Week 9: Application Layer

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World Wide Web (WWW)

- World Wide Web key components are?
  - Client and Server software – **Firefox** is the client software for **Apache** is on the server side
  - Web mark-up languages – how webpages are coded
  - Web scripting languages – More dynamicity to webpages - **Javascript**
  - **HTTP** – about how to transfer

Web Access

- A web page consists of objects
- An object can be HTML file but also JPEG image, Java applet, audio file, …
- A web page which includ ed objects
- Each object is addressa ble by a URL (uniform resource locator)
- Example URL:

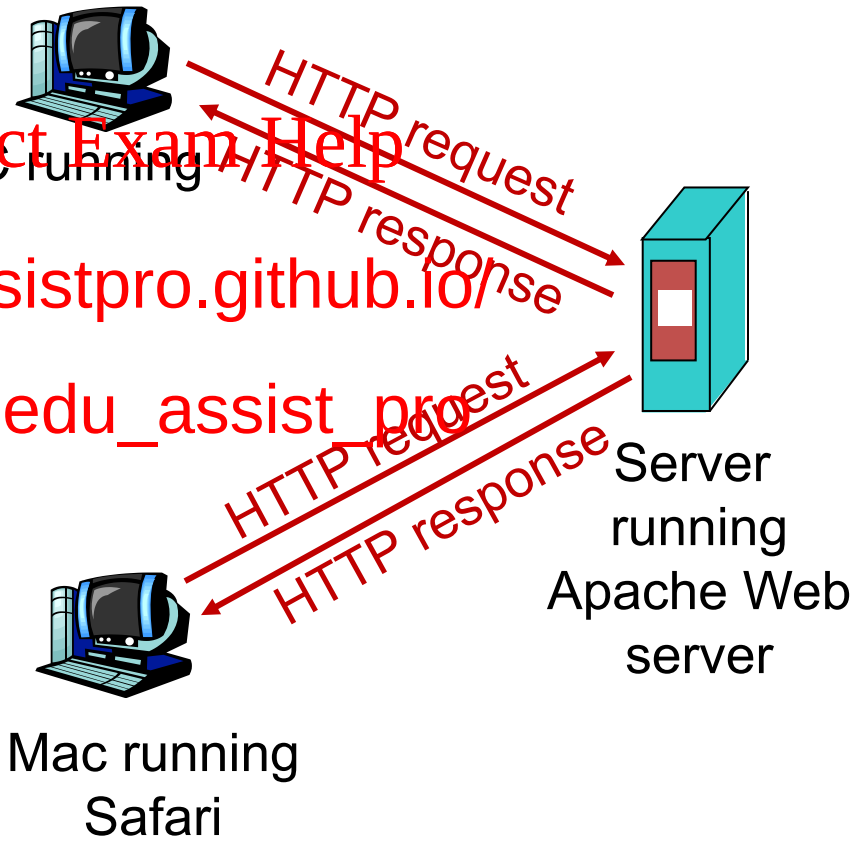
www.someschool.edu/someDept/pic.gif

host name path name

HTTP: hypertext transfer protocol

HyperText "text … cross-referencing between sections of text and associated graphic material"

- HTTP is at the application layer
- client/server
  - ***client:*** brows requests, receives and displays Web objects
  - ***server:*** Web server sends objects in response to requests



HTTP Connections

- Non-persistent HTTP
  - at most one object sent over a TCP connection

- Persistent H
  - multiple objects can be single TCP connection between clie er

Non-persistent HTTP (I)

suppose user enters URL:
`www.someSchool.edu/someDepartment/home.index`

contains text and references to 10 images

1a. HTTP client initiates TCP connection to HTTP server (process) at `www.someScho` on port 80

