Intro to HTTP & Playing with Traceroute

Chapter 2

CSC 249
January 30, 2018

Course Overview

- Fundamental Question:
  - How is data transferred through the Internet?
- Principles to develop
  - Reliable data transfer, to the correct recipient
  - Fast & error-free data transfer
  - Security and privacy safeguards
- Implementation
  - Network layers & Protocols

Packet delay: A packet's trip

- A packet arrives at a router, and…

1. The 'header' is read for source and destination hosts (IP address), and perform error checking of the bits transmitted =
2. If other packets arrived first and are waiting in the output buffer, there is:
3. The rate at which the router can upload the bits onto the physical link =
4. The time to travel from one router to the next router =

Which of these delays are constant and which are variable?

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Self-review Question

- Exploring propagation delay and transmission delay.
- Consider 2 hosts, A and B, connected by a single link of rate R bps. Suppose that the two hosts are separated by d meters and the propagation speed is s m/s. Host A sends a packet of size L to Host B.
  - Find d_{prop} (using what information?)
  - Find d_{trans} (using what information?)

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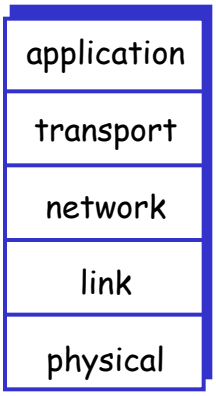
Internet Layers: Services (first glimpse)

- Application layer:
  - User interface
- Transport layer:
  - Reliable data transfer
- Network layer:
  - Find the best path through the network
- Link layer:
  - Transfer *frames* along *shared* links
- Physical layer:
  - Transfer *bits* along one link



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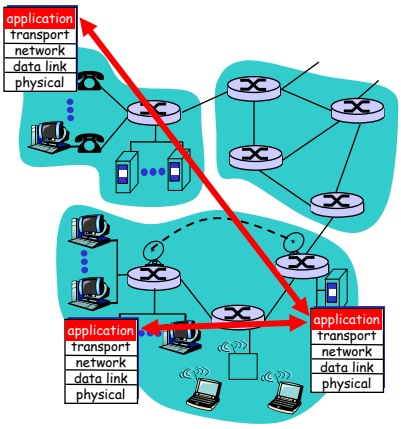
Network Applications

Programs that

- run on different end systems and
- communicate over a network.



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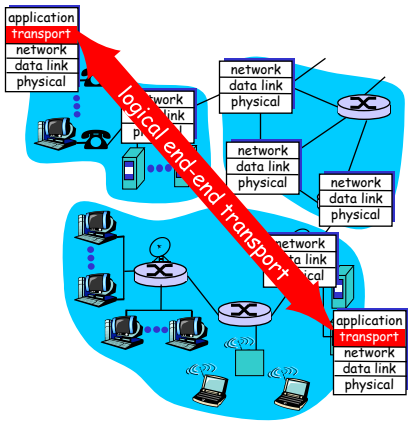
Transport services and protocols

- *Logical communication* between *application processes* running on different hosts
- Provides reliability (TCP)



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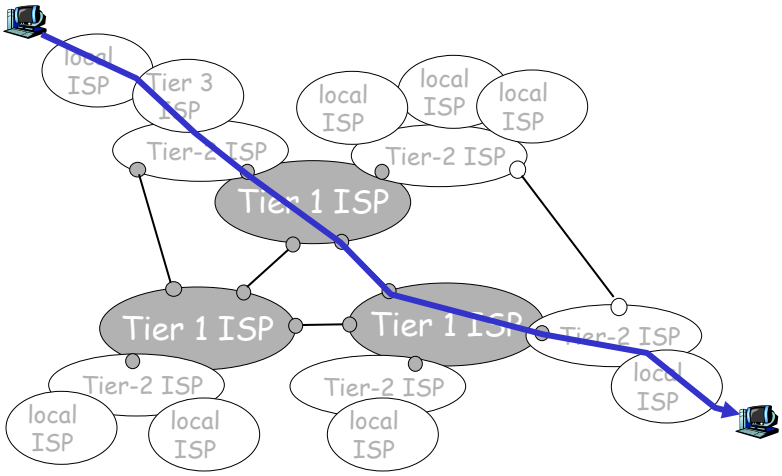
Hierarchical Internet structure: network of networks

