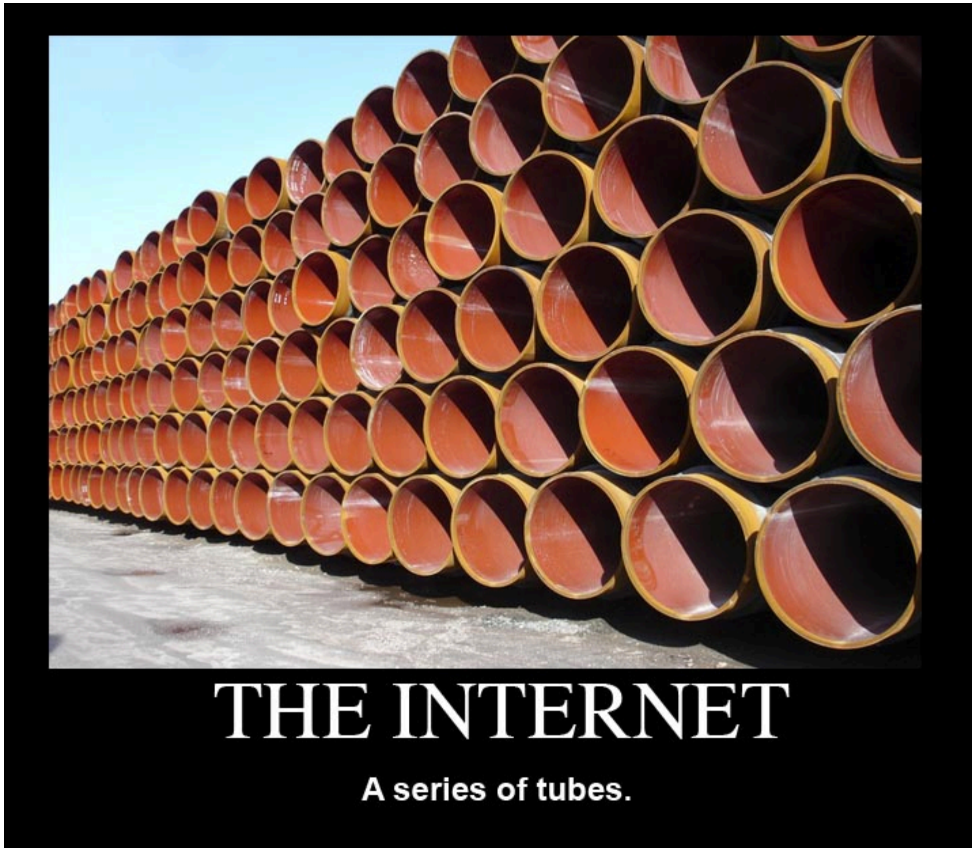
Networking

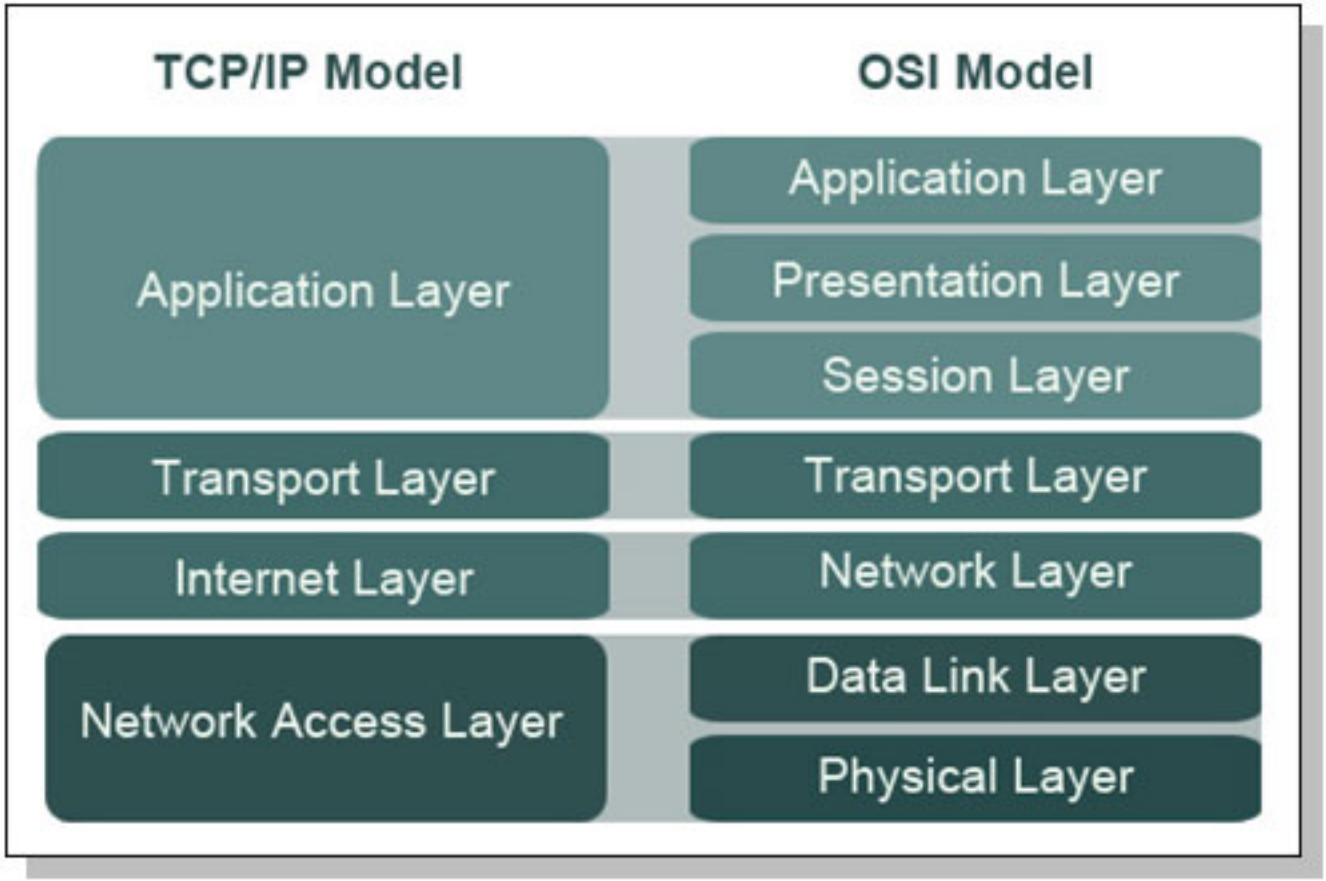
The Internet



First, a video

https://www.youtube.com/watch?v=7_LPdttKXPc

TCP/IP & OSI



TCP/IP Model

Application Layer

Transport Layer

Internet Layer

Network Access Layer

OSI Model

Application Layer

Presentation Layer

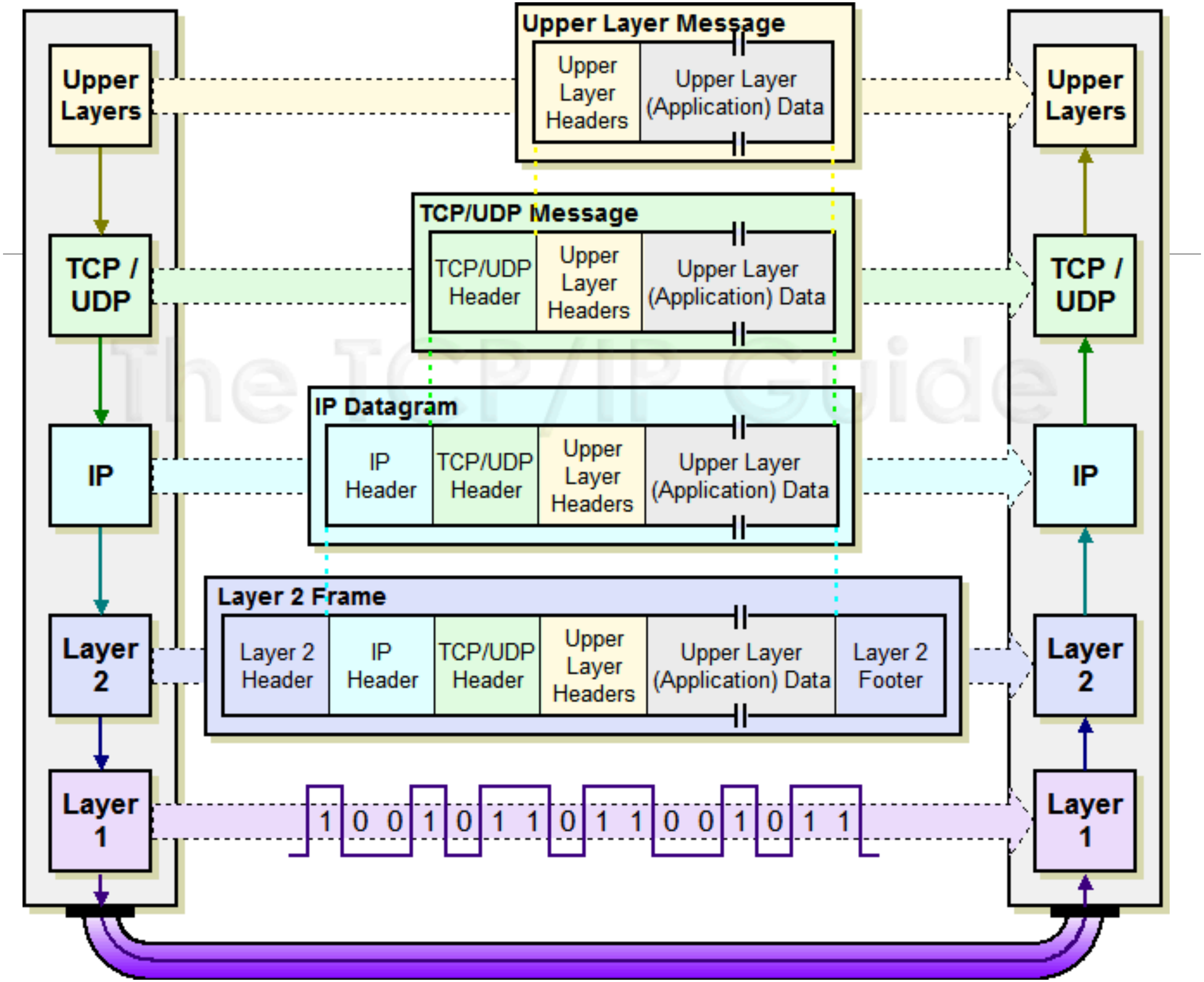
Session Layer

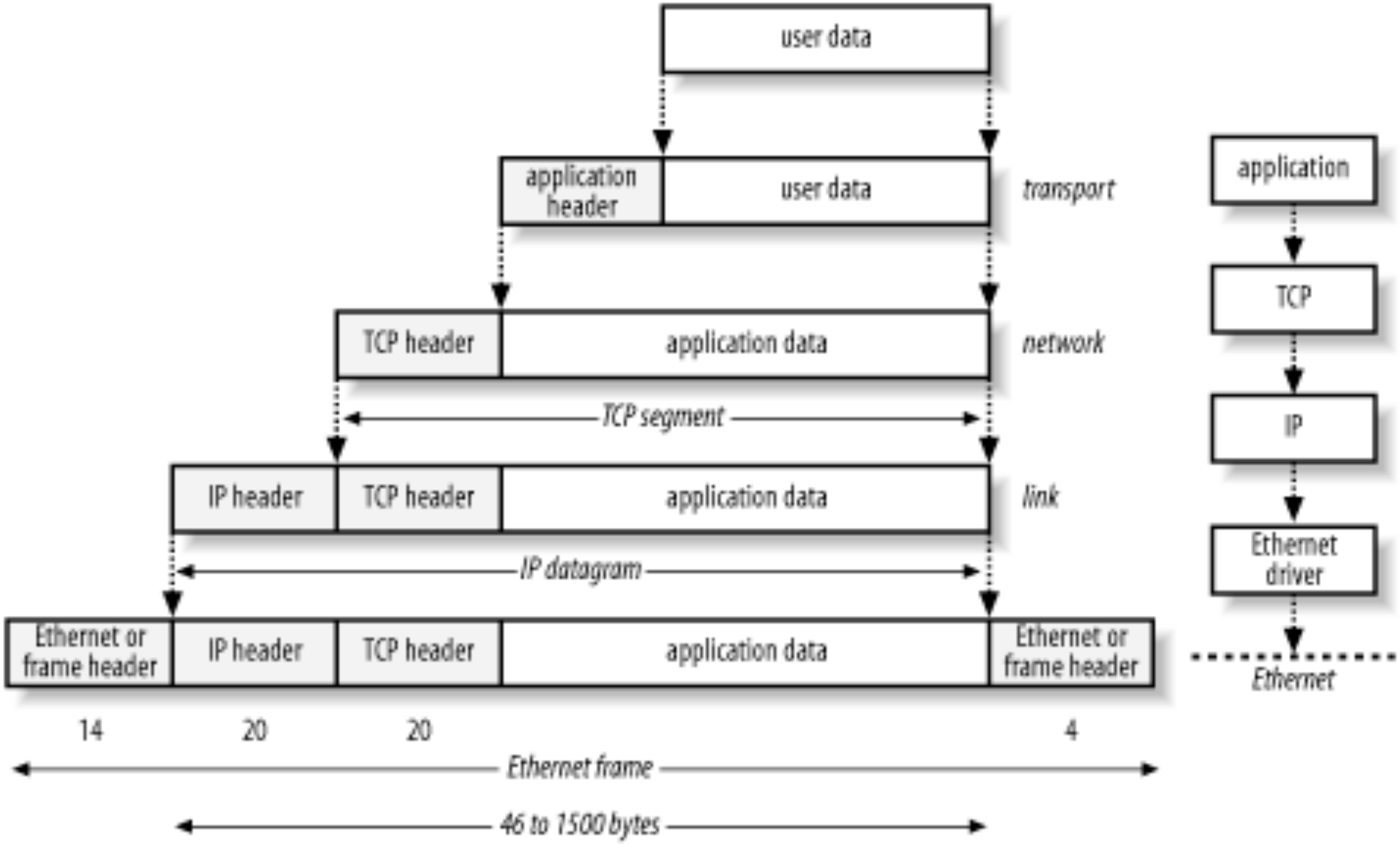
Transport Layer

Network Layer

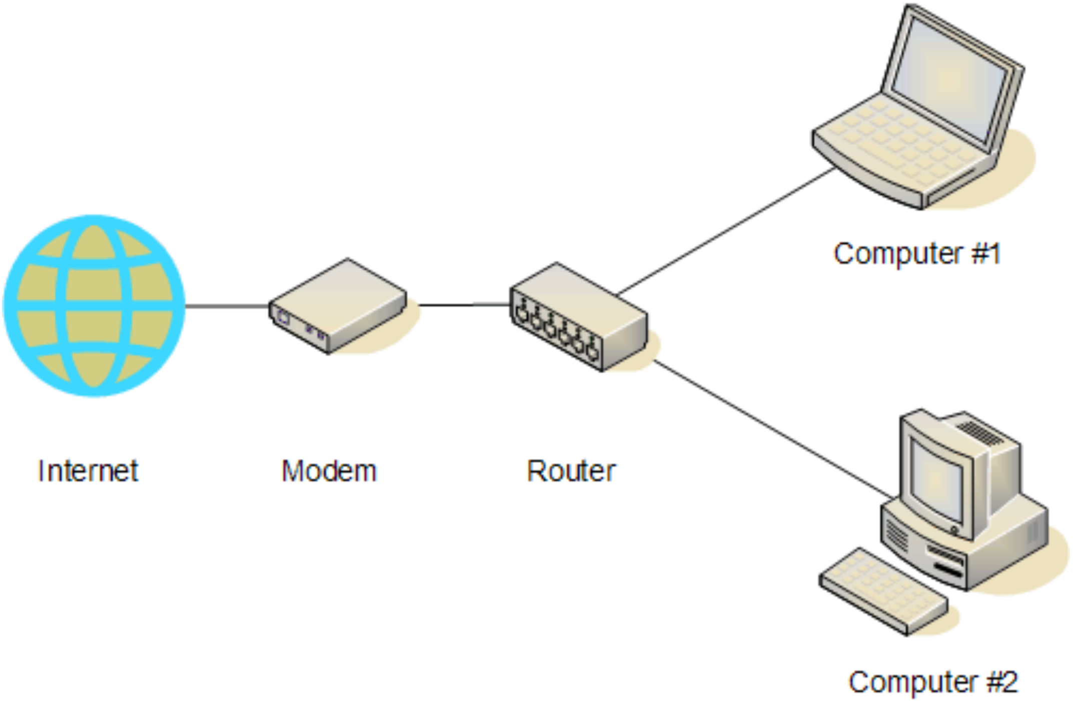
Data Link Layer

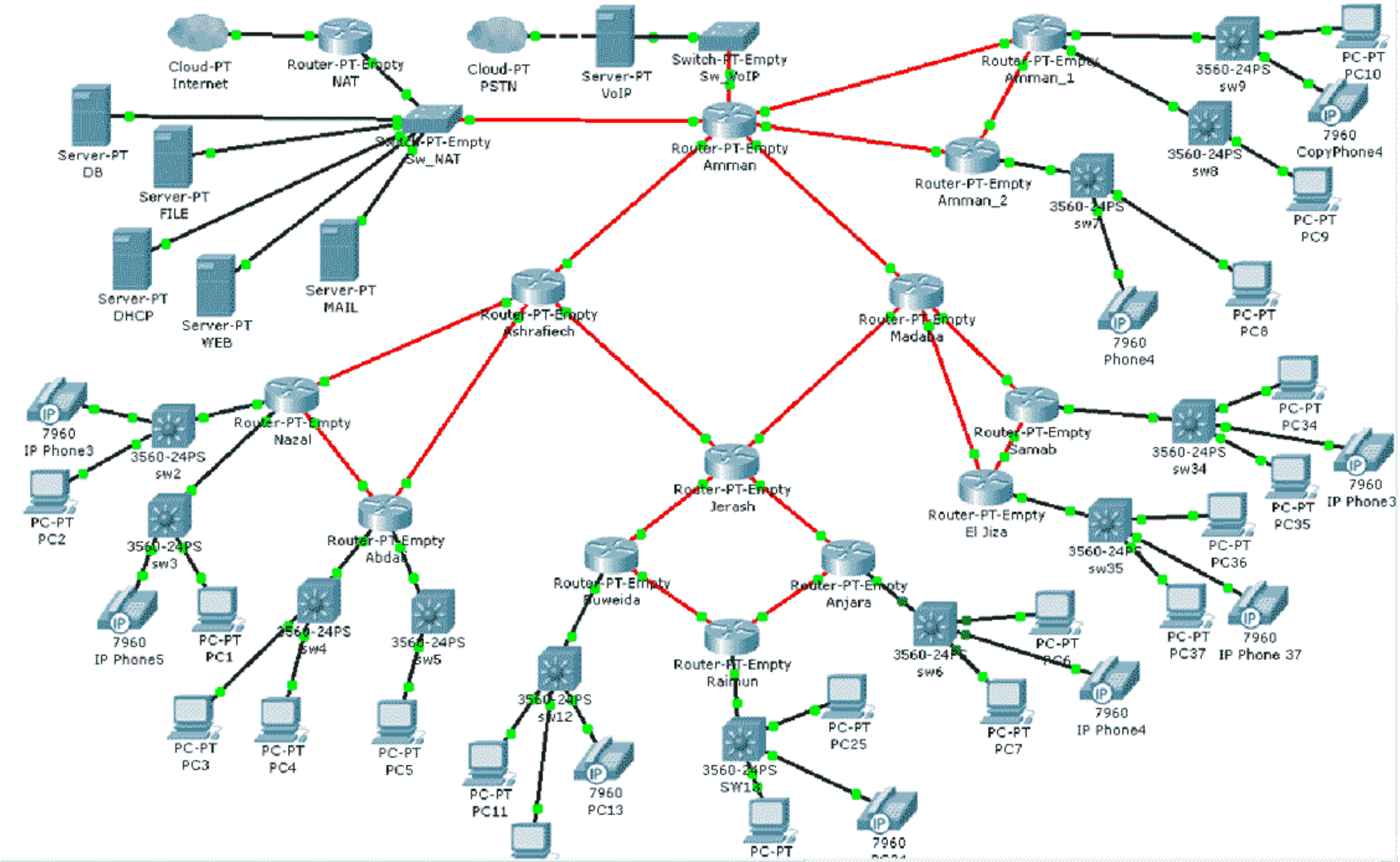
Physical Layer


Upper Layers
TCP / UDP
IP
Layer 2
Layer 1
Upper Layer Message
Upper Layer Headers
Upper Layer (Application) Data
TCP/UDP Message
TCP/UDP Header
Upper Layer Headers
Upper Layer (Application) Data
IP Datagram
