

CS305 Lab3

HTTP

Dept. Computer Science and Engineering
Southern University of Science and Technology

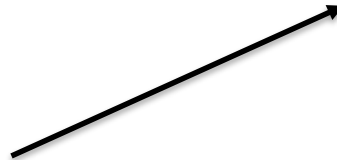
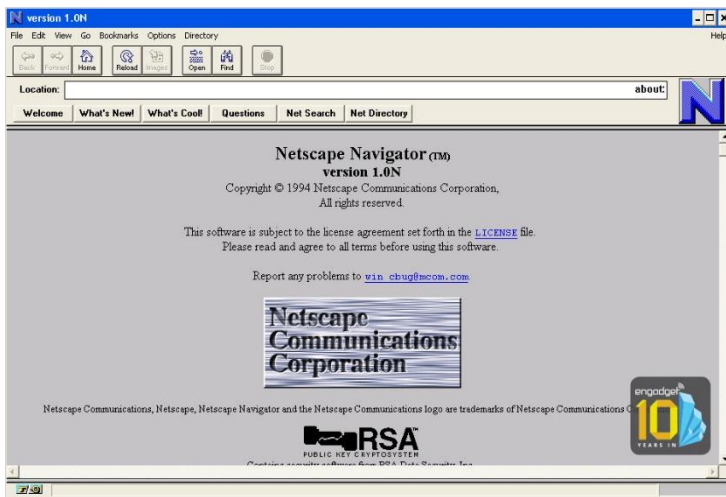
TOPICS

- Client and Server
- URL and MIME
- Request and Response
- Tools: browser, curl, Wireshark

Web browsers

- A **web browser** is a program to retrieve and display resources on the Web

Example: Netscape 1.0N

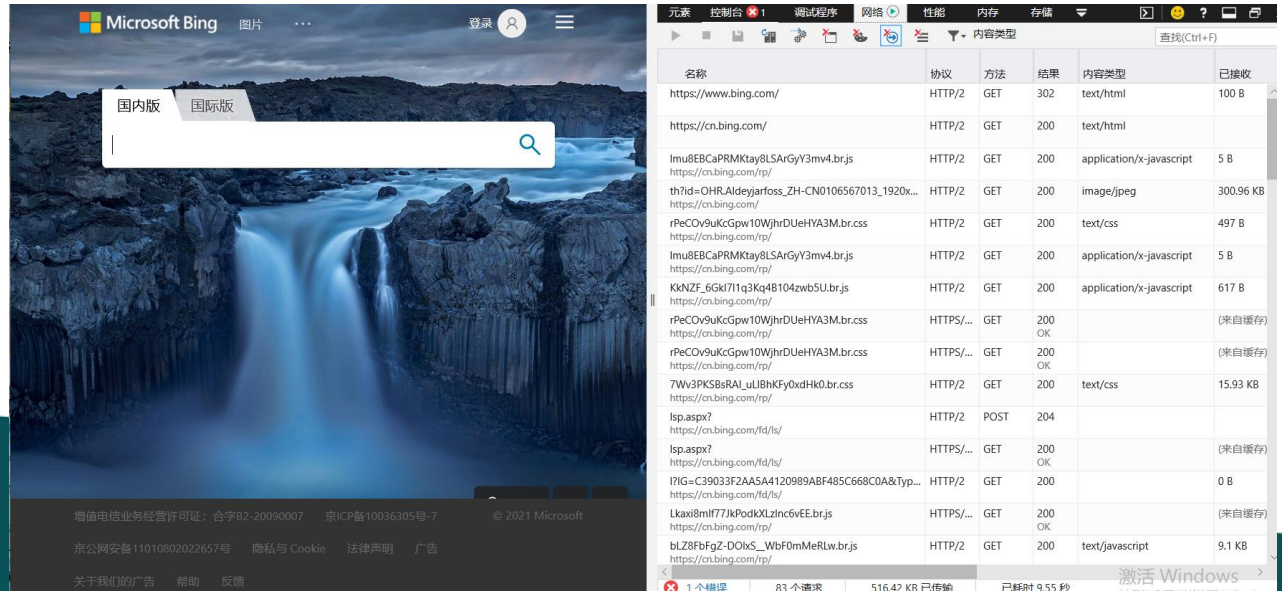


Web browsers and servers

- Popular web browsers: Google Chrome, Apple Safari, Microsoft Internet Explorer & Edge, Mozilla Firefox
 - <https://www.w3counter.com/globalstats.php>
- A **web server** receives requests from a web browser and returns the requested resources.
 - Retrieve the resources from file system on server
 - Run a program to generate the resources
- Popular web servers: Microsoft IIS, Apache HTTP server, Nginx
 - <https://news.netcraft.com/>

Web resources in a web page

- A web page actually consists of several kinds of web resources
 - One or more HTML document
 - Some CSS style sheets
 - Some JavaScript programs
 - Images
 - Objects (*e.g. flash going died*)
 - Font
 - ...



