

# 371 Mini Project 1

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## Step one: Determine Requirements

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### 200 OK:

**Description:** The request was successful, and the server returned the requested resource. The request must be valid, well-formed, and target a file that exists on the server.

**Method:** GET

**Test:** Use a valid GET request with an existing HTML to trigger the response.

**Request Message:**

```
1 GET /test.html HTTP/1.1
2 Host: localhost
```

### 304 Not Modified:

**Description:** The requested resource has not been modified since the date specified in the If-Modified-Since header. The request must include an If-Modified-Since header with a timestamp. The server checks the last modified time of the requested resource. If it hasn't been modified since that time, it returns 304 Not Modified.

**Method:** GET

**Test:** Use a GET request with the If-Modified-Since header and specify a time after the file's last modification.

**Request Message:**

```
1 GET /test.html HTTP/1.1
2
3 Host: localhost
4
5 If-Modified-Since: Wed, 16 Oct 2024 07:28:00 GMT
```

## 400 Bad Request

**Description:** The server cannot understand the request due to malformed syntax. The request must be improperly formatted, missing required components, or contain invalid syntax. This could happen if the request line or headers are incorrect.

**Method:** Any HTTP method can result in a 400 error if the syntax is invalid.

**Test:** Use an invalid or incomplete HTTP request to trigger a 400 Bad Request.

**Request Message:**

```
1 GET /test.html HTTP/1.1
2
3 Host localhost
```

## 404 Not Found

**Description:** The server could not find the requested resource. The request must target a resource that does not exist on the server.

**Method:** GET

**Test:** Use a valid GET request for a non-existent file.

**Request Message:**

```
1 GET /test404.html HTTP/1.1
2 Host: localhost
```

## 501 Not Implemented

**Description:** The server does not support the functionality required to fulfill the request.

The request must use an HTTP method that the server does not support (for example, POST, PUT, DELETE, etc.).

**Test:** Use an unsupported HTTP method such as POST to trigger the 501 Not Implemented response.

**Request Message:**

```
1 POST /test.html HTTP/1.1
2 Host: localhost
```

## Step 2

### 200 Response:

```
ethan@ethan-MS-7A70:~/Desktop/Note/371MP$ curl -i http://127.0.0.1:8080/test.html
HTTP/1.1 200 OK
Content-Type: text/html
Last-Modified: Thu, 17 Oct 2024 03:18:06 GMT
Content-Length: 165

<html>
  <head><title>Test File</title></head>
  <body>
    <h1>Hello, World!!!</h1>
    <p>This is a test HTML file served by the web server.</p>
  </body>
</html>
```

### 304 Response:

```
ethan@ethan-MS-7A70:~/Desktop/Note/371MP$ curl -i -H "If-Modified-Since: Wed, 16 Oct 2024 23:28:00 GMT" http://localhost:8080/test.html
HTTP/1.1 200 OK
Content-Type: text/html
Last-Modified: Thu, 17 Oct 2024 03:18:06 GMT
Content-Length: 165

<html>
  <head><title>Test File</title></head>
  <body>
    <h1>Hello, World!!!</h1>
    <p>This is a test HTML file served by the web server.</p>
  </body>
</html>
ethan@ethan-MS-7A70:~/Desktop/Note/371MP$ curl -i -H "If-Modified-Since: Thu, 17 Oct 2024 23:28:00 GMT" http://localhost:8080/test.html
HTTP/1.1 304 Not Modified
```

### 400 Response:

```
ethan@ethan-MS-7A70:~/Desktop/Note/371MP$ telnet 127.0.0.1 8080
Trying 127.0.0.1...
Connected to 127.0.0.1.
Escape character is '^]'.
GET /test.html HTTP/1.1 Host:
HTTP/1.1 400 Bad Request

Connection closed by foreign host.
```

## 404 Response:

```
ethan@ethan-MS-7A70:~/Desktop/Note/371MP$ curl -i http://127.0.0.1:8080/test404.html
HTTP/1.1 404 Not Found
```

## 501 Response:

```
ethan@ethan-MS-7A70:~/Desktop/Note/371MP$ curl -i -X POST http://localhost:8080/test.html
HTTP/1.1 501 Not Implemented
```

## Step 3

A web server directly serves its own files or resources to a client, while a proxy server acts as an intermediary between the client and another server. It relays the client's request to the target server and returns the response.