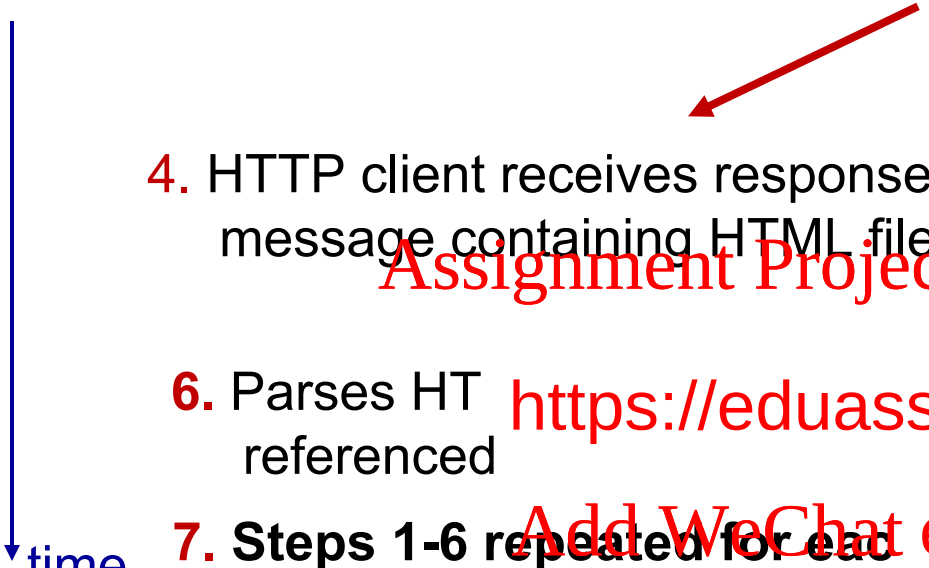
1b. HTTP server at host **`www.someSchool.edu`** for TCP connection at . Accepts connection, client

2. HTTP client sends a HTTP ***request message*** (containing URL) into TCP connection socket. Message indicates that client wants object **`someDepartment/home.index`**

3. HTTP server receives request message, forms ***response message*** containing requested object, and sends message into its socket

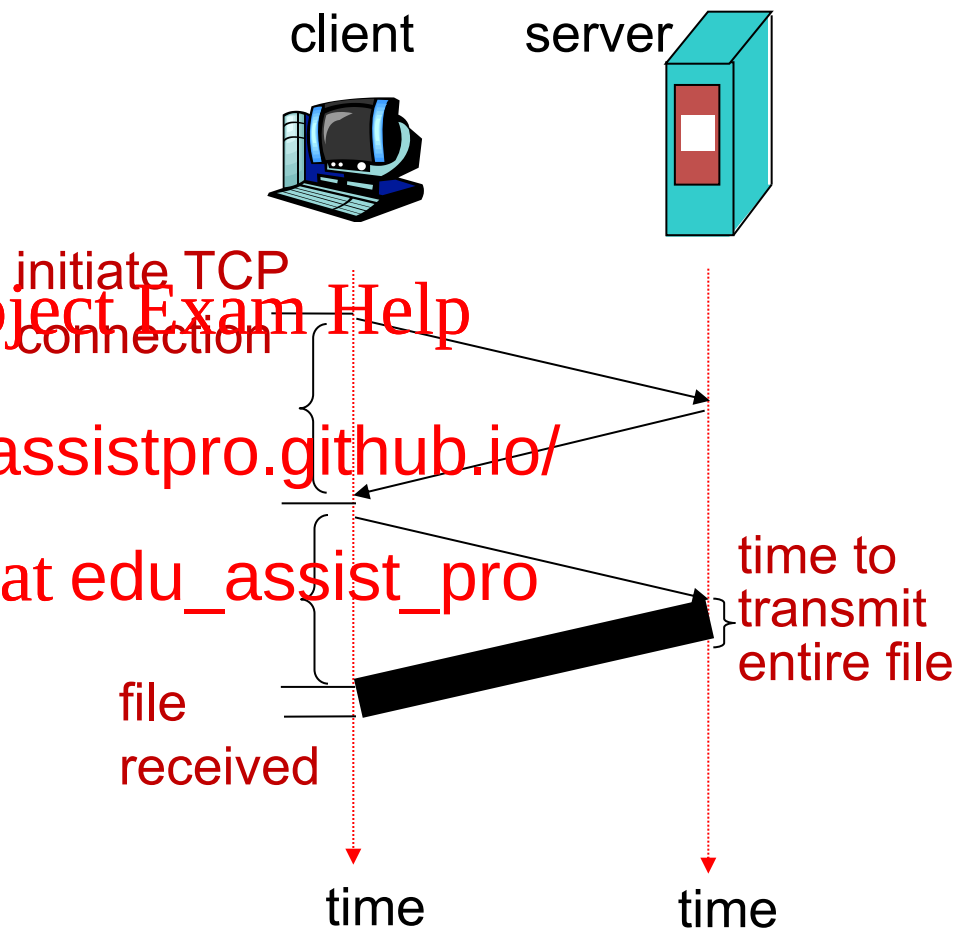
time

Non-persistent HTTP (II)