Web resources

- A **resource** is anything that is important enough to be referenced as a thing in itself.
- A resource has at least one **URL** as its address. A browser uses the URL to download the resource from a server.
- The web server uses **MIME type** to specify the data type of a representation of a resource.
 - Examples of resources:
 - The front page of SUSTech web site
 - The logo of SUSTech
 - A directory of resources pertaining to “web design” found by Google.
 - A json record returned by Facebook graph API:
<https://graph.facebook.com/cocacola>

Address of web resource

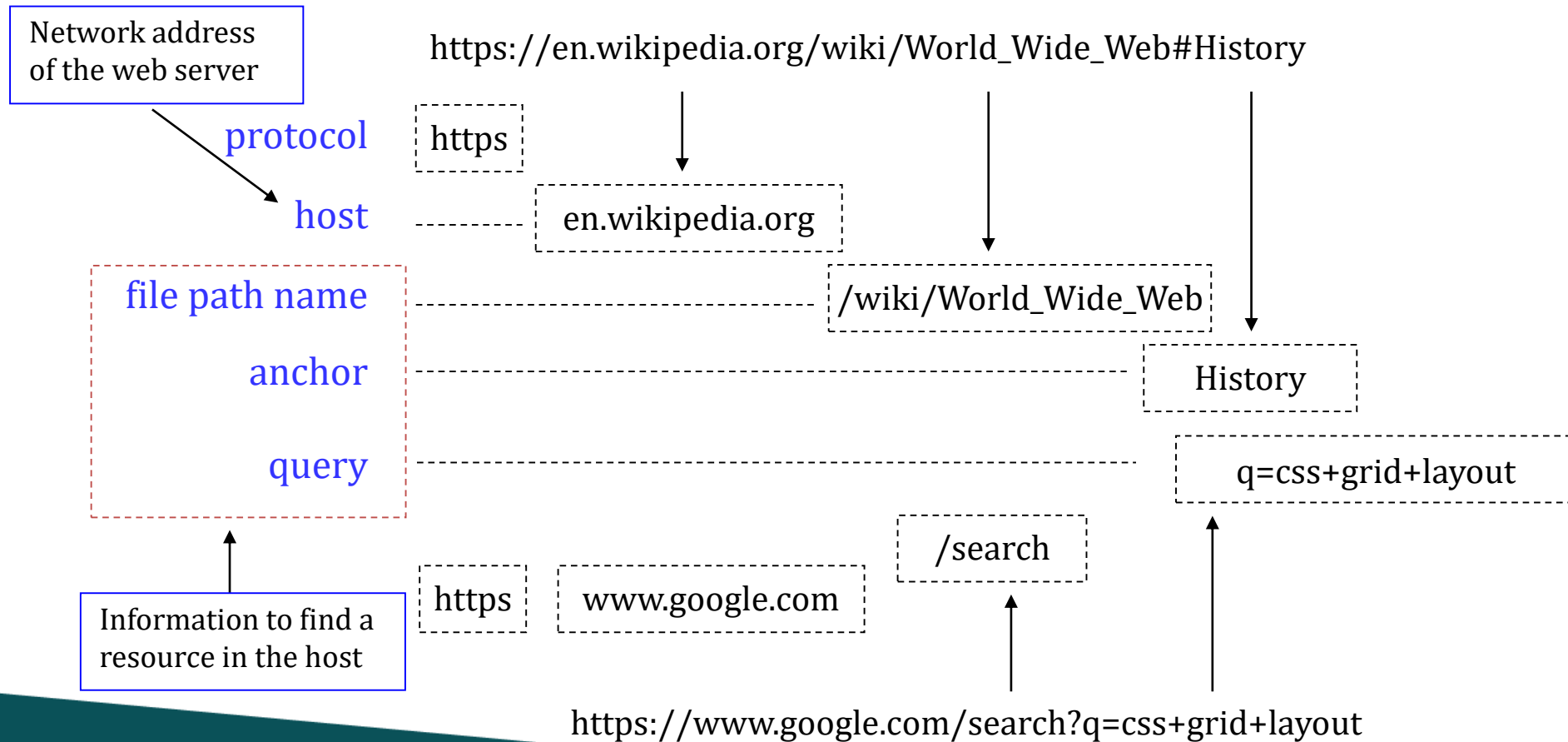
- Each web resource has a **URL** (Universal Resource Locator) as an address. It includes
 - protocol – **how to communicate with the server**
 - address of a web server – **where to find the resource**
 - additional info for the server to find the resource – **which resource in the server**
- Given a URL, a browser has enough info to construct a request to retrieve the resource

Syntax of URL

`protocol://host/filepathname?query#anchor`

- **Protocol** is either 'http' or 'https'
- **Host** is usually a domain name of a web server
- **File path name** identifies a resource in the server
- **Query** is form data submitted to a server-side script. The format is `name1=value1&name2=value2`
- **Anchor** refers to an element with the id in an html or xml file.
- Notice that separator characters in **blue** must be encoded if they are used as ordinary text in URL.