- Each packet passes through many networks



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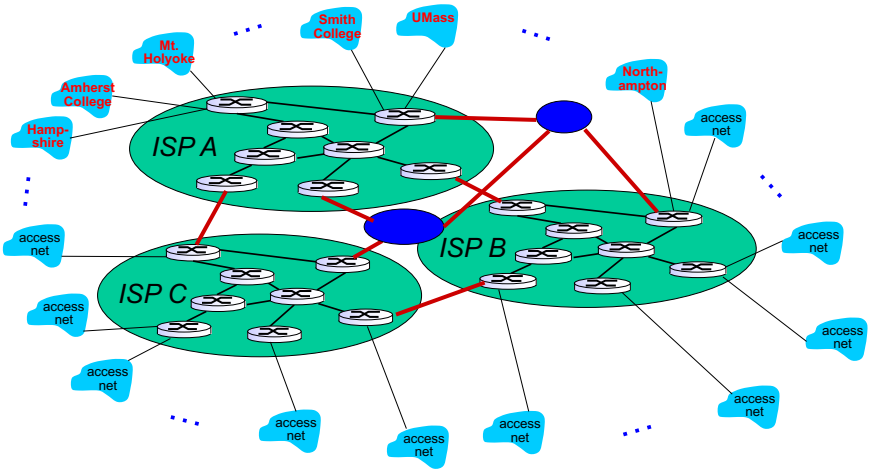
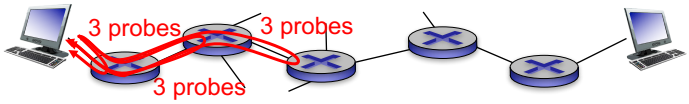
Internet structure: network of networks



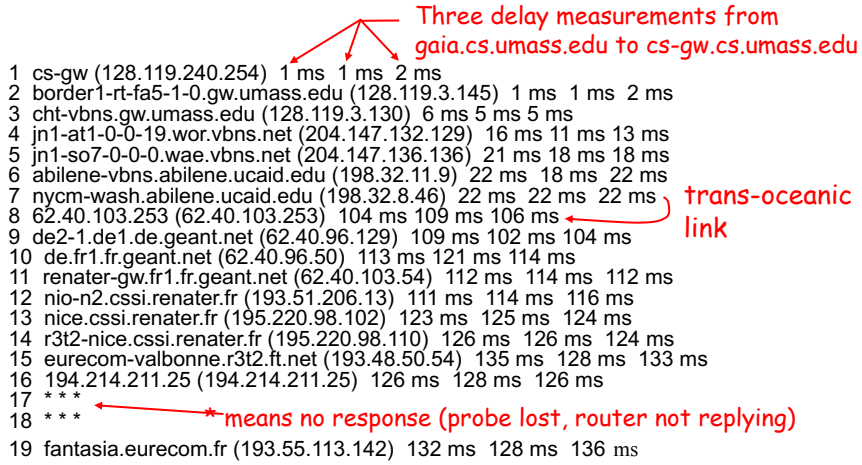
Traceroute

- Provides delay measurement
- Source host sends three packets to each router *i* on path to destination host
  - For all routers in the selected path (route)
- Router *i* returns packets to sender
  - Sender times interval between transmission and reply.



"Real" Internet delays and routes, play around on your own

traceroute: gaia.cs.umass.edu to www.eurecom.fr



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"Real" Internet delays and routes play around on your own

- Traceroute:
  - http://ping.eu/traceroute/
- PingPlotter freeware – might be fun
  - http://www.pingplotter.com/freeware.html

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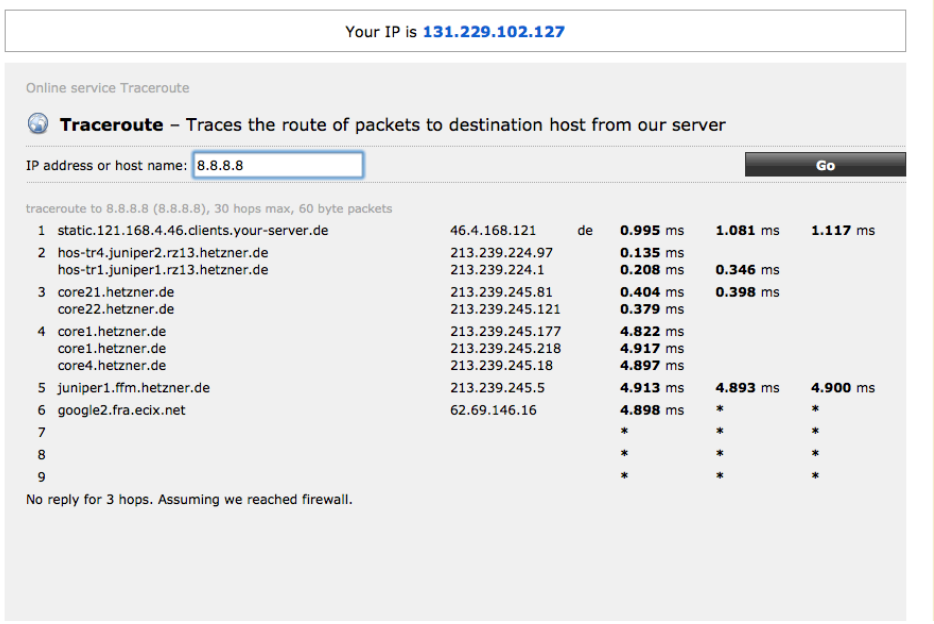