IP Header
TCP/UDP Header
Upper Layer Headers
Upper Layer (Application) Data
Layer 2 Frame
Layer 2 Header
IP Header
TCP/UDP Header
Upper Layer Headers
Upper Layer (Application) Data
Layer 2 Footer
1 0 0 1 0 1 1 0 1 1 0 0 1 0 1 1
Upper Layers
TCP / UDP
IP
Layer 2
Layer 1


user data
application header
user data
transport
TCP header
application data
network
TCP segment
IP header
TCP header
application data
link
IP datagram
Ethernet or frame header
IP header
TCP header
application data
Ethernet or frame header
14
20
20
4
Ethernet frame
46 to 1500 bytes
application
TCP
IP
Ethernet driver
Ethernet

Routing




Cloud-PT
Internet
Router-PT-Empty
NAT
Cloud-PT
PSTN
Server-PT
VoIP
Switch-PT-Empty
Sw_VoIP
Router-PT-Empty
Amman_1
3560-24PS
sw9
PC-PT
PC10
7960
CopyPhone4
Server-PT
DB
Switch-PT-Empty
Sw_NAT
Server-PT
FILE
Router-PT-Empty
Amman
Router-PT-Empty
Amman_2
3560-24PS
sw8
PC-PT
PC9
3560-24PS
sw7
Server-PT
DHCP
Server-PT
WEB
Server-PT
MAIL
Router-PT-Empty
Ashrafiech
Router-PT-Empty
Madaba
7960
Phone4
PC-PT
PC8
7960
IP Phone3
3560-24PS
sw2
Router-PT-Empty
Nazal
PC-PT
PC2
Router-PT-Empty
Samab
3560-24PS
sw34
PC-PT
PC34
7960
IP Phone3
PC-PT
PC35
Router-PT-Empty
Jerash
Router-PT-Empty
El Jiza
3560-24PS
sw35
PC-PT
PC36
3560-24PS
sw3
Router-PT-Empty
Abdali
7960
IP Phone5
PC-PT
PC1
Router-PT-Empty
Suweida
Router-PT-Empty
Anjara
3560-24PS
sw4
3560-24PS
sw5
3560-24PS
sw6
PC-PT
PC6
PC-PT
PC37
7960
IP Phone 37
Router-PT-Empty
Raimun
PC-PT
PC3
PC-PT
PC4
PC-PT
PC5
3560-24PS
SW12
PC-PT
PC25
PC-PT
PC7
7960
IP Phone4
PC-PT
PC11
7960
PC13
3560-24PS
SW13
PC-PT
7960