## Detailed Specifications

- Listening for Client Requests
- Parsing the Request
- Forwarding Requests
- Handling HTTPS Requests (`https` via CONNECT)
- Error Handling
- Connection Lifecycle and Concurrency
  - Implement a timeout mechanism and a decision mechanism that allows the application to either wait for a response or close the connection.
  - Handle multiple client connections

## Test Procedure

- Visit http with `GET`:
  - `curl -x localhost:8081 http://127.0.0.1:3000/test.html`
  - Receive the html file

```
~/Desktop/CMPT 371/MP/371MP > main | 71 | curl -x localhost:8081 http://127.0.0.1:3000/test.html
<!DOCTYPE html>
<html>
  <head>
    <title>File not found</title>
  </head>
  <body>
    <h1>File not found</h1>
    <p>The file <b>"/Users/davidqian/Desktop/CMPT 371/MP/371MP/127.0.0.1:3000/test.html"</b> cannot be found. It may have been moved, edited, or deleted.</p>
    <script type="text/javascript" src="/__vscode_livepreview_injected_script"></script>
  </body>
</html>
```

- Visit https with `CONNECT`:
  - `curl -x localhost:8081 https://www.google.com`
  - Receive the html file

```

$ curl -x localhost:8081 https://www.google.com
<!doctype html><html itemscope="" itemtype="http://schema.org/WebPage" lang="en-CA"><head><meta content="text/html; charset=UTF-8" http-equiv="Content-Type"><meta content="/images/branding/googleg/1x/googleg_standard_color_128dp.png" itemprop="image"><title>Google</title><script nonce="MF2Rg_rsaNnkTI_eOp6_rw">(function(){var _g=(key: 'SV8RZ777B5Xw0PEPzaSbGAc', keyPI: '0,793108,2907233,1043,541533,2891,89155,18161,162437,23024,6699,106647,3997,12871,799,10161,23350,8702,13734,9779,62658,76208,15816,1804,7734,28495,10853,1635,29276,27083,5212675,997,26,8832510,1233,43,4,2797,9753,1007,15665,43887,3,1603,3,2124363,23029351,6889,1294,4636,11730,4706,84045,11643,7,10973,15164,8161,17877,31553,21674,6750,155,2,2482,18716,2530,7033,2186,761,3838,328,3217,4,1238,1766,10,608,9993,4863,2526,5633,687,6592,700,3522,8521,6976,3544,1136,210,13648,54,2213,2,9,3095,10213,2379,2465,3295,4455,1930,1382,1985,12568,50,747,377,8300,1,6398,1796,7114,3066,112,375,4984,2945,8897,1589,256,597,1881,913,402,1257,6569,2829,5,1062,2,2,3,273,2,788,388,41,1938,2,3,3605,55,435,2485,3367,1159,200,398,1,1753,884,615,11,856,239,525,3226,1,29,1348,1023,336,304,261,3,1,199,98,3,396,49,1,22,5,50,813,956,269,141,1371,4,1,6,1075,601,453,1635,1530,21,130,159,1297,139,192,1651,1,6,261,870,2202,472,242,46,718,640,4,1866,285,15,3,1502,68,1179,154,528,42,47,339,872,882,285,192,23,872,3,7,149,27,623,182,258,388,54,7,5,2,25,261,29,2,4,6,985,62,69,866,59,2522,5,387,694,116,157,390,140,5,34,114,184,109,273,10,118,264,663,1657,59,2,197,1288,3,541,50,1141,60,84,522,1,65,374,137,42,386,166,174,29,172,102,109,42,7,1,747,1,8,1,1,4,1,4,60,486,2348,837,4,390,178,1798,2130,21419626,3,15901,3,16993,21,219,239,2323,704,866,362,708,598,7589080', kBL: '71e8', kOPI: 89973449));(function(){var a;((a=window.google)==null?a:stvc)?google.kEI=g.kEI:window.google.g;}.call(this));(function(){(function(){(google.sn='webhp';google.kHL='en-CA');})();(function(){var h=this;self;function l(){return window.google!==(void 0&&window.google.kOPI==void 0&&window.google.kOPI==0?window.google.kOPI:null);var m_n=[];function p(a){for(var b;a&&(a.getAttribute('eid')));}a=a.parentNode;return b}m_n=function q(a){for(var b=null;a&&(a.getAttribute('eid')));}a=a.parentNode;return b}function r(a){if('http://i.test(a)&&window.location.protocol=='https:'&&(google.ml&&google.ml(Error("a"),1,{src:a,gLmm:1})),a="");return a}function t(a,b,c,d,k){var e="";b.search("&ei=")===-1&&(e="&ei="+p(d),b.search("&ei=")===-1&&(d=q(d))&&(e="&ei="+d));d="";var g=b.search("&csid=")===-1&&a!="s"l"l",f=[];f.push("fz",Date.now(),tostring(l));h._csid&&g&&f.push(["csid",h._csid]);c=c();c!=""&&f.push(["opi",c.toString()]);for(c=0;c<f.length;c++){if(c==0){c=0?d="&";d=f[c][0]+""+f[c][1]}return"/"+k["gen_204"]}}"&type="&type"&"&String(a)+"&csid="&(b=a&&d))&google.kEI=google.getEI=google.getEI=google.ml=function l(){return null};google.log=function(a,b,c,d,k,e){e===""&&void 0?lxc(l){c=(a,b,e,d,k);if(c=(c){a=new Image;var g=length;n[g]=a.onerror=a.onload=a.onabort=function l(){delete n[g];a.src=""};google.logUrl=function(a,b){b=""&&void 0?l;b="return t('"+a,b)");}.call(this);(function l){google.y=(f;google.y=1;var d;(d=google).x)||((d.x=function(a,b){if(a)var c=a.id;else do c=Math.random();while(google.y(c))google.y(c)=[a,b];return l});var e;(e=google).sx||(e.sx=function(a){google.y.push(a));google.lm=1;var f;(f=google).plm||(f.plm=function(a){google.lm.push.apply(google.lm,a)});google.lq=[];var g;(g=google).load||(g.load=function(a,b,c){google.lq.push([a,b,c]);});var h;(h=google).loadAll||(h.loadAll=function(a,b){google.lq.push([a,b]);});google.bx=1;var k;(k=google).lx||(k.lx=function l){};var l=1,m;(m=google).fcl||(m.fcl=function(a,b,c,n){l.p

