



University of
Massachusetts
Amherst

ECE697AA – Lecture 2

Application Layer: HTTP

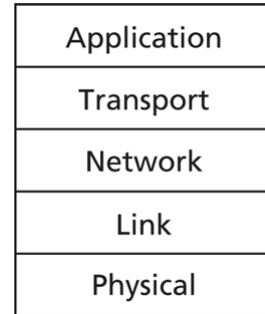
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09/04/08

Today's lecture

- Protocol stack
- Application layer
 - Client-server architecture
 - Example protocol: HTTP
 - Demo
 - Application requirements
 - If time: email

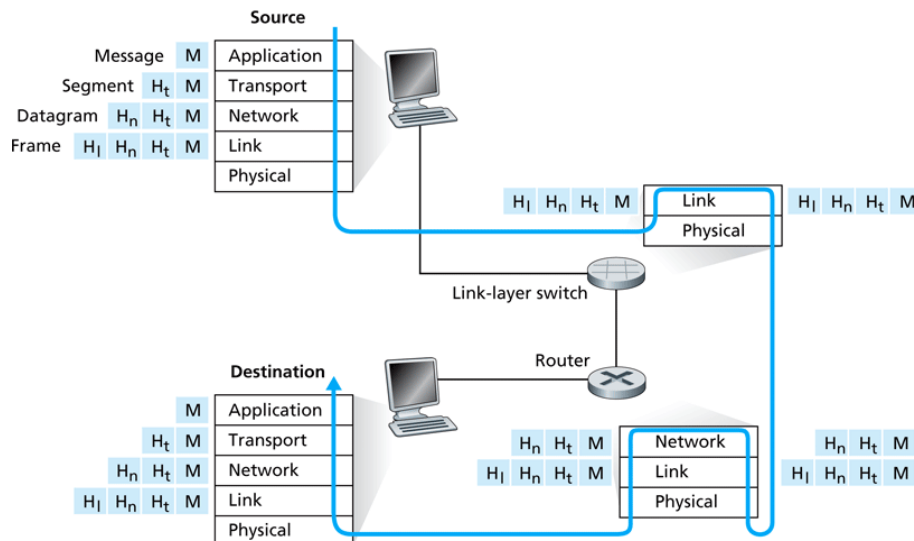
Protocol layering

- What happens when data traverses a protocol stack?



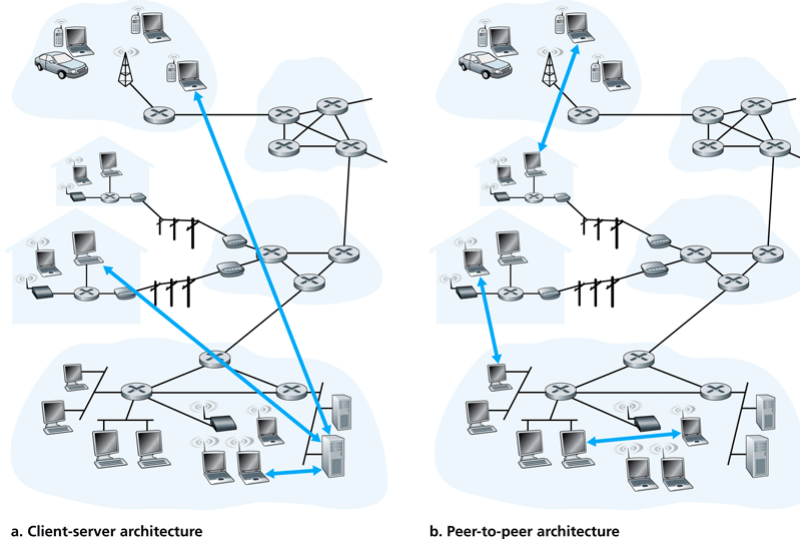
Layered protocol stack

- Processing of layer depends on location



Application layer

- Network applications



a. Client-server architecture

b. Peer-to-peer architecture

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Application layer

- Client-server architecture

- Server
 - » Provides service (e.g., access to data)
 - » Is always on and waits for requests
 - » Has well known address
- Client
 - » Initiates communication with server
 - » Often determines what is communicated
 - » Often unknown to server
- Communication via “socket”

- Peer-to-peer architecture

- End-systems act as clients and servers
- Indexing system figures out which end-system to connect to