Your IP is **131.229.102.127**

Online service Traceroute

Traceroute – Traces the route of packets to destination host from our server

IP address or host name: 8.8.8.8 Go

traceroute to 8.8.8.8 (8.8.8.8), 30 hops max, 60 byte packets

1	static.121.168.4.46.clients.your-server.de	46.4.168.121	de	**0.995** ms	**1.081** ms	**1.117** ms
2	hos-tr4.juniper2.rz13.hetzner.de	213.239.224.97		**0.135** ms		
	hos-tr1.juniper1.rz13.hetzner.de	213.239.224.1		**0.208** ms	**0.346** ms	
3	core21.hetzner.de	213.239.245.81		**0.404** ms	**0.398** ms	
	core22.hetzner.de	213.239.245.121		**0.379** ms		
4	core1.hetzner.de	213.239.245.177		**4.822** ms		
	core1.hetzner.de	213.239.245.218		**4.917** ms		
	core4.hetzner.de	213.239.245.18		**4.897** ms		
5	juniper1.ffm.hetzner.de	213.239.245.5		**4.913** ms	**4.893** ms	**4.900** ms
6	google2.fra.ecix.net	62.69.146.16		**4.898** ms	*	*
7				*	*	*
8				*	*	*
9				*	*	*

No reply for 3 hops. Assuming we reached firewall.

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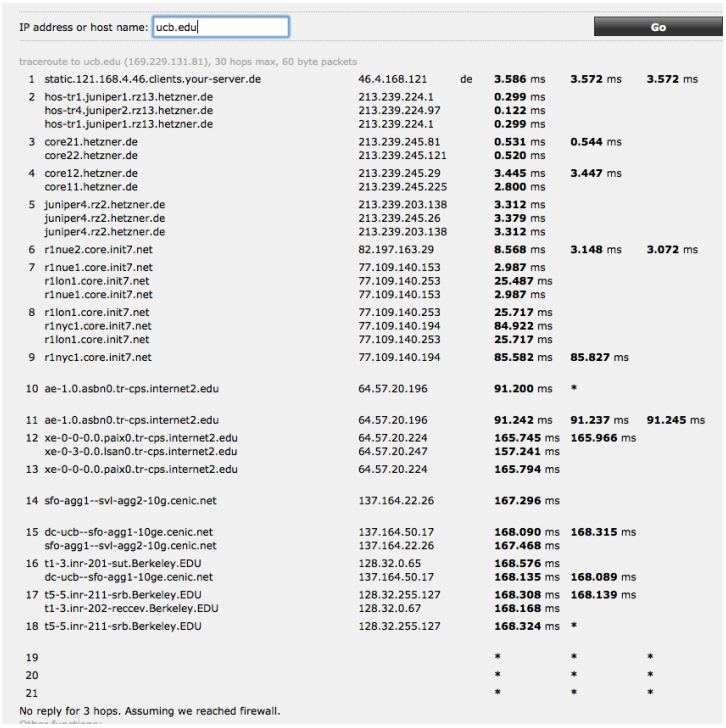

IP address or host name: ucb.edu Go

traceroute to ucb.edu (169.229.131.81), 30 hops max, 60 byte packets

1	static.121.168.4.46.clients.your-server.de	46.4.168.121	de	**3.586** ms	**3.572** ms	**3.572** ms
2	hos-tr1.juniper1.rz13.hetzner.de	213.239.224.1		**0.299** ms		
	hos-tr4.juniper2.rz13.hetzner.de	213.239.224.97		**0.122** ms		
	hos-tr1.juniper1.rz13.hetzner.de	213.239.224.1		**0.299** ms		
3	core21.hetzner.de	213.239.245.81		**0.531** ms	**0.544** ms	
	core22.hetzner.de	213.239.245.121		**0.520** ms		
4	core12.hetzner.de	213.239.245.29		**3.445** ms	**3.447** ms	
	core11.hetzner.de	213.239.245.225		**2.800** ms		
5	juniper4.rz2.hetzner.de	213.239.203.138		**3.312** ms		
	juniper4.rz2.hetzner.de	213.239.245.26		**3.379** ms		
	juniper4.rz2.hetzner.de	213.239.203.138		**3.312** ms		
6	r1nue2.core.init7.net	82.197.163.29		**8.568** ms	**3.148** ms	**3.072** ms
7	r1nue1.core.init7.net	77.109.140.153		**2.987** ms		
	r1lon1.core.init7.net	77.109.140.253		**25.487** ms		
	r1nue1.core.init7.net	77.109.140.153		**2.987** ms		
8	r1lon1.core.init7.net	77.109.140.253		**25.717** ms		
	r1nyc1.core.init7.net	77.109.140.194		**84.922** ms		
	r1lon1.core.init7.net	77.109.140.253		**25.717** ms		
9	r1nyc1.core.init7.net	77.109.140.194		**85.582** ms	**85.827** ms	
10	ae-1.0.asbn0.tr-cps.internet2.edu	64.57.20.196		**91.200** ms	*	
11	ae-1.0.asbn0.tr-cps.internet2.edu	64.57.20.196		**91.242** ms	**91.237** ms	**91.245** ms
12	xe-0-0-0.0.paix0.tr-cps.internet2.edu	64.57.20.224		**165.745** ms	**165.966** ms	
	xe-0-3-0.0.lsan0.tr-cps.internet2.edu	64.57.20.247		**157.241** ms		
13	xe-0-0-0.0.paix0.tr-cps.internet2.edu	64.57.20.224		**165.794** ms		
14	sfo-agg1--svl-agg2-10g.cenic.net	137.164.22.26		**167.296** ms		
15	dc-ucb--sfo-agg1-10ge.cenic.net	137.164.50.17		**168.090** ms	**168.315** ms	
	sfo-agg1--svl-agg2-10g.cenic.net	137.164.22.26		**167.468** ms		
16	t1-3.inr-201-sut.Berkeley.EDU	128.32.0.65		**168.576** ms		
	dc-ucb--sfo-agg1-10ge.cenic.net	137.164.50.17		**168.135** ms	**168.089** ms	
17	t5-5.inr-211-srb.Berkeley.EDU	128.32.255.127		**168.308** ms	**168.139** ms	
	t1-3.inr-202-reccev.Berkeley.EDU	128.32.0.67		**168.168** ms		
18	t5-5.inr-211-srb.Berkeley.EDU	128.32.255.127		**168.324** ms	*	
19				*	*	*
20				*	*	*
21				*	*	*

