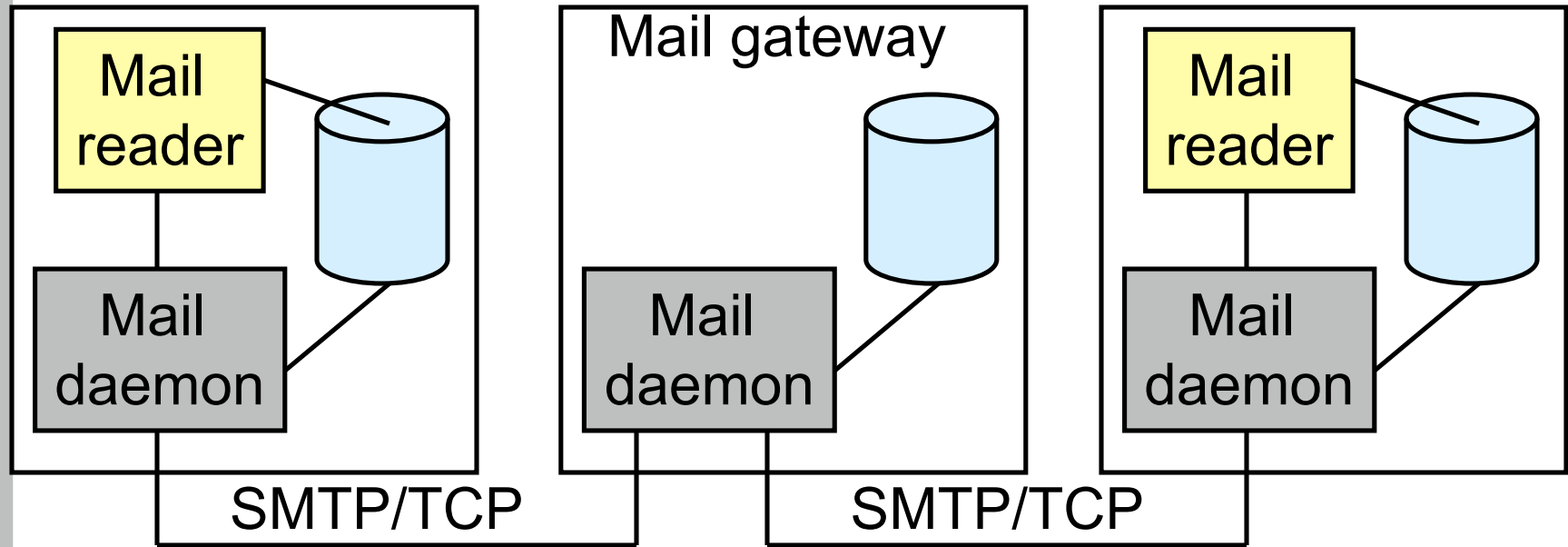
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BgUIBwcHCQkICgwUDQwLCwwZEHMPFB0aHx4dGhwclCQuJyAiLCMcHCg3KSwwMTQ0NB8n
OT04...

SMTP

- Mail Reader
 - User edits/reads/search e-mail
- Mail Daemon
 - Process running on each host (port 25)
 - Uses SMTP/TCP to transmit mail to daemons on other machines
 - Most daemons based on Berkley's **sendmail**
- Mail Gateways
 - Store and forward e-mail (much like IP router)
 - Buffers on disk
 - Attempts to resend

SMTP Mail Gateways



- No need for explicit host in e-mail address
 - User can receive mail at different machines
- Recipient's machine may not be up
 - Mail gateway can hold message for later

SMTP Dialogs

- Client posts commands
 - HELO, MAIL, RCPT, DATA, QUIT
- Server responds with code and human-readable explanation

Example SMTP Dialog

HELO seas.upenn.edu

250 Hello daemon@smtpauth.seas.upenn.edu [158.130.12.180]

MAIL FROM:<stevez@seas.upenn.edu>

250 OK

RCPT TO:<billg@microsoft.com>

250 OK

RCPT TO:<ted@microsoft.com>

550 No such user here

DATA

354 Start mail input; end with <CRLF>.<CRLF>

Blah blah blah...