Hubs and Routers

https://www.youtube.com/watch?v=Ofjsh_E4HFY

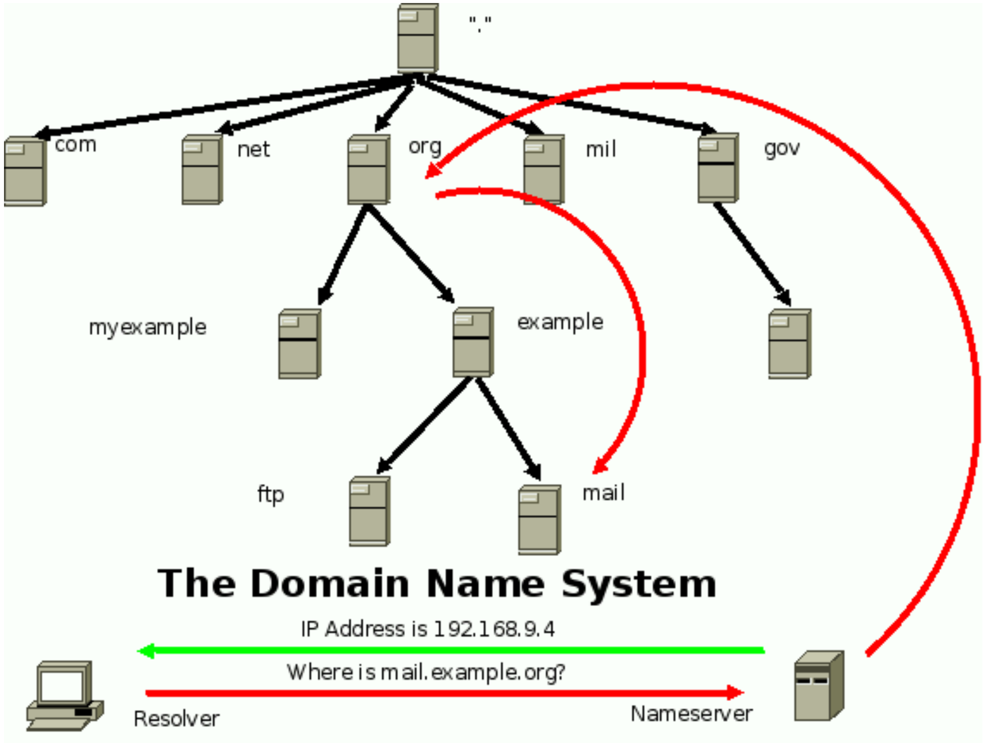
NAT

https://www.youtube.com/watch?v=QBqPzHEDzvo

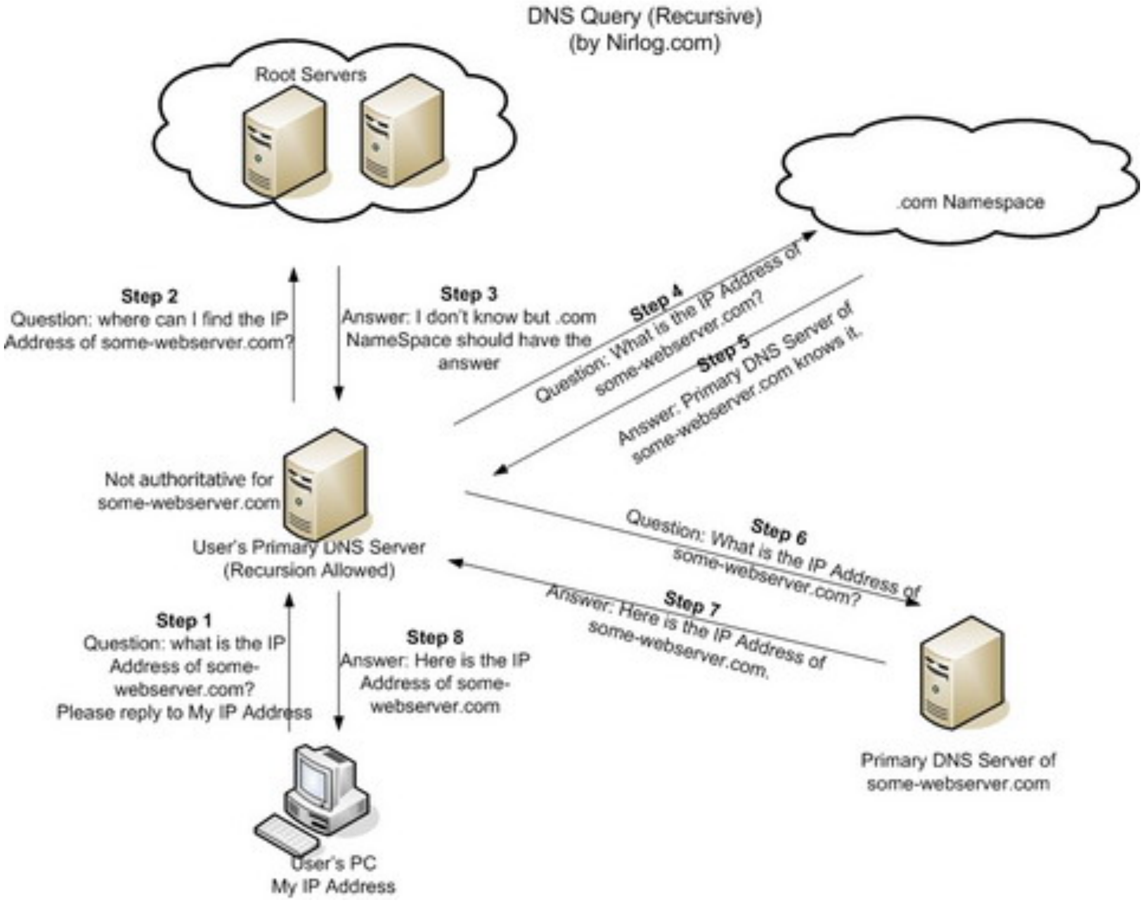
TCP vs UDP

https://www.youtube.com/watch?v=Vdc8TCESIg8

DNS


"."
com
net
org
mil
gov
myexample
example
ftp
mail
The Domain Name System
IP Address is 192.168.9.4
Where is mail.example.org?
Resolver
Nameserver

DNS



DNS Query (Recursive)
(by Nirlog.com)

Root Servers
.com Namespace
Not authoritative for some-webserver.com
User's Primary DNS Server (Recursion Allowed)
User's PC
My IP Address
Primary DNS Server of some-webserver.com

Step 1
Question: what is the IP Address of some-webserver.com? Please reply to My IP Address

Step 2
Question: where can I find the IP Address of some-webserver.com?

Step 3
Answer: I don't know but .com NameSpace should have the answer

Step 4
Question: What is the IP Address of some-webserver.com?

Step 5
Answer: Primary DNS Server of some-webserver.com knows it.

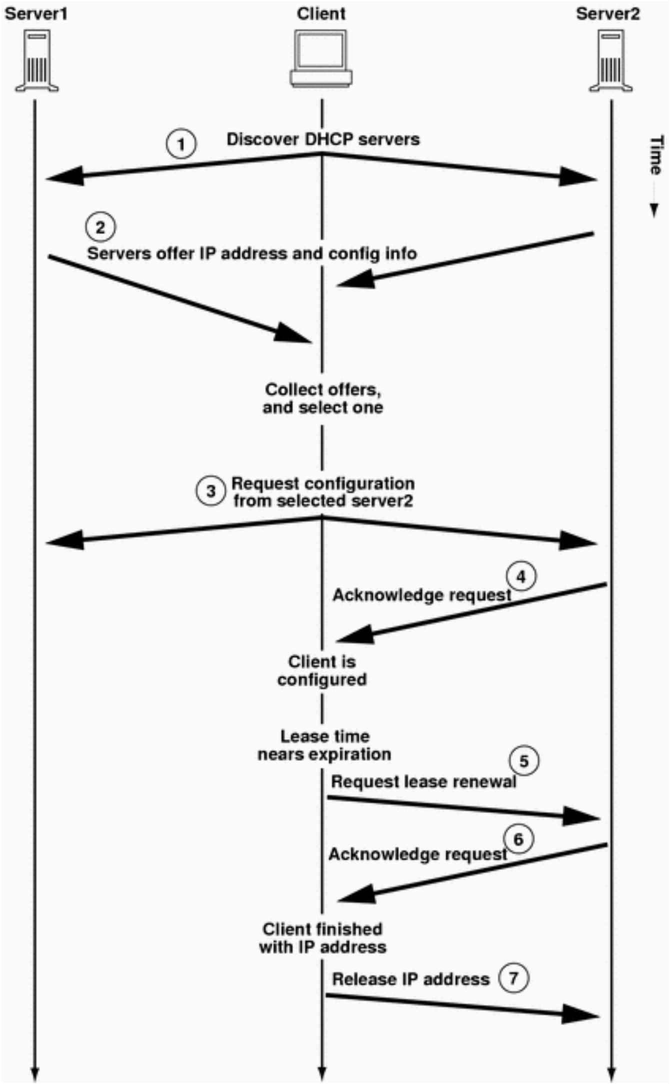
Step 6
Question: What is the IP Address of some-webserver.com?

Step 7
Answer: Here is the IP Address of some-webserver.com.