No reply for 3 hops. Assuming we reached firewall.

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IP address or host name: 139.130.4.5 Go

traceroute to 139.130.4.5 (139.130.4.5), 30 hops max, 60 byte packets

1	static.121.168.4.46.clients.your-server.de	46.4.168.121	de	**1.009** ms	**1.140** ms	**1.306** ms
2	hos-tr3.juniper2.rz13.hetzner.de hos-tr2.juniper1.rz13.hetzner.de	213.239.224.65 213.239.224.33		**0.331** ms **0.126** ms	**0.439** ms	
3	core22.hetzner.de core21.hetzner.de	213.239.245.121 213.239.245.81		**0.584** ms **3.032** ms	**0.740** ms	
4	core11.hetzner.de core12.hetzner.de	213.239.245.221 213.239.245.214		**2.787** ms **2.741** ms	**2.785** ms	
5	juniper4.rz2.hetzner.de juniper4.rz2.hetzner.de juniper4.rz2.hetzner.de	213.239.203.138 213.239.245.26 213.239.203.138		**2.816** ms **2.938** ms **2.816** ms		
6	te0-0-1-2.nr11.b040138-0.nue01.atlas.cogentco.com te0-0-2-0.nr11.b040138-0.nue01.atlas.cogentco.com te0-0-2-1.nr11.b040138-0.nue01.atlas.cogentco.com	149.6.158.21 149.6.158.5 149.6.158.9		**3.366** ms **3.401** ms **3.282** ms		
7	te0-1-0-5.rcr21.nue01.atlas.cogentco.com	154.25.0.9		**3.806** ms		
8	be2279.ccr21.muc01.atlas.cogentco.com	154.54.37.146		**6.588** ms	**5.972** ms	**6.448** ms
9	be2228.ccr41.fra03.atlas.cogentco.com	154.54.38.49		**11.449** ms	**11.716** ms	**11.574** ms
10	be2261.ccr41.ams03.atlas.cogentco.com	154.54.37.29		**18.256** ms	**18.431** ms	**18.134** ms
11	be2275.ccr21.lon13.atlas.cogentco.com	130.117.51.253		**25.396** ms	**25.519** ms	**25.641** ms
12	be2316.ccr21.lon01.atlas.cogentco.com be2314.ccr21.lon01.atlas.cogentco.com	154.54.73.114 154.54.72.254		**26.146** ms **25.991** ms	**26.265** ms	
13	i-0-0-0-2-peer.ulco04.pr.telstraglobal.net	134.159.95.185		**31.532** ms	**34.135** ms	**33.834** ms
14	i-0-0-2-0.ulco-core02.bi.telstraglobal.net i-5-2-2.ulco-core01.bi.telstraglobal.net i-0-0-2-0.ulco-core02.bi.telstraglobal.net	202.40.148.218 202.84.142.209 202.40.148.218		**35.550** ms **33.603** ms **35.550** ms		
15	i-0-4-0-6.ny8a-core01.bx.telstraglobal.net i-0-4-0-5.ny8a-core01.bx.telstraglobal.net	202.84.143.57 202.84.249.21		**170.761** ms **170.521** ms	**170.272** ms	
16	i-0-1-0-3.eqnx-core01.bi.telstraglobal.net i-0-3-0-8.eqnx-core01.bi.telstraglobal.net	202.84.249.34 202.40.149.198		**167.363** ms **171.539** ms	**167.291** ms	
17	i-0-4-0-2.sydp-core01.bx.telstraglobal.net i-0-1-0-1.sydp-core01.bx.telstraglobal.net i-0-4-0-1.sydp-core01.bx.telstraglobal.net	202.84.141.245 202.84.249.70 202.84.141.241		**344.785** ms **344.112** ms **347.359** ms		
18	bundle-ether3.pad-gw1.sydney.telstra.net	203.50.13.21		**347.165** ms	**349.978** ms	**346.883** ms
19	bundle-ether18.chw-core10.sydney.telstra.net	203.50.13.73		**356.403** ms	**356.309** ms	**355.743** ms
20	bundle-ether19.chw-core2.sydney.telstra.net	203.50.11.130		**359.057** ms	**355.662** ms	**355.192** ms
21	gigabitethernet5-1.pit-service1.sydney.telstra.net	203.50.20.250		**353.912** ms	**357.454** ms	**354.207** ms
22				*	*	*
23				*	*	*
24				*	*	*