<CRLF>.<CRLF>

250 OK

QUIT

221 Closing Connection

"Glue" Protocols

- Need some way to handle error conditions
- Need some way to map addresses at one level to addresses at another level.
 - Example: Machine addresses (Ethernet) to IP addresses
- Need some way to provide human-readable addresses
 - So you can write [zero.cis.upenn.edu](#) instead of
 - 158.130.50.198



ICMP: Internet Control Message Protocol

- Collection of error & control messages
- Sent back to the source when Router or Host cannot process packet correctly
- Error Examples:
 - Destination host unreachable
 - Reassembly process failed
 - TTL reached 0
 - IP Header Checksum failed
- Control Example:
 - Redirect – tells source about a better route

ARP - Address Resolution Protocol

- Problem:
 - Need mapping between IP and link layer addresses.
- Solution: ARP
 - Every host maintains IP–Link layer mapping table (cache)
 - Timeout associated with cached info (15 min.)
- Sender
 - Broadcasts “Who is IP addr X?”
 - Broadcast message includes sender’s IP & Link Layer address
- Receivers
 - Any host with sender in cache “refreshes” time-out
 - Host with IP address X replies “IP X is Link Layer Y”
 - Target host adds sender (if not already in cache)

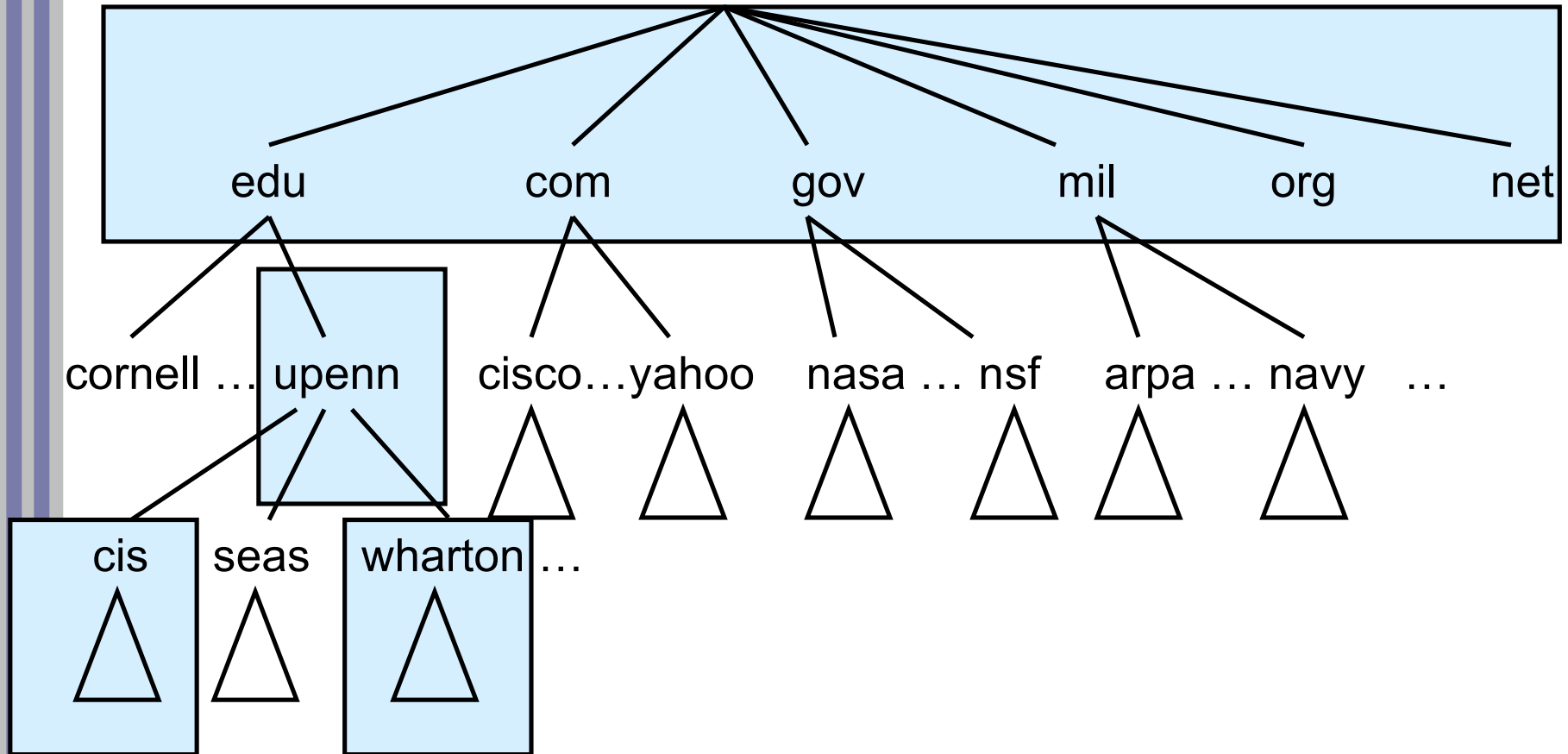
Domain Name System

- System for mapping mnemonic names for computers into IP addresses.