Inside a URL ...



Encode characters in URL

- In general, characters other than letters and numbers should be encoded in URL.
 - Space may be written as '+' or '%20'
 - Other printable character in ASCII should be written in hexadecimal. e.g, 1/2 is encoded as '1%2F2'
 - Non-ascii characters, e.g, Chinese, should be written as UTF-8 in hexadecimal. e.g. 中文 is encoded as '%E4%B8%AD%E6%96%87'

Python urllib

```
C:\Users\Administrator>python
Python 3.8.6rc1 (tags/v3.8.6rc1:08bd63d, Sep 7 2020,
Type "help", "copyright", "credits" or "license" for m
>>> import urllib.parse
>>> urllib.parse.quote('foo=bar')
'foo%3Dbar'
>>> urllib.parse.unquote('foo%3Dbar')
'foo=bar'
>>> obj = { 'name': 'Tonny', 'age': 20 }
>>> urllib.parse.urlencode(obj)
'name=Tonny&age=20'
>>> urllib.parse.parse_qs('name=Tonny&age=20')
{'name': ['Tonny'], 'age': ['20']}
>>>
```

Reference: <https://docs.python.org/3/library/urllib.parse.html>

Data type of web resource

- There are various types of web resources
 - E.g. text, image, audio, video, data
- There are different formats to encode a certain type
 - E.g. an image can be in GIF, JPEG or PNG
 - Some formats are defined by W3C, e.g. HTML, CSS, XML (general data), PNG (bitmap image), SVG (vector graphics)
 - Others are de-facto standards defined by the industry, e.g. GIF, JPEG, SWF (flash movie), JavaScript
- These formats are identified by a standard called **MIME type** (Multipurpose Internet Mail Extensions)
- Most browsers support these formats, and can display them correctly.

Common MIME types


category	MIME type	format
Text	text/html	HTML (.html)
	text/css	CSS (.css)
Images	image/gif	GIF (.gif)
	image/jpeg	JPEG (.jpg)
	image/png	PNG (.png) Portable Network Graphics
	image/svg+xml	SVG (.svg) Scalable Vector Graphics
Audio	audio/mp3, audio/m4a	Mp3 audio, MPEG4 audio
Video	video/mp4, video/m4v	MPEG4 video
Multipurpose	application/xml	General XML
	application/json	JSON data
	application/javascript	JavaScript source (.js)
	application/octet-stream	Arbitrary binary data
	application/x-www-form-urlencoded	HTML form submission


Practice 3.1


- Find the MIME types of all files in the specified directory by python. Files in archive file “CS305_LAB3.zip” on Blackboard are compulsory.
- Tips: analyze the suffix of each file, including files in subfolders.


Lab slides ▾


Build Content ▾ Assessments ▾ Tools ▾


 **lab1_commands for network detection** ▾

 **lab2_wireshark** ▾

Attached Files:  lab2_python_wireshark.pdf ▾ (2.116 MB)

 **lab3_http** ▾

Attached Files:  lab3_http.pdf ▾ (1.579 MB)

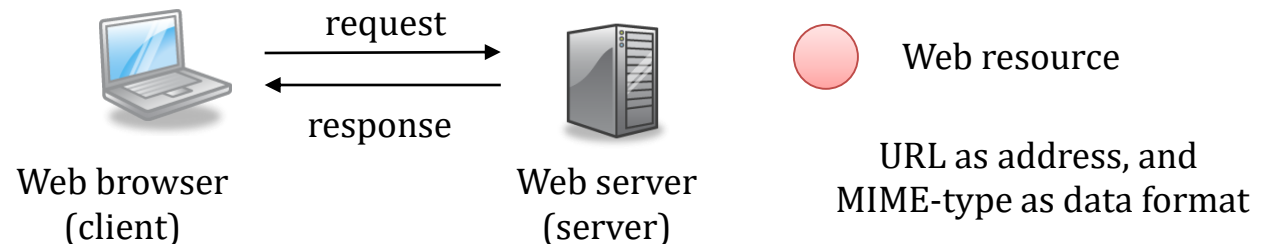
 CS305_LAB3.zip ▾ (3.673 MB)

HTTP operation

- Each HTTP transaction consists of one request and one response.
 - A client sends a request for a resource to the server. Then the server returns a response containing a representation of the resource to the client.
- HTTP/1.0 requires a new TCP connection for each HTTP transaction.
 - the server closes the connection after sending the response.
- HTTP/1.1 can transfer several web resources in a TCP connection.

Basic retrieval

- To retrieve a static file in server
 - A browser sends a request to GET a resource at a URL
 - The server receives the request, maps the URL to a file in its file system, e.g.
`http://example.com/home.html -> c:\inetpub\home.html`
 - The server infers the MIME-type from the file extension, e.g.
`*.html -> text/html, *.gif -> image/gif`
 - The server constructs and returns the response



Example: Basic retrieval

HTTP
request

```
GET /home.html HTTP/1.1
Host: example.com
User-Agent: Mozilla/5.0 ... Chrome/57.0
```



example.com



Simple HTTP retrieval of the page
<http://example.com/home.html>.