No reply for 3 hops. Assuming we reached firewall.

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Also could try…

- (a) Visit the site www.traceroute.org and perform traceroutes from two different cities in France to the same destination host in the United States. How many links are the same in the two traceroutes? Is the transatlantic link the same?
- (b) Repeat (a) but this time choose one city in France and another city in Germany.
- (c) Pick a city in the United States, and perform traceroutes to two hosts, each in a different city in China. How many links are common in the two traceroutes? Do the two traceroutes diverge before reaching China?

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Vocabulary for the Application Layer

- Protocol – a set of steps to follow
- Application packet is a "message"
- Architecture
  - **Client – Server** vs. Peer to Peer (P2P)
- Application ≈ Process
- Port number (assigned to each application)
- TCP Connection & handshaking

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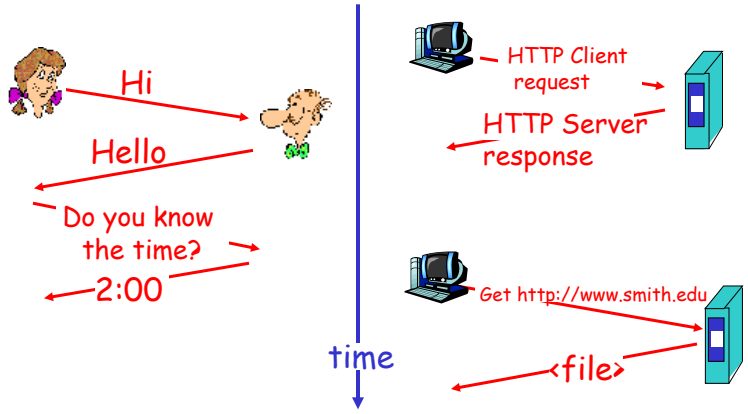
What is a protocol?

a human protocol and a computer network protocol:



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At the tables now, play with some web browsers

- Open a web browser
- Type in a URL
- Brainstorm everything that happens after you press the 'enter' or 'return' key
  - What is the meaning of every element in the URL?
  - What happens at your 'source' computer?
  - What happens in the Internet?
  - What is the destination host and what does that host do?

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HTTP Principles

- Characteristics
- Message format
  - telnet example
- Cookies
- Proxy cache

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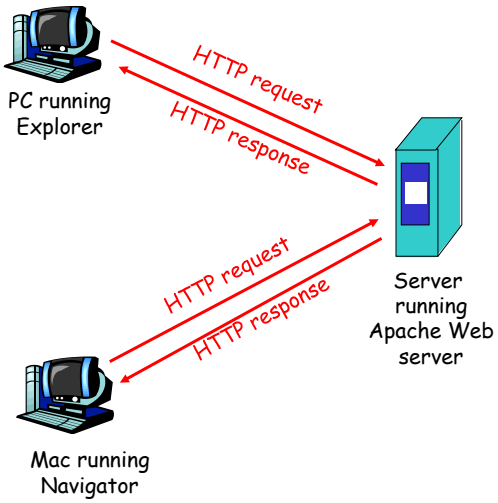
HTTP overview



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Connections between Hosts

- Persistent connections
  - Connection from source to destination is kept open after the initial message and data exchange
  - vs. non-persistent
- Pipelining
  - Multiple connections are opened in order to allow sending multiple files simultaneously, such as images on a webpage