Non-Persistent HTTP:Response Time

- Round Trip Time (RTT) – time for a small packet to travel from client to server and back
- Response time
  - one RTT to initia connection
  - one RTT for HTTP request and first few bytes of HTTP response to return
  - file transmission time
- Total response time = 2 RTT+ file transmission time



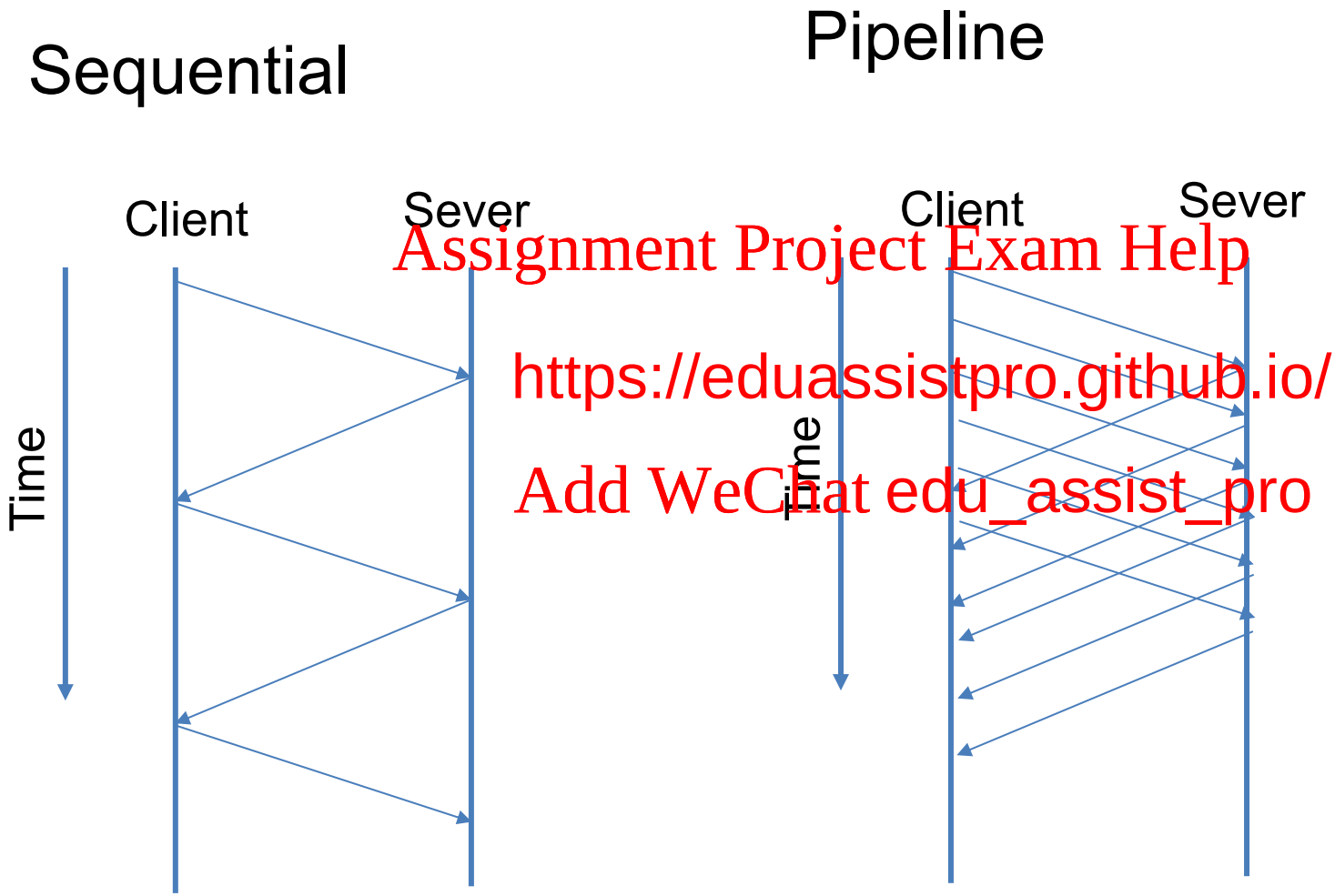
Non-Persistent HTTP – Issues

- Requires new connection per requested object
- OS overhea ection
- Delivery delay of 2 RTTs sted object