```

- See more information:
  - `curl -i -x localhost:8081 http://127.0.0.1:3000/test.html`
  - It is worth to say that the first `200 ok` comes from proxy server and the second `200 ok` comes from target server. Both of them is necessary.

```

$ curl -i -x localhost:8081 http://127.0.0.1:3000/test.html
HTTP/1.1 200 Connection Established

HTTP/2 200
date: Thu, 17 Oct 2024 19:09:54 GMT
expires: -1
cache-control: private, max-age=0
content-type: text/html; charset=ISO-8859-1
content-security-policy-report-only: object-src 'none';base-uri 'self';script-src 'nonce-ifCh8b0dq7NH_qzLRR502A' 'strict-dynamic' 'report-sample' 'unsafe-eval' 'unsafe-inline' http;report-uri https://csp.withgoogle.com/csp/gws/other-hp
accept-ch: Sec-CH-Prefers-Color-Scheme
p3p: CP="This is not a P3P policy! See g.co/p3phelp for more info."
server: gws
x-xxss-protection: 0
x-frame-options: SAMEORIGIN
set-cookie: AEC=AVVb7cnBZjDDISKewQvo3ytpCwy6E00DFby7fz8mu2wWnbP4odIZF5rMc; expires=Tue, 15-Apr-2025 19:09:54 GMT; path=/; domain=.google.com; Secure; HttpOnly; SameSite=Lax
set-cookie: NID=518=FT4qVYSbU0KTYliwPhY83lwjqvKsAs1EoQwFzNV2f_teyLR4i8t5T07r4W50PDPzm9fGEM5zyp-zRTGteHvK45ryb0qUpDxRhZ4V8MzUgAWZPw0IhBs7XtQwAAViq6FvEPJ9ph1XA6bup-1-DzD_h01wiQ7N4mESM42da7hDzAdFRt-51Wv9Ayw4qR0g; expires=Fri, 18-Apr-2025 19:09:54 GMT; path=/; domain=.google.com; HttpOnly
alt-svc: h3="443"; ma=2592000,h3-29="443"; ma=2592000
accept-ranges: none
vary: Accept-Encoding

<!doctype html><html itemscope="" itemtype="http://schema.org/WebPage" lang="en-CA"><head><meta content="text/html; charset=UTF-8" http-equiv="Content-Type"><meta content="/images/branding/googleg/1x/googleg_standard_color_128dp.png" itemprop="image"><title>Google</title><script nonce="ifCh8b0dq7NH_qzLRR502A">(function(){var _g=(key: 'AmERZ7u4L0D08PEP3N0e6AI', keyPI: '0,3700289,150,5,0,435,538661,2872,2891,43028,30022,16105,18161,162437,23024,6699,96770,9877,17667,2006,8155,23351,8702,13733,9779,62657,76209,15816,1804,7734,18673,8862,960,10853,342,1290,13496,15783,27083,5,09427,3249,1020,8832512,1208,9,9,52,2,7439815,19357858,1182080,16672,43887,3,1603,3,2124363,23029351,8163,4636,16436,84045,11725,10897,15165,8181,17876,31554,13737,382,7549,6756,2639,13504,26,7472,9140,4599,328,3217,4,1230,1766,6760,13841,4063,2526,5633,688,10813,5452,13589,1136,205,13651,56,353,1060,2,9,6800,1,2,5184,1341,2379,2465,3295,7767,1988,6396,5,6164,49,748,3026,1076,3,1,6,4571,1,3024,2,3070,2,4,291,1793,7112,3180,375,4550,2,3369,4611,251,488,164,22,1805,687,2,223,63,3,2,2,331,2096,2455,5222,883,5,1062,2,2,3,273,2,1176,441,1930,2,3,1354,2,2252,486,2486,3366,11,0,121,77,400,1,1754,865,642,1097,3108,4,380,256,1,31,1347,150,105,1106,88,477,3,1,199,989,395,46,1,80,814,1224,138,1289,4,1,6,1693,320,1827,271,1250,152,158,1297,748,906,1111,354,2677,69,218,4,439,234,600,40,4,925,1241,3,1188,5,285,93,638,73,467,154,570,46,340,862,5,887,285,192,23,17,227,5,623,3,7,149,27,623,110,214,116,388,54,6,6,2,25,74,186,28,4,4,6,115,4,131,8,647,62,62,7,863,