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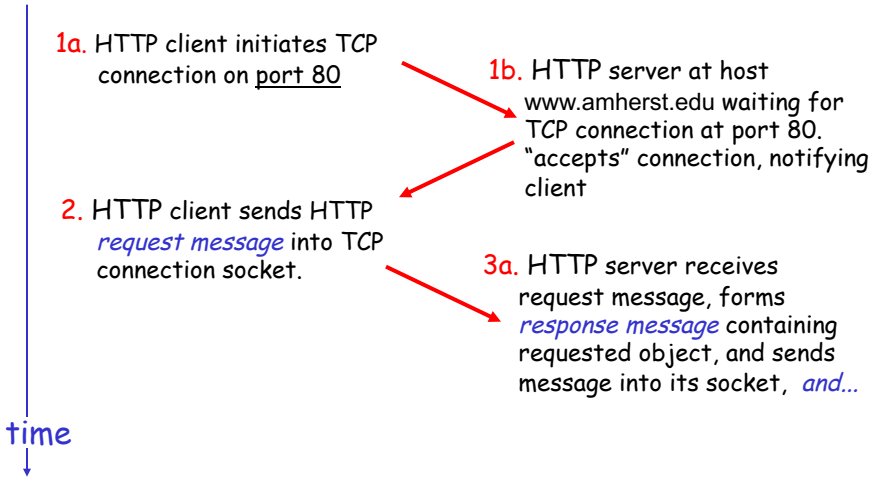
Non-persistent HTTP (for comparison)

Suppose user enters URL
www.amherst.edu/history/home.index

(contains text, references to 10 jpeg images)



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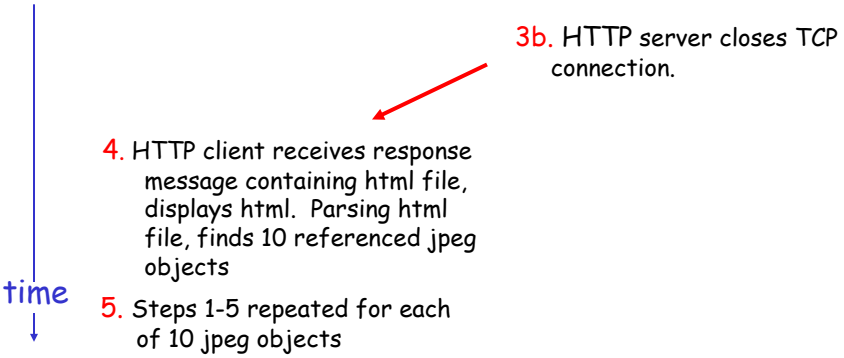
Non-persistent HTTP (cont.)



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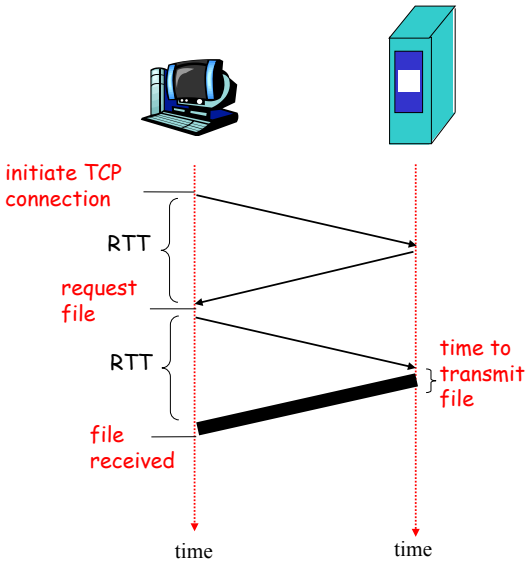
Non-Persistent HTTP: Response time



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Persistent HTTP

Nonpersistent HTTP

- server closes connection after first file is transferred, and then must repeat connection procedure

Persistent HTTP

- server leaves (TCP) connection open after sending response
- subsequent HTTP messages between same client/server sent over the existing, open connection

Persistent ***without*** pipelining:

- client issues new request only when previous response has been received

Persistent ***with*** pipelining:

- default in HTTP/1.1
- client sends requests as soon as it encounters a referenced object

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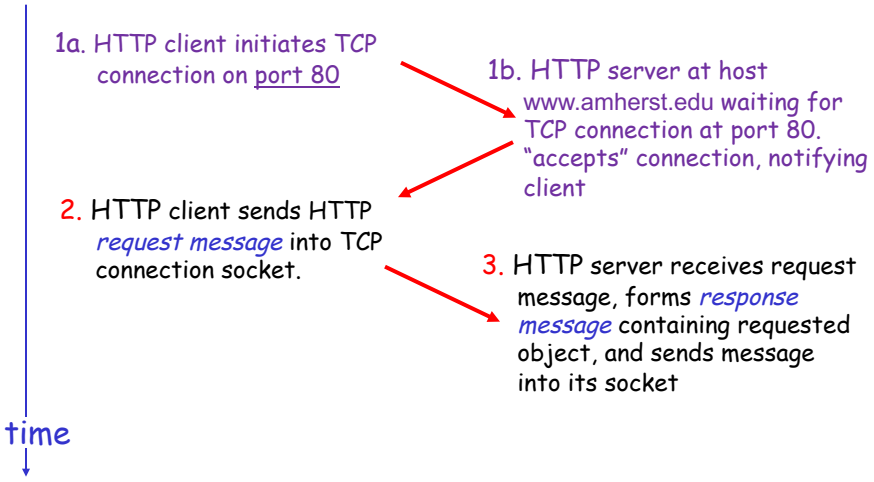
HTTP Review