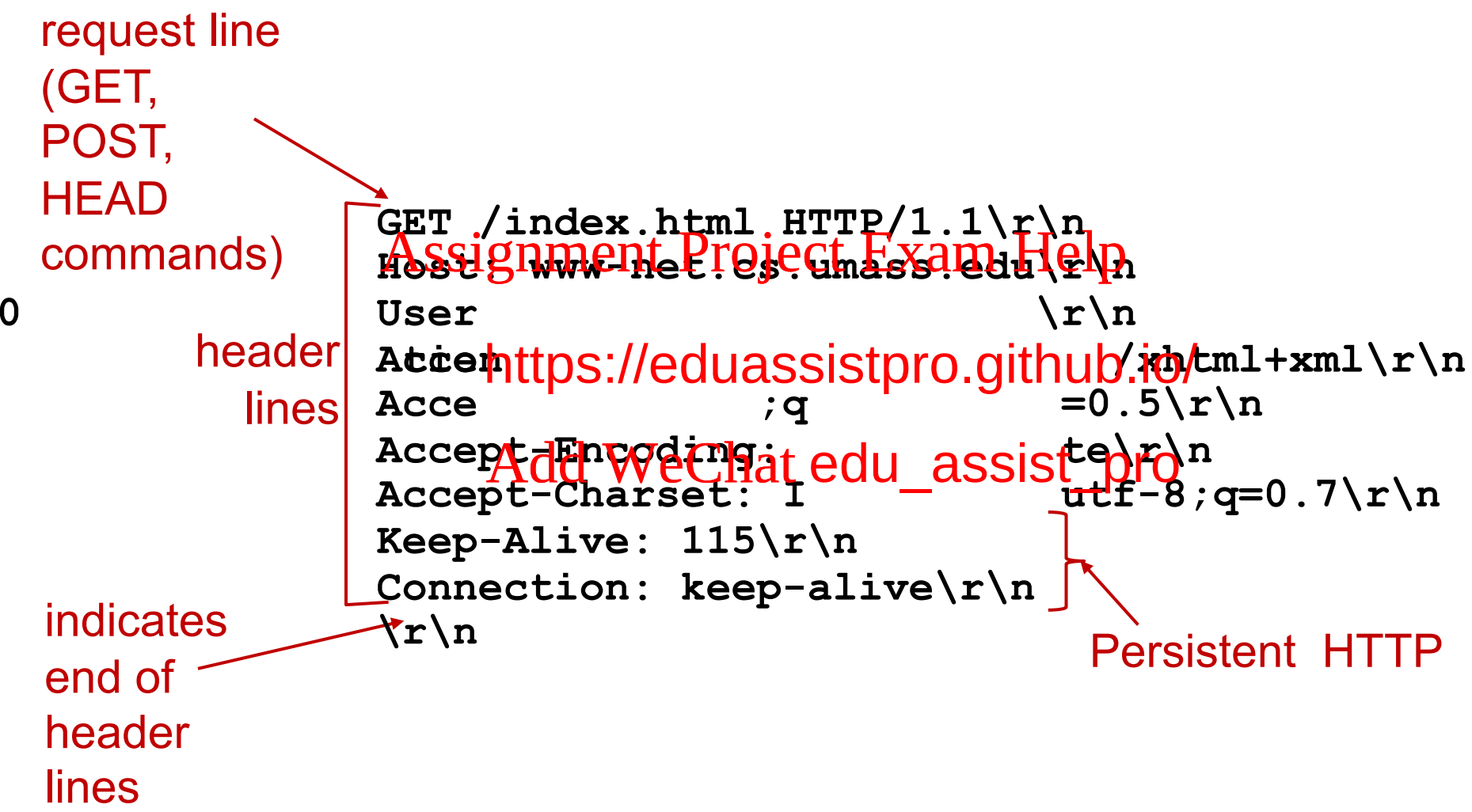
Persistent HTTP

- Server leaves connection open after sending response
- Subsequent HTTP messages between same client/server ection
- *Pipelining* – as soon as it encounters a referenced
  - ➔as little as one RTT f ferenced objects
- Server closes a connection if it hasn't been used for some time