Step 8
Answer: Here is the IP Address of some-webserver.com

DNS

https://www.youtube.com/watch?v=GlZC4Jwf3xQ

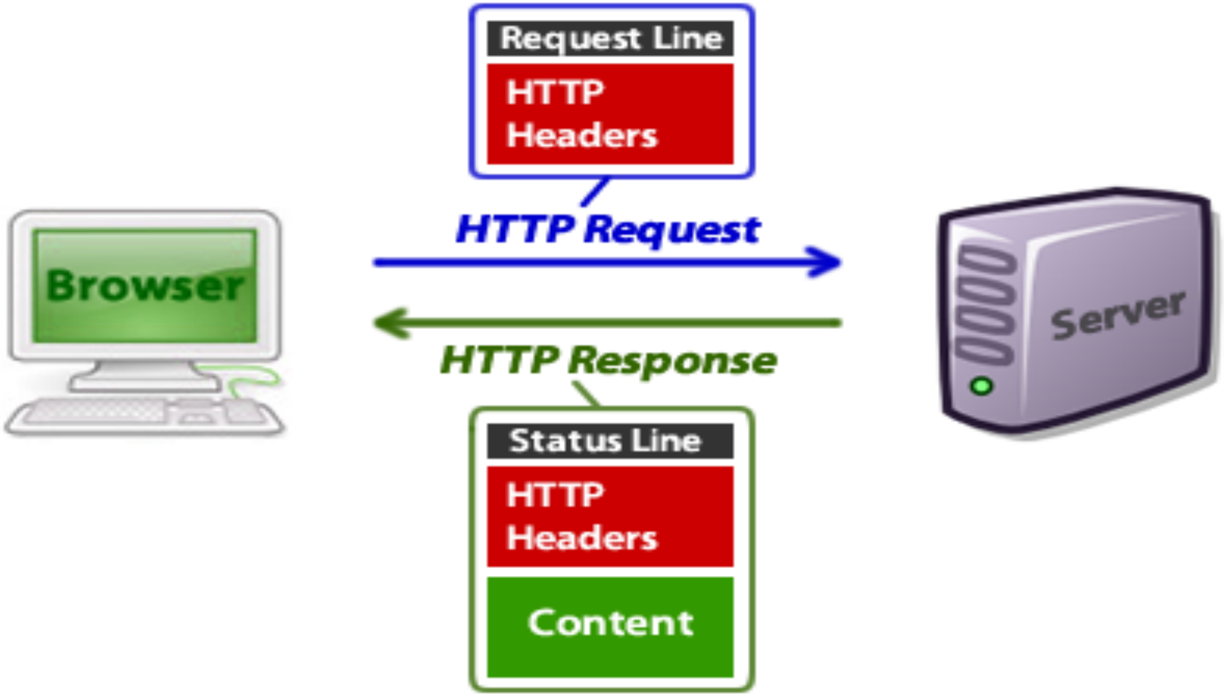

Server1
Client
Server2
Time
1 Discover DHCP servers
2 Servers offer IP address and config info
Collect offers,
and select one
3 Request configuration
from selected server2
4 Acknowledge request
Client is
configured
Lease time
nears expiration
5 Request lease renewal
6 Acknowledge request
Client finished
with IP address
Release IP address 7