1) Connection request to port 80 (handshaking)
2) File/data request via dedicated connection/socket



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Client Server Review

- Client

- Server

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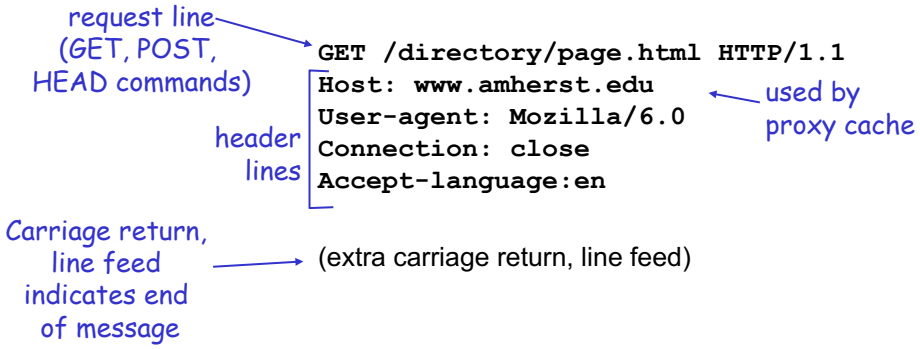
Basic HTTP request message

- ASCII (human-readable format)



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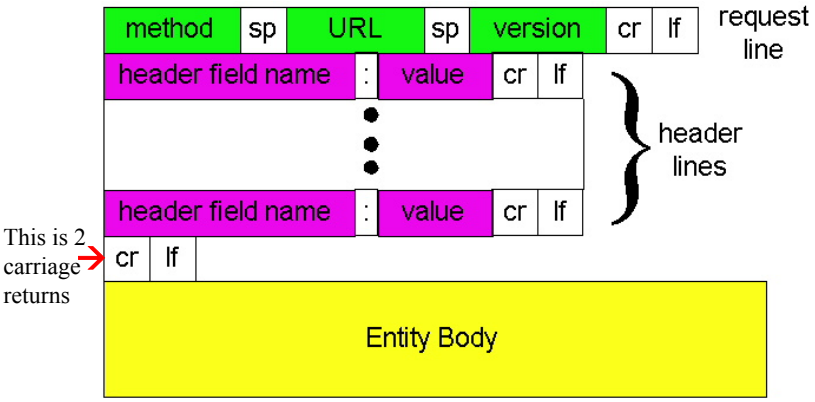
HTTP request message: general format



→ When is the "Entity Body" filled in with an HTTP request message?

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Example: Uploading form input

GET method: (the most basic)

- The 'entity body' in the request is empty
- Also can try the HEAD method (page header info)

Post method:

- A web page often includes "form" input
- This input information is uploaded to server in the message's "entity body"

(but also have the URL method:)

- Uses the GET method
- Input is uploaded in URL field of request line:

```
www.somesite.com/animalsearch?monkeys&banana
```

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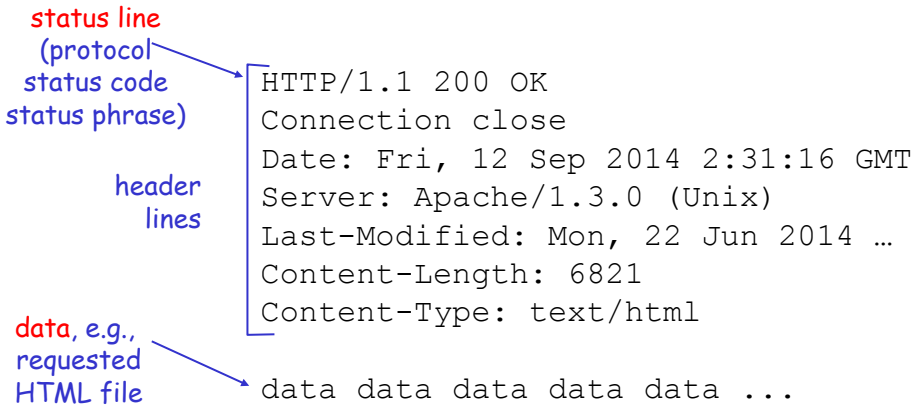
Basic HTTP response message



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HTTP response status codes

In the first line of a server->client response message.
A few sample codes:

200 OK

- request succeeded, requested object later in this message

301 Moved Permanently

- requested object moved, new location specified later in this message (Location:)

400 Bad Request

- request message not understood by server

404 Not Found

- requested document not found on this server

505 HTTP Version Not Supported

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Trying out HTTP (client side) for yourself

1. Telnet to a Web server (from 'Terminal' window):

```
telnet www.science.smith.edu 80
```

Opens TCP connection to port 80
(default HTTP server port)
Anything typed in sent
to port 80 at science.smith.edu