Sequential vs Pipeline



HTTP Request Message: Example



HTTP Response Message: Example

200 OK – request succeeded, requested object later in this msg
….
404 Not Found – requested document not found on this server

status line:

header lines

```
HTTP/1.1 200 OK\r\n
Date: Su                                          \r\n
Server:                                      \r\n
Last-Mod                                                \r\n
Content-Length: 2652\
Keep-Alive: timeout=1                  \r\n
Connection: Keep-Alive\r\n
Content-Type: text/html; charset=ISO-8859-1\r\n
\r\n
data data data data data ...
```

GMT

17:00:02 GMT

data, e.g., requested HTML file

HTTP Request Methods

HTTP Error Codes

Cookies

- **The http servers are stateless**

- Cookies to place small amount (<4Kb) of info on users computer and (RFC 2109)

- Questionable mechanism for users (invisibly perhaps)

User-server Interaction: Cookie Example 1

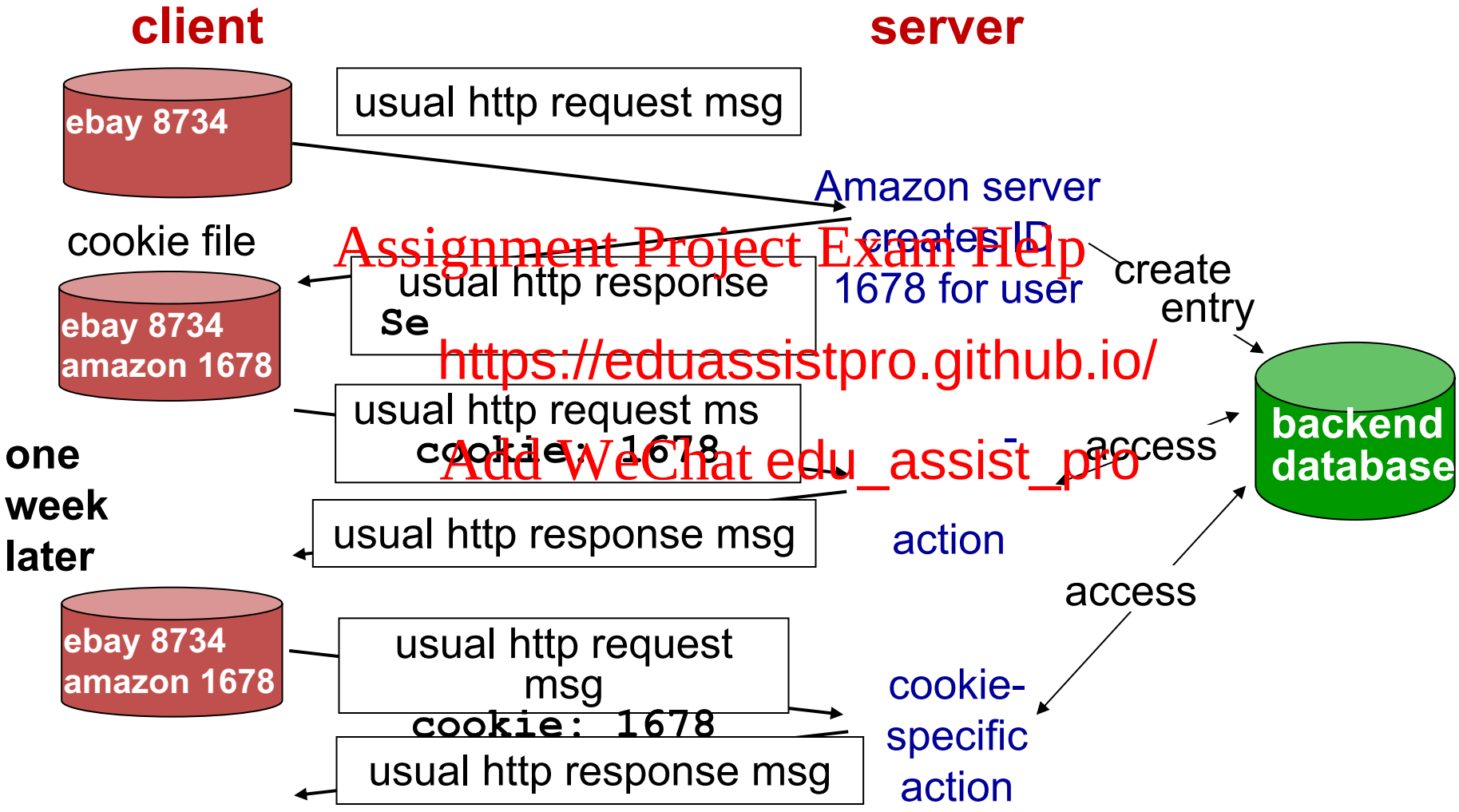
Susan always accesses the Internet from her (*cookie-enabled*) home PC. She visits a specific (*cookie-enabled*) e-commerce site for the first time

- When the initial HTTP requests arrives at the site, the site creates:
  - unique ID
  - entry in backend database for ID
- The e-commerce site then responds to Susan's browser, including in the HTTP response
  - Set-cookie: 1234 — ID

User-server Interaction: Cookie Example (Contd.)