Notice how the URL of the resource is specified in the request, and how the data type is stated in the response.

```
HTTP/1.1 200 OK
Date: Fri, 18 Sep 2020 08:00:29 GMT
Server: nginx/1.10.3
Content-Type: text/html; charset=utf-8
```

```
<html>... </html>
```

HTTP response

Basic HTTP request and response

- A basic **request** contains
 - Method GET to retrieve a resource
 - URL (or part of URL) – address of the resource
 - Other headers, e.g. name of user-agent
- A basic **response** contains
 - Status code
 - A representation of the resource
 - its MIME-type and encoding (for text resource) in Content-type header
 - Other headers, e.g. name of server

HTTP message structure(1)

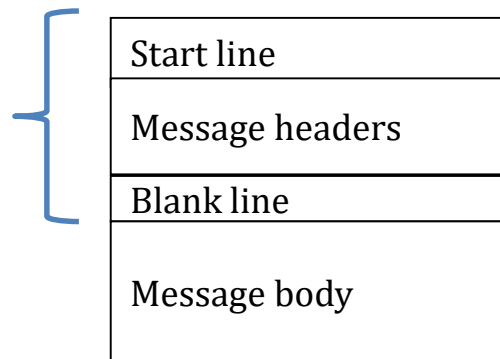
- HTTP requests and responses have similar structure
 - **Start line** – URL requested, any error
 - Headers – additional info
 - **Blank line**
 - Body – representation of the resource
- **Start line** and **blank line** are **required**.
- Headers and body are **optional**.

Start line
Message headers
Blank line
Message body

HTTP message structure(2)

- Start line and headers must be in US-ASCII
 - i.e. Chinese characters must be encoded
- Message body can be text in any encoding or binary data
 - The header **Content-Type** defines the data type
 - The header **Content-Length** defines the size (in bytes)

Each line ends with CR LF (ASCII 13 and 10), and can only contain US-ASCII characters.



The body can be in any encoding or binary data

Request Line

- The request line has three parts:
 - Method name: GET, POST, HEAD, etc
 - (partial) URL of the resource
 - Version of HTTP: HTTP/1.0 or HTTP/1.1

GET /test.html HTTP/1.0

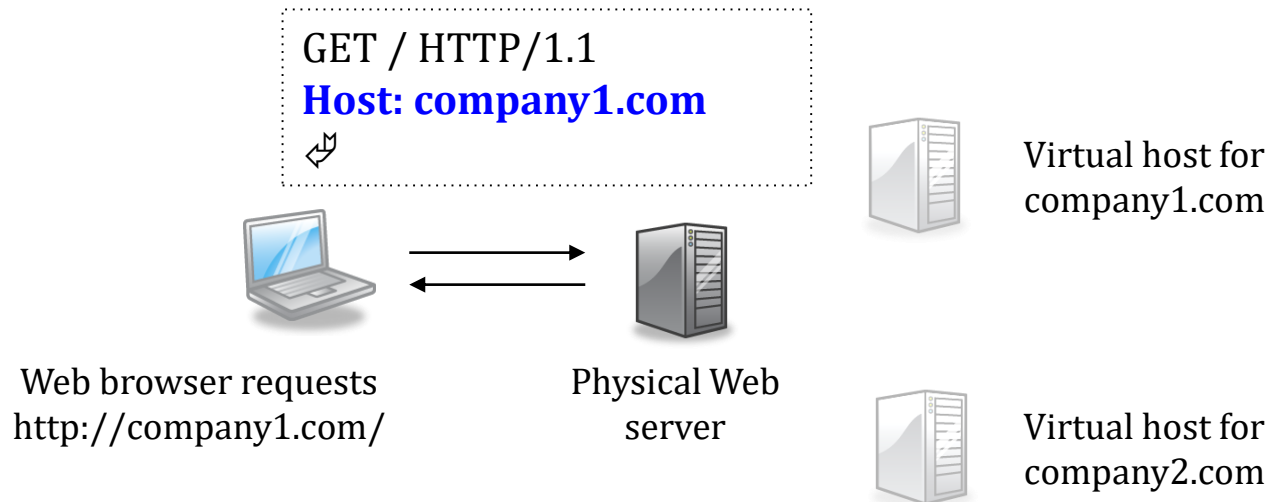
GET http://www.example.com/test.html HTTP/1.0

GET /search?hl=en&q=HTTP+headers&btnG=Google+Search HTTP/1.1

POST /accounts/ServiceLoginAuth?service=mail HTTP/1.1

Host:

- Compulsory header in HTTP/1.1
- Specifies the host of the requested URL
 - Useful for multi-homed web servers. Several web sites (with different host names) may be using the same IP address.