2. Type in a GET HTTP request:

```
GET /~jcardell/ HTTP/1.1
Host: www.science.smith.edu
```

End with 2 CR
This is a minimal (but complete)
GET request to an HTTP server

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Trying out HTTP (client side) for yourself

3. Look at response message sent by HTTP server

```
HTTP/1.1 ___  ___
Date:
Server:
Last-Modified:
ETag:
Accept-Ranges:
Content-Length:
Vary:
Content-Type:
```

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Trying out HTTP (client side) for yourself

3. Look at response message sent by HTTP server

```
HTTP/1.1 200 OK
Date: Tue, 23 Jan 2018 19:13:04 GMT
Server: Apache/2.4.7 (Ubuntu)
Last-Modified: Fri, 31 Aug 2014 20:08:20 GMT
ETag: "a95-506bd8eec7500"
Accept-Ranges: bytes
Content-Length: 2709
Vary: Accept-Encoding
Content-Type: text/html

(... followed by the HTML file)
```

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Trying out HTTP

What should you type to initiate an HTTP connection via telnet?

jcardell-fcap:~ jcardell$ **telnet www.science.smith.edu** ← left off port number '80'
Trying 131.229.72.74…

telnet: connect to address 131.229.72.74: Operation timed out
telnet: Unable to connect to remote host

jcardell-fcap:~ jcardell$

Trying out HTTP

```
jcardell-fcap:~ jcardell$ telnet www.science.smith.edu 80
Trying 131.229.72.74...
Connected to cirrus.smith.edu.
Escape character is '^]'.
HEAD /~jcardell/ HTTP/1.1
Host: www.science.smith.edu    <… return twice>

HTTP/1.1 200 OK
Date: Tue, 23 Jan 2018 19:13:04 GMT
Server: Apache/2.4.7 (Ubuntu)
Last-Modified: Fri, 31 Aug 2014 20:08:20 GMT
ETag: "a95-506bd8eec7500"
Accept-Ranges: bytes
Content-Length: 2709
Vary: Accept-Encoding
Content-Type: text/html
```

```
ford352-r10578:~ jcardell$ telnet gaia.cs.umass.edu 80
Trying 128.119.245.12...
Connected to gaia.cs.umass.edu.
Escape character is '^]'.
GET /wireshark-labs/HTTP-wireshark-file1.html HTTP/1.1
Host: gaia.cs.umass.edu

HTTP/1.1 200 OK
Date: Thu, 02 Feb 2017 21:07:00 GMT
...
Last-Modified: Thu, 02 Feb 2017 06:59:01 GMT
ETag: "80-54786b333b730"
Accept-Ranges: bytes
Content-Length: 128
Content-Type: text/html; charset=UTF-8

<html>
Congratulations.  You've downloaded the file
http://gaia.cs.umass.edu/wireshark-labs/HTTP-wireshark-
file1.html!
</html>
Connection closed by foreign host.
ford352-r10578:~ jcardell$
```

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Fun With Telnet

- Terminal emulation, for UNIX, to log on to remote computers
- A protocol and an application (using that protocol)
- Poke around on http://www.telnet.org/

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http://www.telnet.org/

Miscellaneous fun places

- rainmaker.wunderground.com :: weather via telnet!
- india.colorado.edu 13 (Get the time) :: get the time
- telehack.com 23 :: Telehack
- telehack.com :: Telehack - web
- towel.blinkenlights.nl 23 :: Star Wars asciimation
- towel.blinkenlights.nl 666 :: The Bofh Excuse Server

Other systems

- thehatshop.mudhosting.net 3000 :: Hallowed Halls
- eclipse.cs.pdx.edu 7680 :: New Moon
- batmud.bat.org 23 :: BatMUD
- forgottenkingdoms.org 4000 :: Forgotten Kingdoms
- mush.shelteringcolorado.com 2601 :: Sheltering Sky: Colorado by Night
- igormud.org 1701 :: Igor MUD/
- zombiemud.org 23 :: Zombie MUD
- achaea.com 23 :: Achaea, Dreams of Divine Lands
- gcomm.com 23 :: Galacticomm BBS
- 1984.ws 23 :: 1984

Ping – To play with on own

- Use a terminal window, or a web client
  - Such as http://ping.eu/ping/
- Addresses to test:
  - Google DNS servers: 8.8.8.8 and 8.8.4.4.
  - Australia at 139.130.4.5
  - OpenDNS 208.67.222.222 and 208.67.220.220
  - Norton Connectsafe: 198.153.192.1 and 198.153.194.2 that respond to ICMP requests
  - Yourself: 127.0.0.1

HTTP Characteristics

- Client-server architecture
- Is "stateless"
  - Compare to FTP – read through text sections
- Persistent connection
  - and pipelining
- Push vs. pull protocol
- Uses TCP (rather than UDP)

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Summary

- Recap causes of delay in the Internet
- Client-Server architecture
- Hypertext Transfer Protocol
  - Messages: request & response
  - Message format
- Playing with telnet
  - Pretending you are a web browser
  - Be careful not to make more of this than intended

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