- Susan's browser appends a line to a cookie file that it manages
  - www.e-commerce-site.com: 1234
- Next time Sus [illegible] that site, a cookie header line will be added to h
  - Cookie: 1234
- The server will then perform a cookie-specific action

Keeping state with Cookies: Example 2



Beyond User Tracking: Advantages of Cookies

- Authorization
- Shopping carts
- Recommen
- User sessi

Cookies vs Sessions

- **Both introduce "memory" or state into HTTP and are about multiple TCP connections**

Sessions

- Sessions information regarding visitor's interaction s server side: up to so
- When user closes the website, the session ends
- Sessions information size can be large

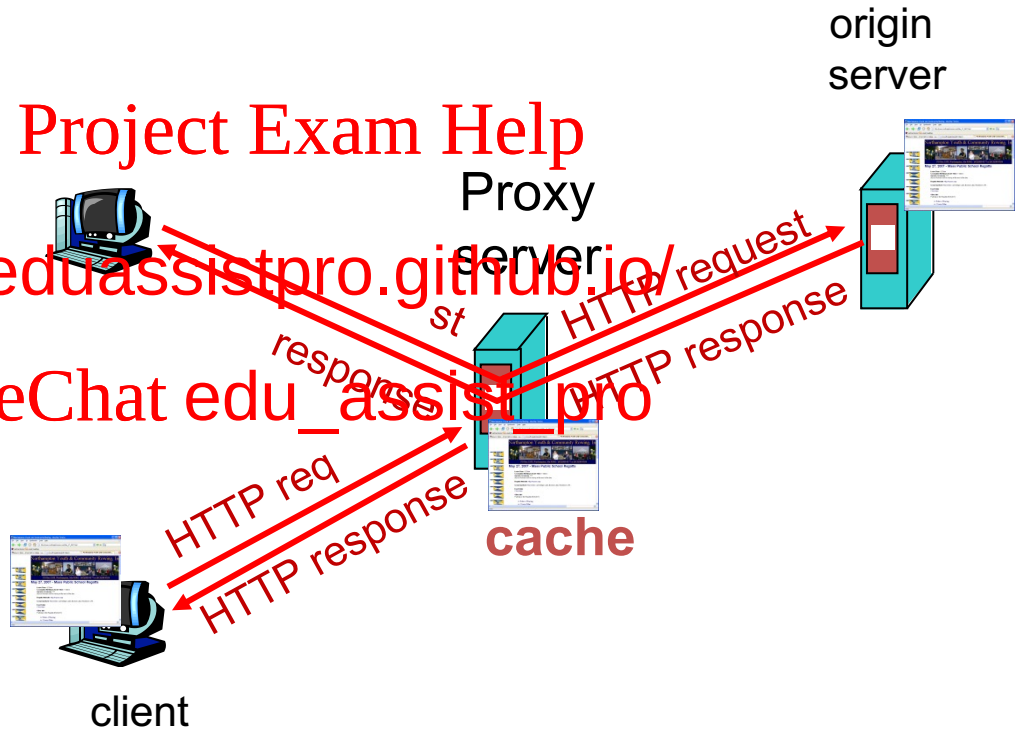
Cookies

- Cookies are transferred between and client
  information stored at
  t and server
  client information until deleted
- Cookies information size limited

Web Caches (Proxy Server)

Goal: satisfy client request without involving origin server

- User sets browser to access Web via cache
  - ➔browser send HTTP reques cache
    - **if object in cache,** cache returns object
    - **else** cache requests object from origin server, then returns object to client



More about Web Caching

- Cache acts as both client and server
- Typically cache is installed by ISP (university, company, residential ISP)
- Causes pro hanging data though

Why Web caching?

- Reduce response time for client request
- Reduce traffic on an institution's access link