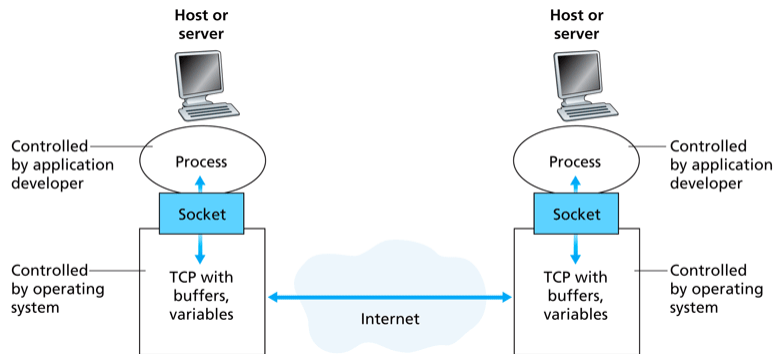
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Application layer

- Functionality provided layer below (transport layer):
 - UNIX socket (=“bit pipe”)



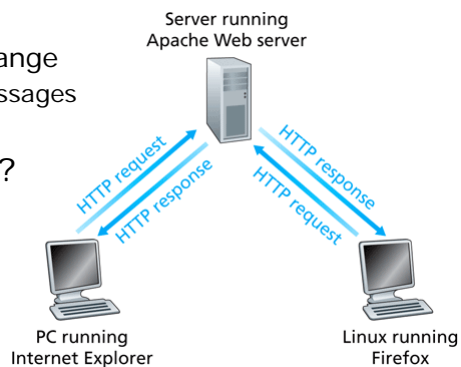
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Application layer example: HTTP

- Hypertext Transfer Protocol (HTTP)
 - Protocol to access to web pages
- Remember: purpose of protocol
 - Definition of message format
 - » Types of messages
 - » Syntax of messages (i.e., fields and delineation)
 - » Semantics of fields
 - Definition of message exchange
 - » When and how to send messages
 - » When and how to respond
- What does HTTP look like?



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Web documents

- Typical web pages use HTML format

```
Source of: http://www.ecs.umass.edu/ece/wolf/courses/ECE697AA/ - Mozilla
File Edit View Help
<html>
<head>
<meta http-equiv="Content-Type" content="text/html; charset=windows-1252">
<meta name="GENERATOR" content="Microsoft FrontPage 6.0">
<meta name="ProgId" content="FrontPage.Editor.Document">
<title>Computer Networks</title>
<!--mstheme--><link rel="stylesheet" type="text/css" href="_themes/modular-umass/modu1000.css"><meta
<meta name="Microsoft Border" content="t1b">
</head>
<body topmargin="0"><!--msnavigation--><table border="0" cellpadding="0" cellspacing="0" width="100%"
```

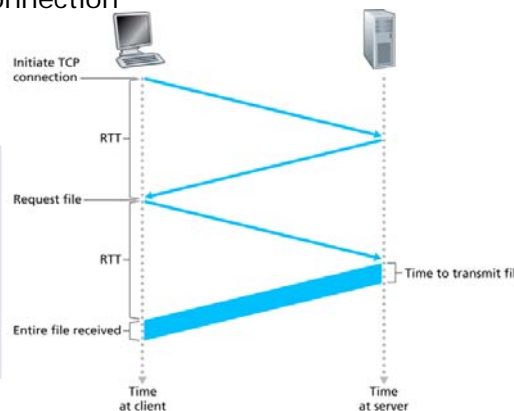
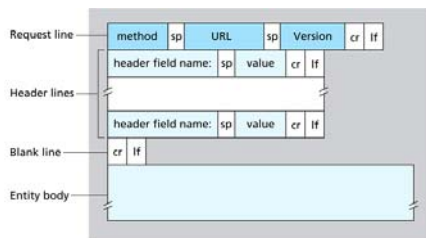
- Multiple objects for each page
 - Base HTML document
 - Images
 - Etc.
- Browser
 - Fetches HTML page and objects
 - Renders HTML on screen

Hypertext Transfer Protocol

- Sequence of messages
 1. Establish connection (transport layer and below)
 2. Send request for document
 3. Receive document
 4. Repeat 2.-3. or close connection

- Format of messages

- Plain text
- Request format:



Hypertext Transfer Protocol

- Example:

Request

Response

```

GET /ece/wolf/courses/ECE697AA/ HTTP/1.1
Host: www.ecs.umass.edu
User-Agent: Mozilla/5.0 (Windows; U; Windows NT 5.1; ...
Accept: text/xml,application/xml,application/xhtml+xml,...
Accept-Language: en-us,en;q=0.5
Accept-Encoding: gzip,deflate
Accept-Charset: ISO-8859-1,utf-8;q=0.7,*;q=0.7
Keep-Alive: 300
Connection: keep-alive
Cookie: SignOnDefault=ATWOLF

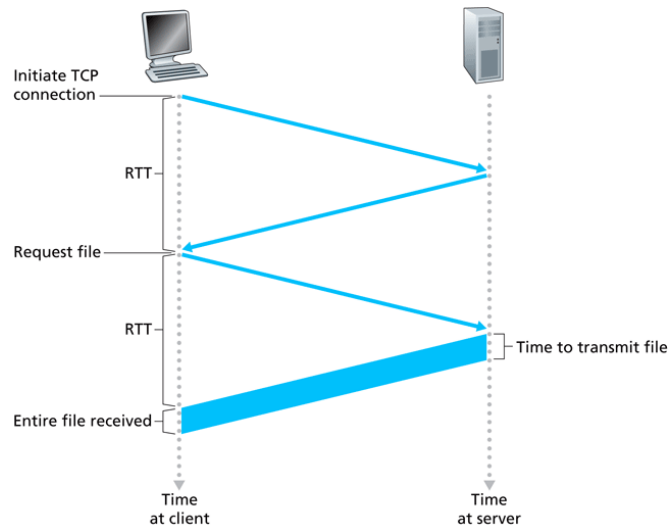
HTTP/1.1 200 OK
Date: Wed, 30 Jan 2008 20:22:02 GMT
Server: Apache/1.3.26 (Unix) mod_ssl/2.8.10 OpenSSL/0.9.6e
Last-Modified: Tue, 29 Jan 2008 15:14:47 GMT
ETag: "373857-14ae-41e90567"
Accept-Ranges: bytes
Content-Length: 5294
Keep-Alive: timeout=15, max=100
Connection: Keep-Alive
Content-Type: text/html

<html>
<head>
<meta http-equiv="Content-Type" content="text/html; ...
    
```

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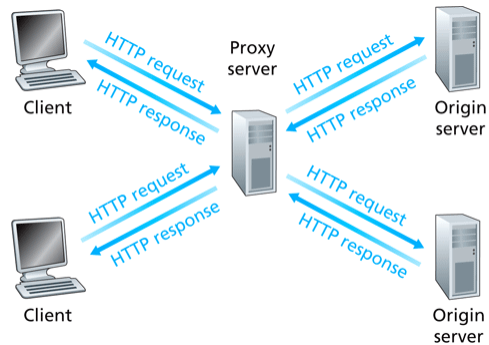
Performance considerations

- What is the performance bottleneck of web surfing?



Performance considerations

- Performance improvements
 - Persistent connections
 - Caching of documents

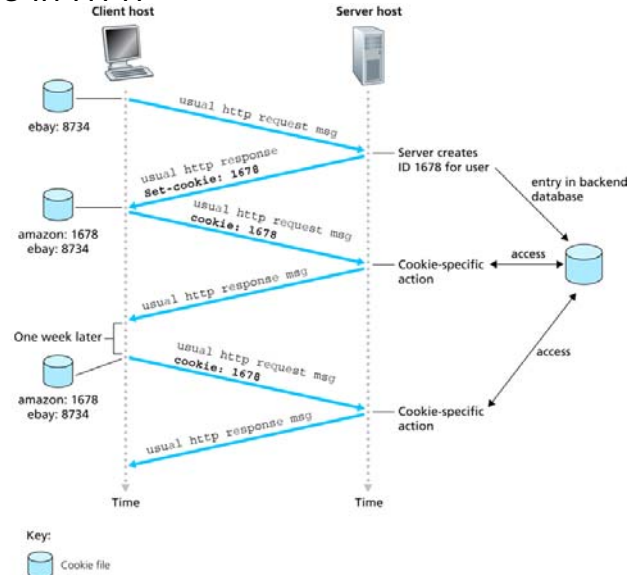


User state in HTTP

- How can a shopping site remember what I have in my shopping cart?