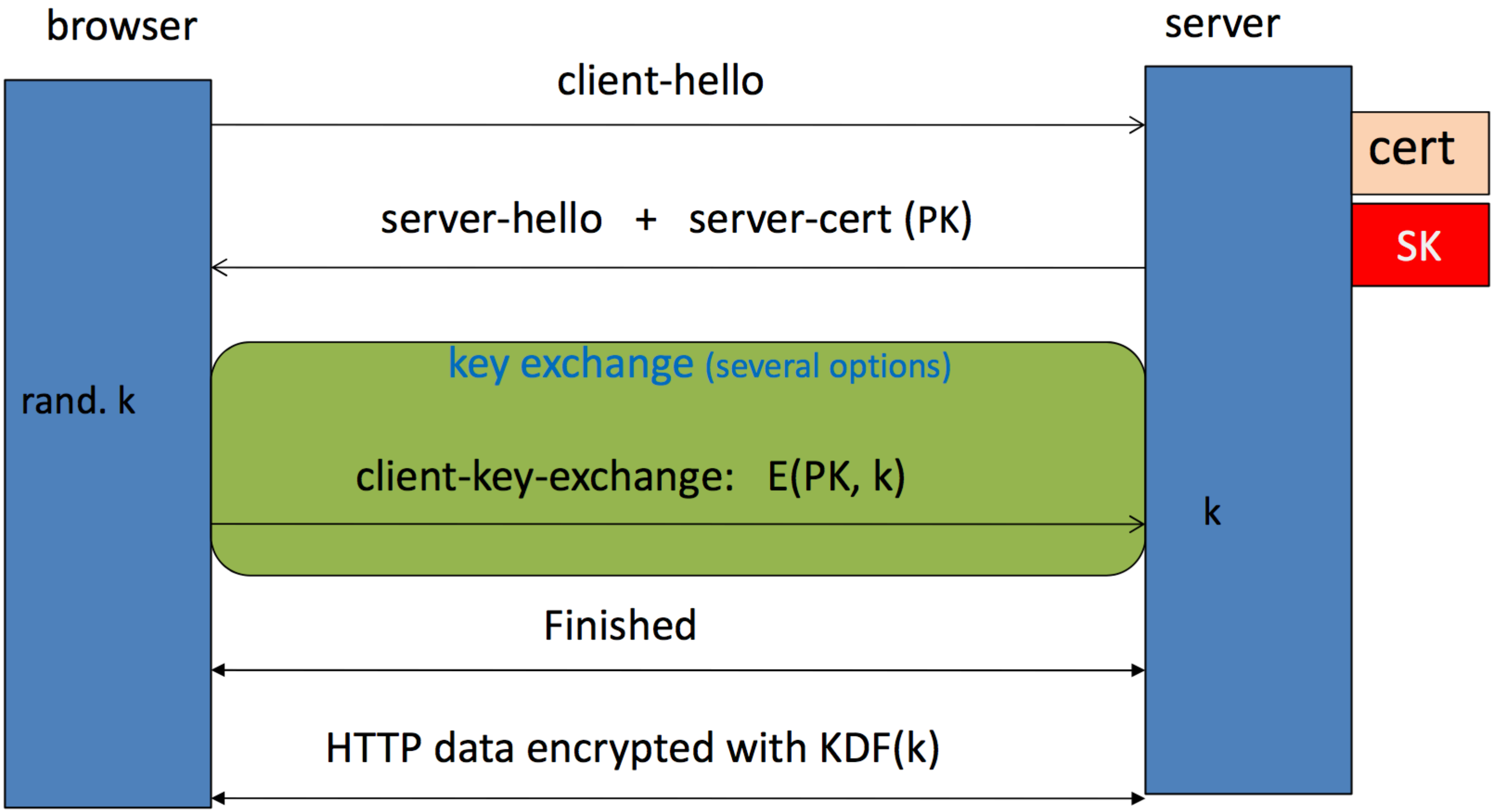
DHCP

https://www.youtube.com/watch?v=RUZohsAxPxQ

Traceroute and Port-scan

Demo

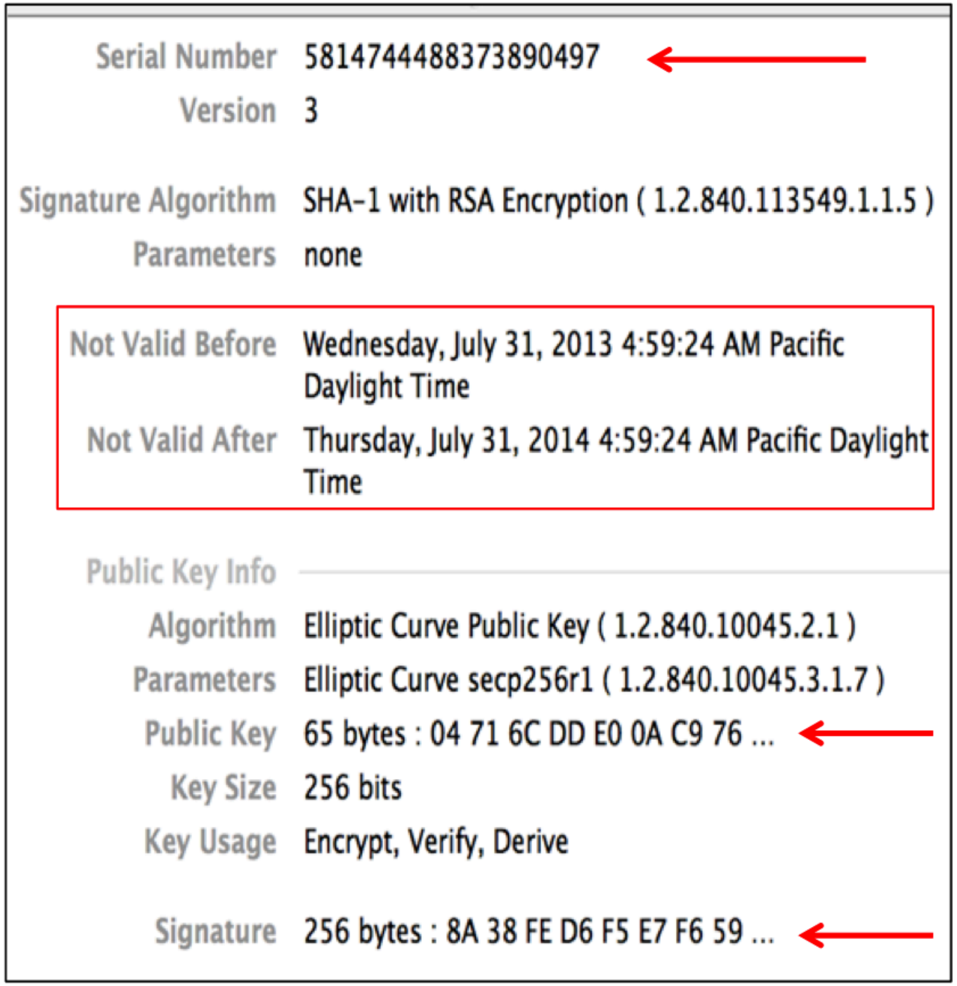

Request Line
HTTP Headers
HTTP Request
Browser
Server
HTTP Response
Status Line
HTTP Headers
Content


browser
server
client-hello
cert
SK
server-hello + server-cert (PK)
key exchange (several options)
rand. k
client-key-exchange: E(PK, k)
k
Finished
HTTP data encrypted with KDF(k)

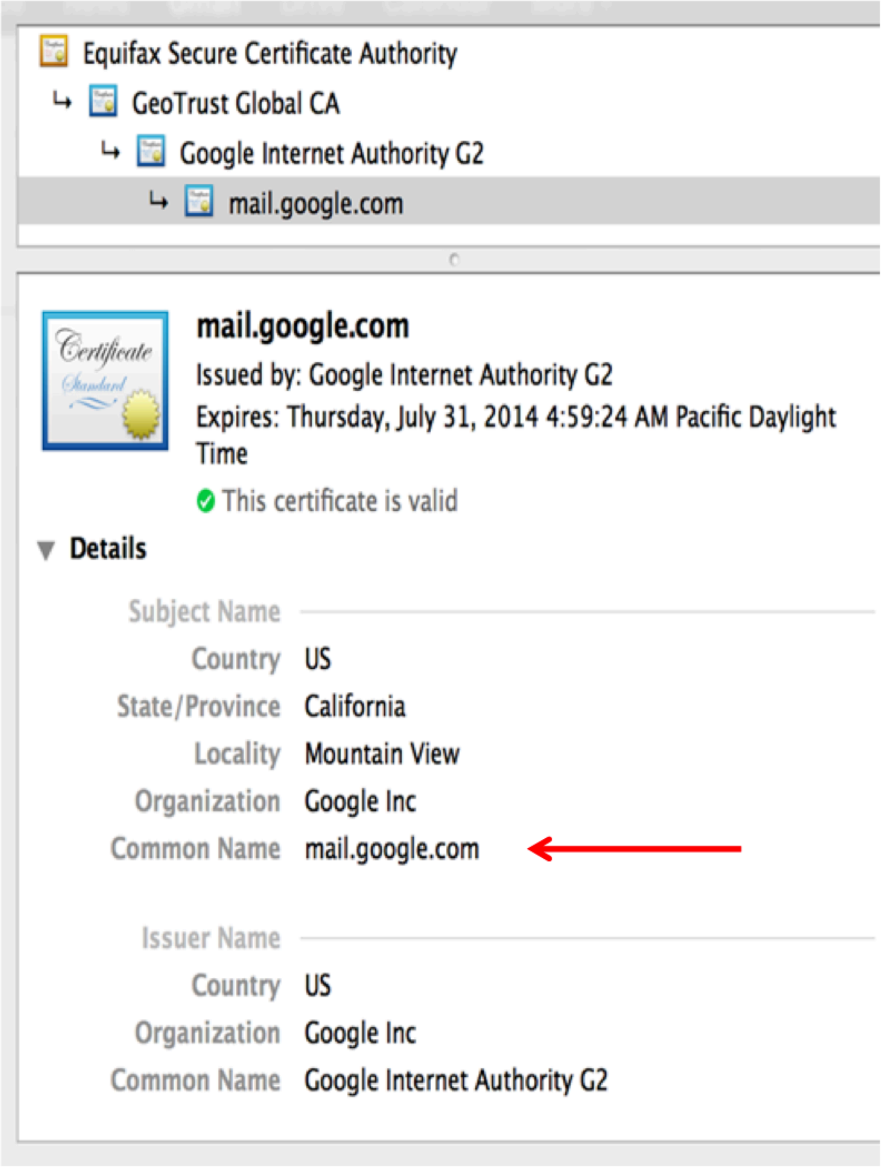
Most common: server authentication only

Certificates

Important Fields:



Serial Number	5814744488373890497
Version	3
Signature Algorithm	SHA-1 with RSA Encryption (1.2.840.113549.1.1.5)
Parameters	none
Not Valid Before	Wednesday, July 31, 2013 4:59:24 AM Pacific Daylight Time
Not Valid After	Thursday, July 31, 2014 4:59:24 AM Pacific Daylight Time
Public Key Info	
Algorithm	Elliptic Curve Public Key (1.2.840.10045.2.1)
Parameters	Elliptic Curve secp256r1 (1.2.840.10045.3.1.7)
Public Key	65 bytes : 04 71 6C DD E0 0A C9 76 ...
Key Size	256 bits
Key Usage	Encrypt, Verify, Derive
Signature	256 bytes : 8A 38 FE D6 F5 E7 F6 59 ...



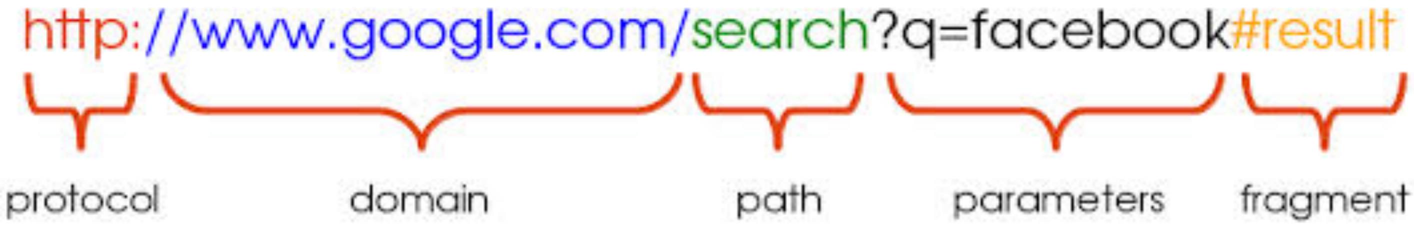
Equifax Secure Certificate Authority
↳ GeoTrust Global CA
↳ Google Internet Authority G2
↳ mail.google.com

mail.google.com
Issued by: Google Internet Authority G2
Expires: Thursday, July 31, 2014 4:59:24 AM Pacific Daylight Time
✓ This certificate is valid

▼ **Details**

Subject Name	
Country	US
State/Province	California
Locality	Mountain View
Organization	Google Inc
Common Name	mail.google.com
Issuer Name	
Country	US
Organization	Google Inc
Common Name	Google Internet Authority G2

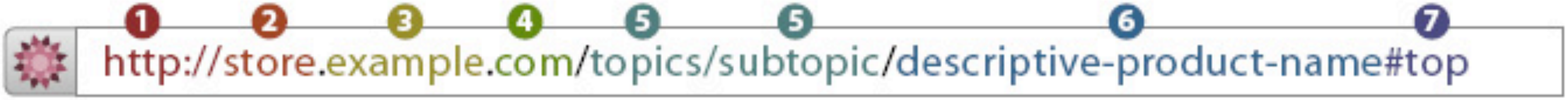
URLs


http://www.google.com/search?q=facebook#result
protocol
domain
path
parameters
fragment

seomoz.org
Read SEOmoz. Rank Better

SEO Cheat Sheet: Anatomy of A URL

1 SEO-FRIENDLY URL



http://store.example.com/topics/subtopic/descriptive-product-name#top

1. Protocol
2. Subdomain
3. Domain
4. Top-Level Domain
5. Folders / Paths
6. Page
7. Named Anchor

Keyword Priority[1]