Example: HTTP requests

To retrieve the web page

<http://www.example.com/test.html>

The web browser constructs a HTTP request and sends it to the web server at www.example.com.

```
GET /test.html HTTP/1.1 ↵  
Host: www.example.com ↵  
↵
```

```
GET /test.html HTTP/1.0 ↵  
↵
```

```
GET http://www.example.com/test.html HTTP/1.1 ↵  
Host: www.example.com ↵  
↵
```

Status line

- The status line has three parts:
 - HTTP version
 - Response status code
 - 200 – success
 - 404 – file not found
 - 500 – server error
 - English reason phrase, which describes the status code
- HTTP defines five classes of status code
 - 1xx – informational message
 - 2xx - success of some kind
 - 3xx – redirects the client to another URL
 - 4xx – an error on the client's part
 - 5xx – an error on the server's part

HTTP/1.1 200 OK

HTTP/1.1 404 Not found

Here you go.
Go away.
you screwed up.
I screwed up.

Common codes for success and error

Status code	Meaning
200 OK	The server successfully carried out the action that the client requested. For GET request, the response body contains a representation of the requested resource.
204 No content	The server successfully carried out the action, but declined to return any representation. In Ajax, this usually means the browser should not refresh the user interface.
400 Bad request	Generic client-side error. Probably a request format error.
404 Not found	The server cannot find the resource at the requested URL.
500 Internal server error	Generic server-side error. Probably a server-side program run-time error.
503 Service unavailable	The web server is not available, probably because of overloading or maintenance.

Example: HTTP responses

After receiving the request for

<http://www.example.com/test.html>

The web server will return a response containing the page, or an error message if it cannot find the page.

```
HTTP/1.1 200 OK ↵
```

```
Content-Type: text/html ↵
```

```
Content-Length: 2300 ↵
```

```
↵
```

```
<html>... content of test.html ...</html>
```

```
HTTP/1.1 404 Not found ↵
```

```
Content-Type: text/html ↵
```

```
Content-Length: 1024 ↵
```

```
↵
```

```
<html>... error message ...</html>
```

Content-Type:

- Indicates the data type (MIME) and character encoding of the message body in requests and responses
 - Omitted if empty body
 - **Content-Type: application/octet-stream** if server cannot decide

HTTP request to login mail.com

POST /accounts/auth?service=mail HTTP/1.1

Host: www.mail.com

Content-Type: application/x-www-form-urlencoded

Content-Length: 194

...&email=username&passwd=password&...

Notice how character encoding is specified.

HTTP response

HTTP/1.1 200 OK

Content-Type: text/html; charset=UTF-8

Content-Length: 12800

<html>...</html>

Content-Length:

- Indicates the size (in bytes) of the message body in requests and responses
 - Content-length header is sent before the message body
 - Difficult to determine message size if the response is generated dynamically by a program
 - A solution: chunked-transfer encoding (to be discussed)

HTTP request to login mail.com

POST /accounts/auth?service=mail HTTP/1.1

Host: www.mail.com

Content-Type: application/x-www-form-urlencoded

Content-Length: 194

...&email=username&passwd=password&...

HTTP response

HTTP/1.1 200 OK

Content-Type: text/html; charset=UTF-8

Content-Length: 12800

<html>...</html>

User-Agent: & Server:

- Indicate which web browser generates the request and which web server generates the response
 - May be used for collecting statistics about web browser market share
 - A server may generate browser specific response

```
GET /test.html HTTP/1.1  
Host: httpbin.org  
User-Agent: Mozilla 5.0 (Windows)  
...
```

request

Browser and server names in actual use are much longer.

```
HTTP/1.1 200 Ok  
Server: nginx/1.10  
...
```

response

Common headers

Header	Request	Response
Host:	Domain name of requested URL	
User-agent:	Which web browser?	
Server:		Which web server?
Referer:	From which web page does the browser obtain this URL?	
Content-type:	Type of content in the body	
Content-length:	Length of the body in bytes	

Methods in HTTP/1.0

- HTTP methods are operations on resources
- HTTP/1.0 supports three methods
 - GET – to retrieve a representation of a resource
 - HEAD – to retrieve only the metadata of a resource
 - POST – to submit some data to a resource (program) in web server for processing

GET method

- **GET** retrieves a representation of a resource
 - Usually empty body in request message
 - Browsers mainly use this method to retrieve web resources
 - Usually a read-only operation

```
GET /a.txt HTTP/1.1  
Host: example.com
```

request

```
HTTP/1.1 200 OK  
Content-Type: text/plain  
Content-Length: 5
```

Hello

response

HEAD method

- **HEAD** is similar to **GET**, but the response only contains headers and an empty body
- Useful to check the characteristics of a resource without retrieving it, e.g.
 - What is its size?
 - Is the resource still available?

```
HEAD/a.txt HTTP/1.1  
Host: example.com
```

request

```
HTTP/1.1 200 OK  
Content-Type: text/plain  
Content-Length: 5
```

response

POST method

- **POST** submits some data to a resource for processing
 - The resource is usually a server-side program
 - The data are usually encoded in the body of the POST request
 - Usually invokes some server-side action

```
POST /accounts/auth?service=mail HTTP/1.1
Host: www.mail.com
Content-Type: application/x-www-form-urlencoded
Content-Length: 194

...&email=username&passwd=password&...
```