User state in HTTP

- Cookies in HTTP



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Application requirements

- Not all applications have same needs
- What are examples of different applications?
 - Requirements: reliability, bandwidth, time-sensitivity

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Application requirements

Application	Data Loss	Bandwidth	Time-Sensitive
File transfer	No loss	Elastic	No
E-mail	No loss	Elastic	No
Web documents	No loss	Elastic (few kbps)	No
Internet telephony/ Video conferencing	Loss-tolerant	Audio: few kbps–1Mbps Video: 10 kbps–5 Mbps	Yes: 100s of msec
Stored audio/video	Loss-tolerant	Same as above	Yes: few seconds
Interactive games	Loss-tolerant	Few kbps–10 kbps	Yes: 100s of msec
Instant messaging	No loss	Elastic	Yes and no

- Reliability
 - Different sockets: TCP is reliable, UDP is unreliable

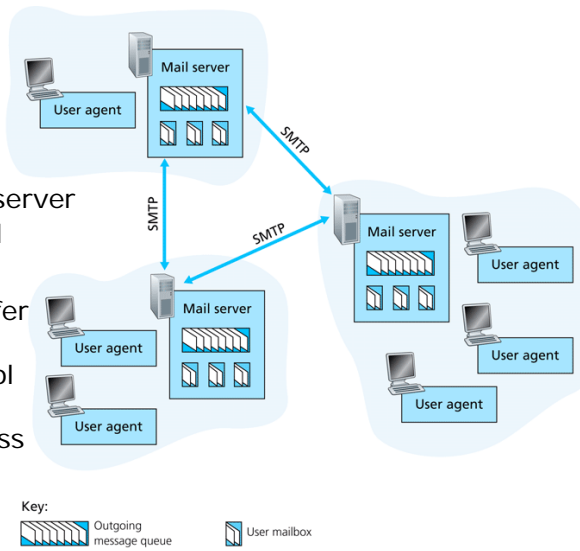
Application protocol examples

- Many different application layer protocols

Application	Application-Layer Protocol	Underlying Transport Protocol
Electronic mail	SMTP [RFC 2821]	TCP
Remote terminal access	Telnet [RFC 854]	TCP
Web	HTTP [RFC 2616]	TCP
File transfer	FTP [RFC 959]	TCP
Streaming multimedia	HTTP (e.g., YouTube), RTP	TCP or UDP
Internet telephony	SIP, RTP, or proprietary (e.g., Skype)	Typically UDP

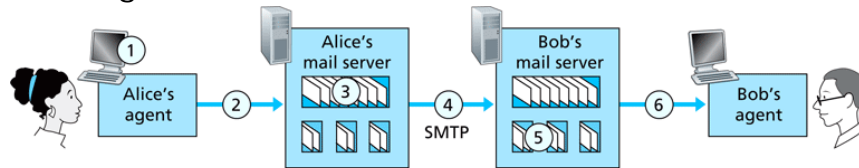
Electronic mail

- Mail servers
 - Transfer mail
 - Store mail in mailboxes
- User agents
 - Access mail from server
 - Transmit new mail
- Protocols
 - Simple Mail Transfer Protocol (SMTP)
 - Post Office Protocol (POP)
 - Internet Mail Access Protocol (IMAP)
 - Web-based email access (HTTP)



Electronic mail

- Sending of email:



- SMTP “pushes” email to destination mail server
- POP/IMAP/HTTP “pulls” email from mail server
- SMTP messages are in cleartext

```

nog@telnet mailhost 25
Trying 128.119.91.124...
Connected to franklin.ecs.umass.edu.
Escape character is '^]'.
220 franklin.ecs.umass.edu ESMTP Sendmail 8.12.10/8.12.10; Wed, 30 Jan 2008 16:32:57 -0500
HELO ece697aa.umass.edu
250 franklin.ecs.umass.edu Hello nog.ecs.umass.edu [128.119.91.192], pleased to meet you
MAIL FROM: <ece697aa@ecs.umass.edu>
250 2.1.0 <ece697aa@ecs.umass.edu>... Sender ok
RCPT TO: <tw@ieee.org>
250 2.1.5 <tw@ieee.org>... Recipient ok
DATA
354 Enter mail, end with "." on a line by itself
You don't have to do your homework.
Your ECE697AA instructor
.
250 2.0.0 j0ULWw1016257 Message accepted for delivery
QUIT
221 2.0.0 franklin.ecs.umass.edu closing connection
Connection closed by foreign host.
    
```

Assignments

- Read
 - Kurose & Ross: Chapter 3
- SPARK
 - Assessment quiz