Observed Google priority of keyword placement:

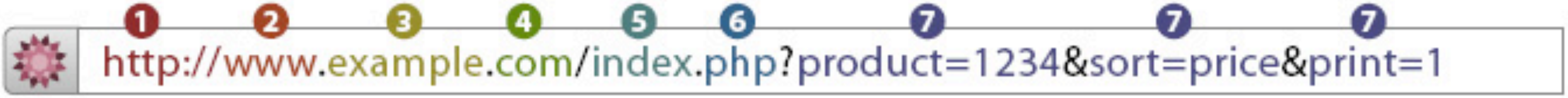
(1) Domain
(2) Subdomain
(3) Folder
(4) Path/Page

SEO Tips for URLs

- Use subdomains carefully. They may be treated as separate entities, splitting domain authority.
- Separate path & page keywords with hyphens ("-").
- Anchors may help engines understand page structure.
- Keyword effectiveness in URLs decreases as URL length and keyword position increases.[1]

[1] SEOmoz correlational data (2009)

2 OLD DYNAMIC URL



http://www.example.com/index.php?product=1234&sort=price&print=1

1. Protocol
2. Subdomain
3. Domain
4. Top-Level Domain
5. Page / File Name
6. File Extension
7. CGI Parameters

Popular TLDs[2]

.com	commercial
.net	infrastructure
.org	non-profit
.edu	schools
.info	informational
.biz	small business
.name	personal sites

Popular ccTLDs*

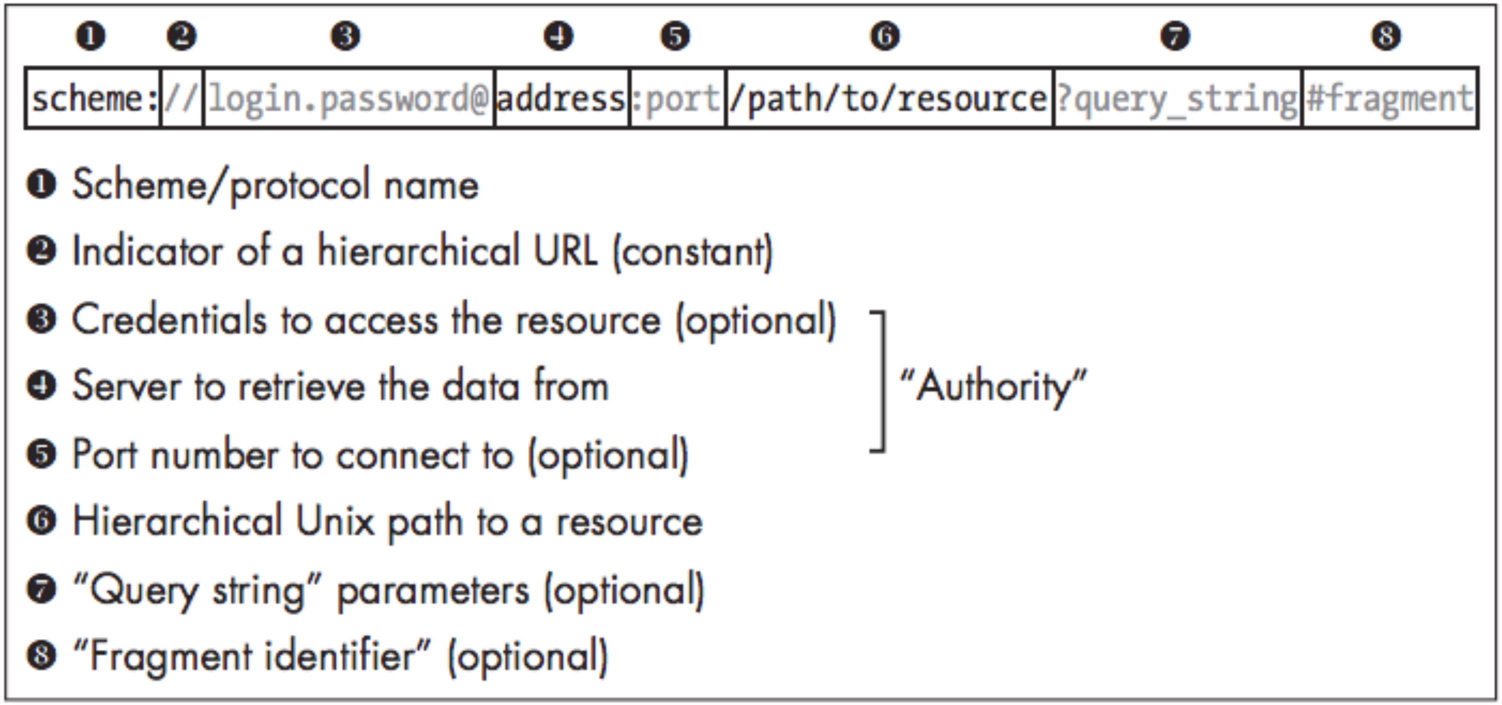
.cn	China
.de	Germany
.uk	United Kingdom
.nl	Netherlands
.eu	European Union
.ru	Russian Federation
.ar	Argentina

Popular Extensions

.htm	Static HTML
.html	Static HTML
.php	PHP code
.asp	ASP code
.aspx	ASP.NET
.cfm	ColdFusion
.jsp	Java Code

[2] Verisign domain report (2009)

* ccTLD = Country Code TLD



```
scheme://login.password@address:port/path/to/resource?query_string#fragment
```

❶ Scheme/protocol name

❷ Indicator of a hierarchical URL (constant)

❸ Credentials to access the resource (optional)

❹ Server to retrieve the data from

❺ Port number to connect to (optional)

❻ Hierarchical Unix path to a resource

❼ “Query string” parameters (optional)

❽ “Fragment identifier” (optional)

URL Schemes

Tons of supported schemes

- https://www.iana.org/assignments/uri-schemes/uri-schemes.xhtml

Supporting these can lead so some weirdness

Common ones you may see:

- file://
- ftp://
- http://
- https://
- mailto://
- sms://

Things can get weird

http://127.0.0.1/

- This is a canonical representation of an IPv4 address.

http://0x7f.1/

- This is a representation of the same address that uses a hexadecimal number to represent the first octet and concatenates all the remaining octets into a single decimal value.

http://017700000001/

- The same address is denoted using a 0-prefixed octal value, with all octets concatenated into a single 32-bit integer.

http://example.com&gibberish=1234@167772161/

- Where do you think this goes?