HTTP request to login mail.com

Observation

- The **GET** request in form submission can be ...
 - saved in bookmark
 - saved in browser history (possible security problem!)
 - used in a hyperlink . When users click the link, the browser sends the same GET request as in submitting the HTML form.

```
GET /login.php?user=philip&passwd=12345 HTTP/1.1  
Host: example.com
```

Request for

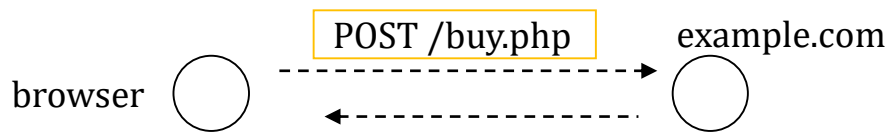
<http://example.com/login.php?user=philip&passwd=12345>

Side-effect

- **GET** and **HEAD** have no side-effect
 - read-only operations in web servers
 - A browser may repeat sending these requests without user confirmation
 - May repeat a **GET** request in case of network error
- **POST** may have side-effect
 - May cause some actions in the server (e.g. adding a record, sending an email, placing an order)
 - A browser must confirm with users before resending such requests

Example: resubmit a POST request

- In this example, a purchase request is sent as a POST (because it has side-effect).
- The server returns the transaction result in the response
- If the user refreshes the result page, the browser would need to send the POST request twice.
 - What would happen?



```
HTTP/1.1 200 Ok
Content-Type: text/html
Content-Length: 5000
```

```
<html>...
Thanks for your
purchase! ...</html>
```

```
POST /buy.php HTTP/1.1
Host: example.com
Content-Type: application/x-www-form-urlencoded
Content-Length: 194

...&productID=554433&quantity=1&...
```

Confirmation when resubmitting request

- Because GET causes no action in the server, it should make no difference to repeat or skip a GET request
 - The browser may resubmit a GET request
- POST may have side-effect. If the browser resubmits a POST request, the server may perform some action twice.
 - The browser must confirm with users before resubmitting a POST request
 - *Users may be confused by the resend warning ... Solution: Post/Redirect/Get pattern*

Comparison: GET and POST

	GET	POST
Typical usage	Read-only query like Google search, Google Charts	Request that triggers action on server side. E.g. place an order, login, save a file
Side-effect?	Read-only operations in servers. Browsers can resubmit requests without confirmation	May cause write operations in servers. Browsers must confirm with users.
Form data in URL?	Yes. The query URL can be saved in bookmark and hyperlinks.	No
Support file upload	No	Yes

cURL: Utility for URL

- cURL is a computer software project providing a library and command-line tool for transferring data using various protocols.

Download: <https://curl.haxx.se/download.html>

- Example:

```
$ curl http://httpbin.org/headers
```

```
{  
  "headers": {  
    "Accept": "*/*",  
    "Host": "httpbin.org",  
    "User-Agent": "curl/7.55.1"  
    "X-Amzn-Trace-Id": "Root=1-5f646cba-4f1892177757747d3883a5ed"  
  }  
}
```


cURL: Inspect HTTP transaction

```
$ curl http://httpbin.org/headers --HEAD -v
```

```
> HEAD /headers HTTP/1.1
```

```
> Host: httpbin.org
```

```
> User-Agent: curl/7.55.1
```

```
> Accept: */*
```

```
...
```

```
< HTTP/1.1 200 OK
```

```
< Date: Mon, 27 Feb 2023 03:12:42 GMT
```

```
< Content-Type: application/json
```

```
< Content-Length: 173
```

```
< Connection: keep-alive
```

```
< Server: gunicorn/19.9.0
```

```
< Access-Control-Allow-Origin: *
```

```
< Access-Control-Allow-Credentials: true
```