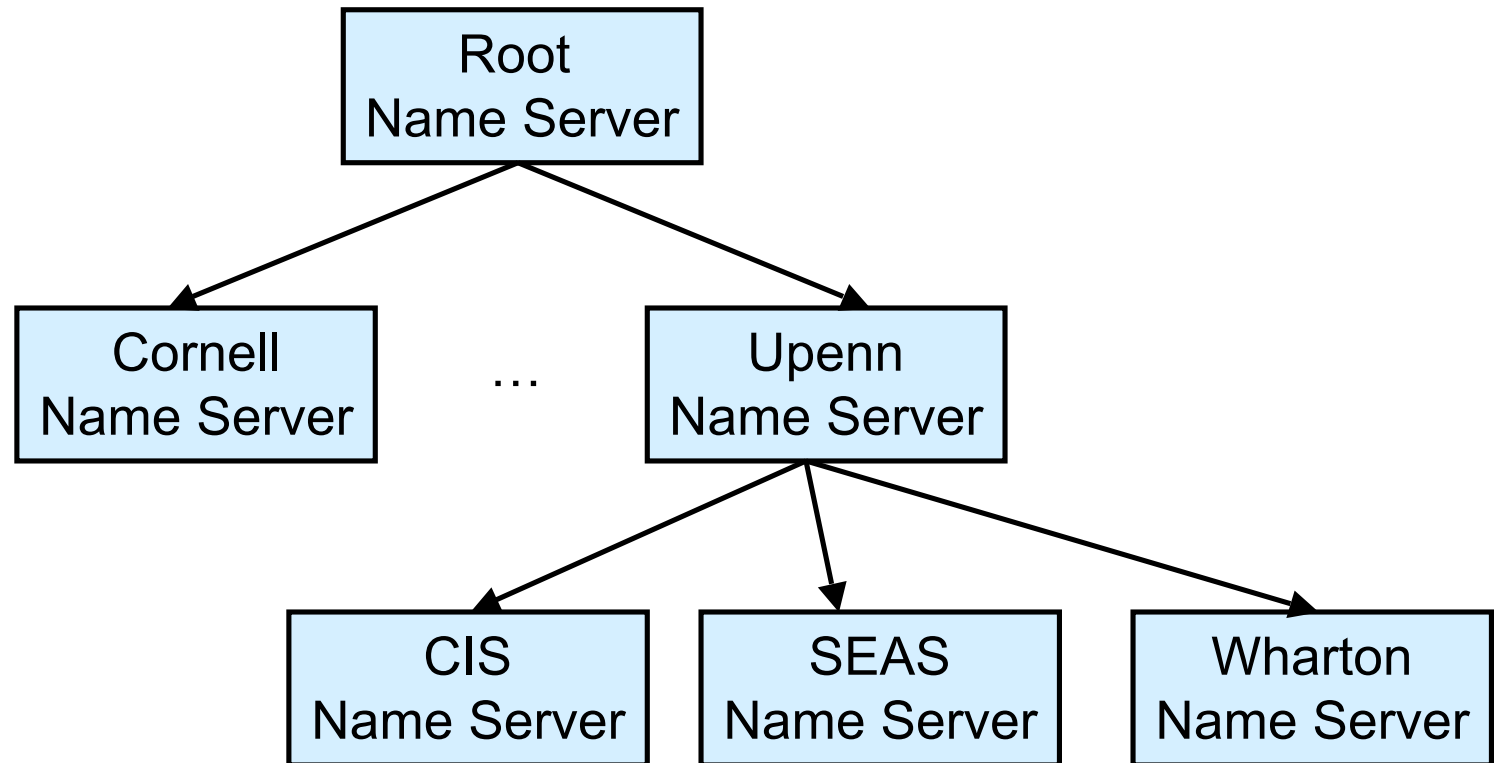
zeta.cis.upenn.edu → 158.130.12.244

- Domain Hierarchy
- Name Servers
- Name Resolution

Domain Name Hierarchy



Hierarchy of Name Servers





Records on Name Servers

- < Name, Value, Type, Class >
- Types
 - A Host to address mappings
 - NS Name server address mappings
 - CNAME Aliases
 - MX Mail server mappings
- Class IN for IP addresses

Name resolution