```

## Multi-thread

- Pro:
  - Thread Creation for Each Client
  - Requesting simultaneously
- Improvement:
  - Increased Throughput
  - Multiple clients
  - Reduced Latency
- Test Procedure
  - Using `ab` (Apache Benchmark)

- `ab -n 100 -c 5 http://localhost:8080/test.html`

- Result:

```

$ ab -n 100 -c 5 http://localhost:8080/test.html

This is ApacheBench, Version 2.3 <$Revision: 1913912 $>
Copyright 1996 Adam Twiss, Zeus Technology Ltd, http://www.zeustech.net/
Licensed to The Apache Software Foundation, http://www.apache.org/

Benchmarking localhost (be patient).....done

Server Software:        localhost
Server Hostname:        localhost
Server Port:            8080
Document Path:          /test.html
Document Length:        165 bytes

Concurrency Level:      5
Time taken for tests:    0.026 seconds
Complete requests:      100
Failed requests:         0
Total transferred:      27600 bytes
HTML transferred:       16500 bytes
Requests per second:    3835.53 [#/sec] (mean)
Time per request:       1.304 [ms] (mean)
Time per request:       0.261 [ms] (mean, across all concurrent requests)
Transfer rate:          1033.80 [Kbytes/sec] received

Connection Times (ms)
  min  mean[+/-sd] median   max
Connect:    0    0  0.0      0    0
Processing:  1    1  0.3      1    2
Waiting:     1    1  0.3      1    2
Total:       1    1  0.3      1    2

Percentage of the requests served within a certain time (ms)
 50%    1
 66%    1
 75%    1
 80%    1
 90%    2
 95%    2
 98%    2

```

## Part 4

We've made changes to our web server to send data in chunks instead of in a single request to avoid the HOL problem using frames.

- We set `chunk_size` as 512 and add `Transfer-Encoding: chunked` into our `response_headers`

```

if is_chunk == True:
    response_headers = (
        f"HTTP/1.1 200 OK\r\n"
        f"Content-Type: text/html\r\n"
        f"Last-Modified: {last_modified_str}\r\n"
        f"Content-Length: {len(body)}\r\n"
        f"Transfer-Encoding: chunked\r\n\r\n"
    )
    client_socket.sendall(response_headers.encode())

    with open(path, 'rb') as file:
        while chunk := file.read(512):
            client_socket.sendall(f"{len(chunk):X}\r\n".encode())
            print(f"Message is sent chunk size is {len(chunk)}")
            client_socket.sendall(chunk)
            client_socket.sendall(b"\r\n")

    client_socket.sendall(b"0\r\n\r\n")
    print("\n\n")
else:
    response = f"HTTP/1.1 200 OK\r\nContent-Type: text/html\r\nLast-Modified: {last_modified_str}\r\nContent-Length: {len(body)}\r\n\r\n{body}"
    client_socket.sendall(response.encode())

```

- The decision to implement this feature on the web server side is due to the server's role in sending data.
- We also offer a flag `is_chunk` to control whether the server enables this feature.

```
1  if __name__ == "__main__":
2      is_chunk = False # enable feature by turning this flag to True
3      server_process = multiprocessing.Process(target=start_server, args=('localhost', 8080,
is_chunk))
4      proxy_process = multiprocessing.Process(target=start_proxy_server, args=('localhost',
8081))
5      server_process.start()
6      proxy_process.start()
7      server_process.join()
8      proxy_process.join()
```