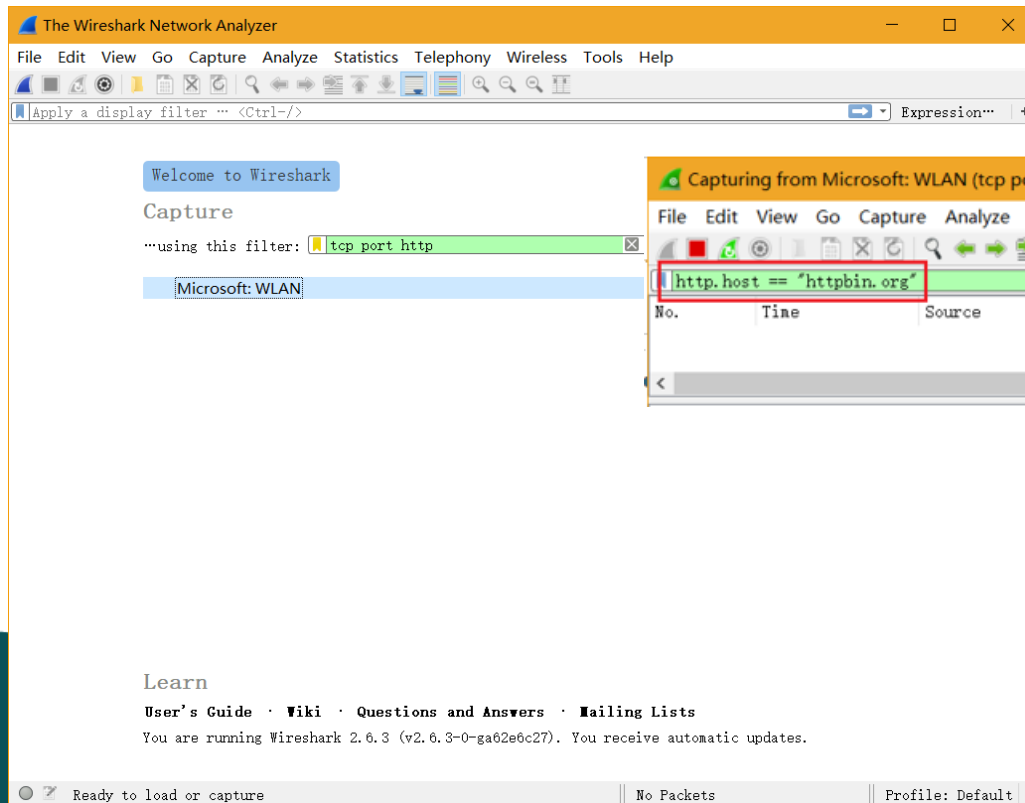
cURL: Inspect GET request

```
$ curl http://httpbin.org/get
{
  "args": {},
  "headers": {
    "Accept": "*/*",
    "Host": "httpbin.org",
    "User-Agent": "curl/7.55.1",
    "X-Amzn-Trace-Id": "Root=1-63fc202d-
5a3e36e573d3f24e0238ade8"
  },
  "origin": "116.7.234.233",
  "url": "http://httpbin.org/get"
}
```

```
$ curl http://httpbin.org/get?date=2021-09-18
{
  "args": {
    "date": "2023-02-27"
  },
  "headers": {
    "Accept": "*/*",
    "Host": "httpbin.org",
    "User-Agent": "curl/7.55.1",
    "X-Amzn-Trace-Id": "Root=1-63fc204f-
70b3d13907e9de546eaa6219"
  },
  "origin": "116.7.234.233",
  "url": "http://httpbin.org/get?date=2023-02-27"
}
```

Wireshark: Capture HTTP Request

- Wireshark is a free and open source packet analyzer. It is used for network troubleshooting, analysis, software and communications protocol development, and education.



Tips: When using `http.host == "***"` as a display filter, only HTTP request packet will be showed, as here "host" represents a specified field, instead of a network endpoint.

http.host == "httpbin.org"						
No.	Time	Source	Destination	Protocol	Length	Info
76	0.006232	10.25.2.205	34.205.150.168	HTTP	132	GET /get HTTP/1.1
> Frame 76: 132 bytes on wire (1056 bits), 132 bytes captured (1056 bits) on interface \Device\NPF_{AC26F8F2-1569-40C4-BFA1-7D37028C3CA4}, id 0 > Ethernet II, Src: IntelCor_ee:81:49 (04:ed:33:ee:81:49), Dst: JuniperN_d0:93:c1 (3c:8c:93:d0:93:c1) > Internet Protocol Version 4, Src: 10.25.2.205, Dst: 34.205.150.168 > Transmission Control Protocol, Src Port: 5656, Dst Port: 80, Seq: 1, Ack: 1, Len: 78 > Hypertext Transfer Protocol > GET /get HTTP/1.1\r\n Host: httpbin.org\r\n User-Agent: curl/7.55.1\r\n Accept: */*\r\n \r\n						

http.host == "httpbin.org"						
No.	Time	Source	Destination	Protocol	Length	Info
195	0.000252	10.25.2.205	34.205.150.168	HTTP	148	GET /get?date=2023-02-27 HTTP/1.1
> Frame 195: 148 bytes on wire (1184 bits), 148 bytes captured (1184 bits) on interface \Device\NPF_{AC26F8F2-1569-40C4-BFA1-7D37028C3CA4}, id 0 > Ethernet II, Src: IntelCor_ee:81:49 (04:ed:33:ee:81:49), Dst: JuniperN_d0:93:c1 (3c:8c:93:d0:93:c1) > Internet Protocol Version 4, Src: 10.25.2.205, Dst: 34.205.150.168 > Transmission Control Protocol, Src Port: 5662, Dst Port: 80, Seq: 1, Ack: 1, Len: 94 > Hypertext Transfer Protocol > GET /get?date=2023-02-27 HTTP/1.1\r\n Host: httpbin.org\r\n User-Agent: curl/7.55.1\r\n Accept: */*\r\n \r\n [Full request URI: http://httpbin.org/get?date=2023-02-27] [HTTP request 1/1] [Response in frame: 200] [Community ID: 1:j8zr0LC+7vtIMgUI0Cx3Gkwe2Y=] > TRANSUM RTE Data						

cURL: Inspect POST request

```
$ curl -d "username=foo&password=bar" -X POST http://httpbin.org/post
```

```
{  
  "args": {},  
  "data": "",  
  "files": {},  
  "form": {  
    "password": "bar",  
    "username": "foo"  
  },  
  "headers": {  
    ...  
  }  
}
```

http.host == "httpbin.org"					
No.	Time	Source	Destination	Protocol	
43	0.000162	10.25.2.205	52.200.117.68	HTTP	
<					
v Hypertext Transfer Protocol					
> POST /post HTTP/1.1\r\n					
Host: httpbin.org\r\n					
User-Agent: curl/7.55.1\r\n					
Accept: */*\r\n					
> Content-Length: 25\r\n					
Content-Type: application/x-www-form-urlencoded\r\n					
\r\n					
[Full request URI: http://httpbin.org/post]					
[HTTP request 1/1]					
[Response in frame: 47]					
File Data: 25 bytes					
v HTML Form URL Encoded: application/x-www-form-urlencoded					
> Form item: "username" = "foo"					
> Form item: "password" = "bar"					
<					
00a8	01110000	01101100	01101001	01100011	01100001 01110100 01101001 01101111
00b0	01101110	00101111	01111000	00101101	01110111 01110111 01110111 00101101
00b8	01100110	01101111	01110010	01101101	00101101 01110101 01110010 01101100
00c0	01100101	01101110	01100011	01101111	01100100 01100101 01100100 00001101
00c8	00001010	00001101	00001010	01110101	01110011 01100101 01110010 01101110
00d0	01100001	01101101	01100101	00111101	01100110 01101111 01101111 00100110
00d8	01110000	01100001	01110011	01110011	01110111 01101111 01110010 01100100
00e0	00111101	01100010	01100001	01110010	

*Microsoft: WLAN (tcp port http)

File Edit View Go Capture Analyze Statistics Telephony Wireless Tools Help

http.host == "httpbin.org" Expression...

No.	Time	Source	Destination	Protocol	Length	Info
70	2158.704716	10.20.39.170	52.22.213.157	HTTP	148	GET /get?date=2018-09-
81	2366.245687	10.20.39.170	52.5.182.176	HTTP	230	POST /post HTTP/1.1 (
91	2392.349646	10.20.39.170	52.5.182.176	HTTP	228	POST /nost HTTP/1.1 (

User-Agent: curl/7.61.0\r\n
 Accept: */*\r\n
 > Content-Length: 25\r\n
 Content-Type: application/x-www-form-urlencoded\r\n
 \r\n
[\[Full request URI: http://httpbin.org/post\]](http://httpbin.org/post)
 [HTTP request 1/1]
[\[Response in frame: 93\]](#)
 File Data: 25 bytes

HTML Form URL Encoded: application/x-www-form-urlencoded

- > Form item: "username" = "foo"
- > Form item: "password" = "bar"

0000	2c 21 31 aa 6d c2 18 4f 32 f4 10 8f 08 00 45 00	,!1.m..0 2.....E.
0010	00 d6 5d 01 40 00 80 06 80 ad 0a 14 27 aa 34 05	..].@... ..'.4.
0020	b6 b0 12 99 00 50 32 c8 9a 8f 82 9a f4 2a 50 18P2.*p.
0030	01 00 8a 2e 00 00 50 4f 53 54 20 2f 70 6f 73 74PO ST /post
0040	20 48 54 54 50 2f 31 2e 31 0d 0a 48 6f 73 74 3a	HTTP/1. 1..Host:
0050	20 68 74 74 70 62 69 6e 2e 6f 72 67 0d 0a 55 73	httpbin .org..Us
0060	65 72 2d 41 67 65 6e 74 3a 20 63 75 72 6c 2f 37	er-Agent : curl/7
0070	2e 36 31 2e 30 0d 0a 41 63 63 65 70 74 3a 20 2a	.61.0..A ccept: *
0080	2f 2a 0d 0a 43 6f 6e 74 65 6e 74 2d 4c 65 6e 67	/*..Cont ent-Leng

wireshark_EFA9B5F3-A6FF-4A35-82...F1_20180914113509_a06784.pcapng Packets: 96 · Displayed: 6 (6.3%) Profile: Default

Practice 3.2

- Try to using following URLs to invoke several http sessions:

– http://www.sustech.edu.cn	80 301
– https://www.sustech.edu.cn	443 200
– http://sustech.edu.cn	80 301
– https://sustech.edu.cn	443 200
– http://sina.com.cn	80 301
– http://www.sina.com.cn	80 302
– https://www.sina.com.cn	443 200

Use curl or Wireshark to find:

- 1) the status code of the http responses, and explain the meanings.
- 2) the port number of the server.