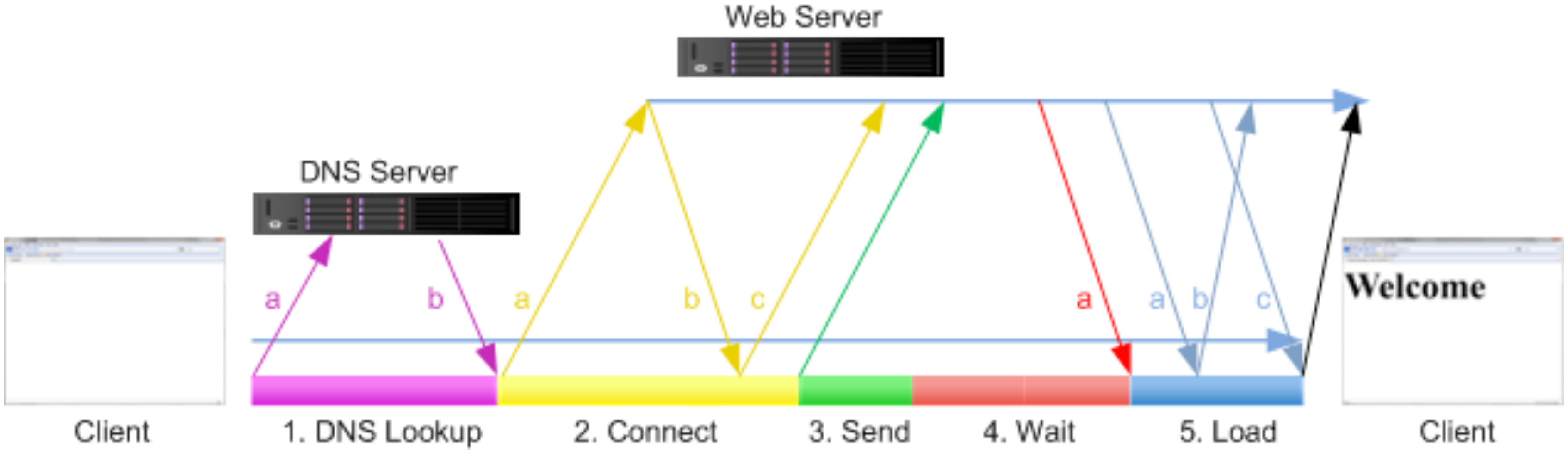
http://example.com\@coredump.cx/

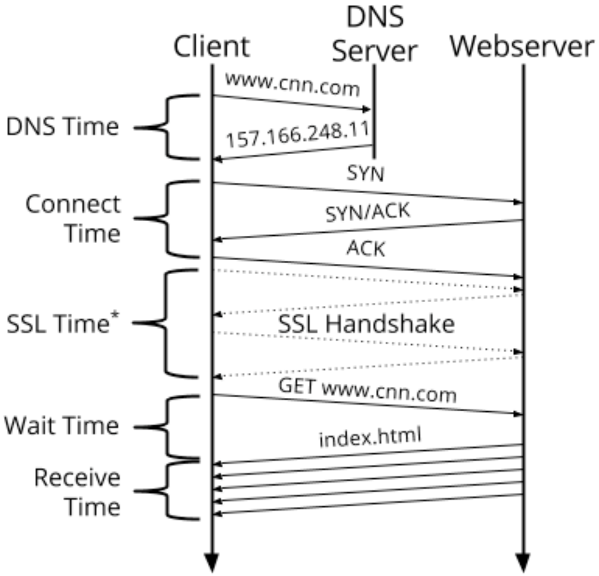
- How about this one?

http://example.com;.coredump.cx/

- And this?

Source: Tangled Web by Michal Zalewski (pages 26 and 30)


Web Server
DNS Server
a
b
a
b
c
a
a
b
c
Welcome
Client
1. DNS Lookup
2. Connect
3. Send
4. Wait
5. Load
Client


Client
DNS Server
Webserver
www.cnn.com
157.166.248.11
DNS Time
SYN
SYN/ACK
ACK
Connect Time
SSL Handshake
SSL Time*
GET www.cnn.com
Wait Time
index.html
Receive Time

HTTP Requests

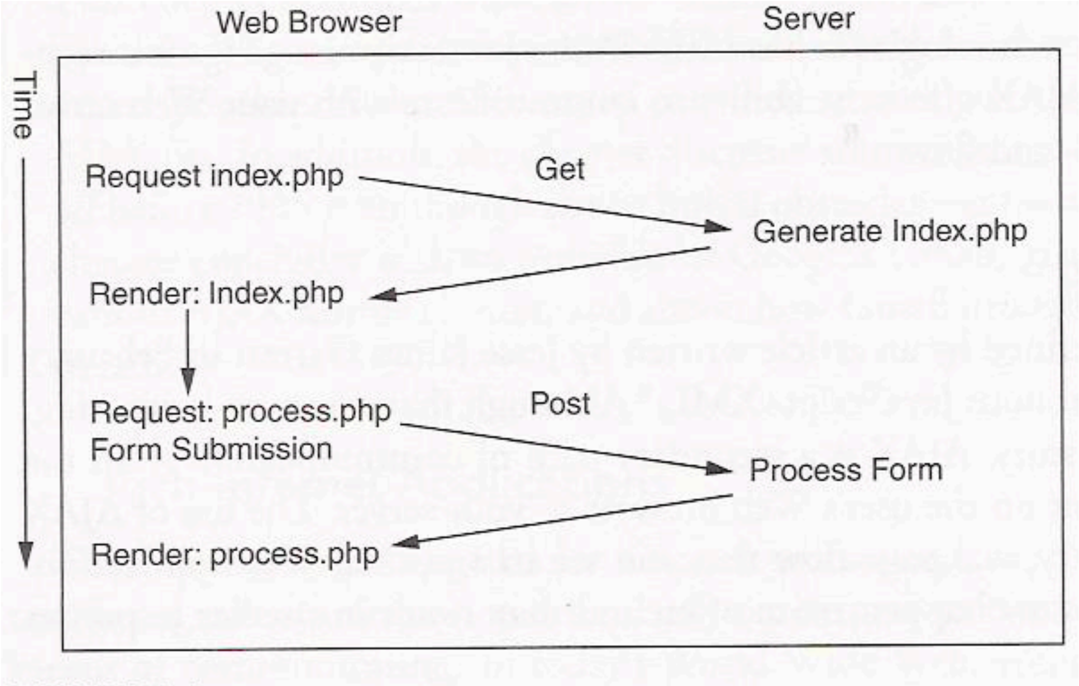


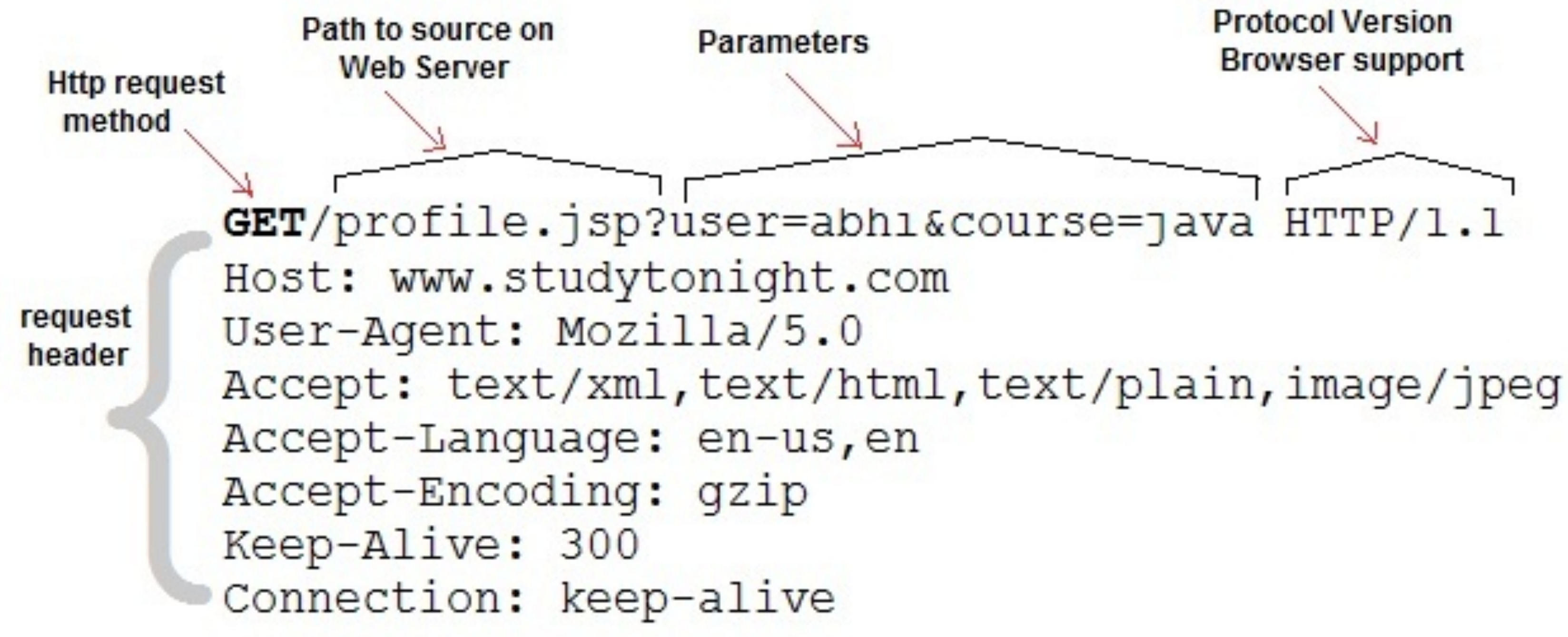
FIGURE 1-1
Web application request flow

HTTP Request/Response

```
POST /fuzzy_bunnies/bunny_dispenser.php HTTP/1.1
Host: www.fuzzybunnies.com
User-Agent: Bunny-Browser/1.7
Content-Type: text/plain
Content-Length: 17
Referer: http://www.fuzzybunnies.com/main.html
I REQUEST A BUNNY
```

```
HTTP/1.1 200 OK
Server: Bunny-Server/0.9.2
Content-Type: text/plain
Connection: close
BUNNY WISH HAS BEEN GRANTED
```

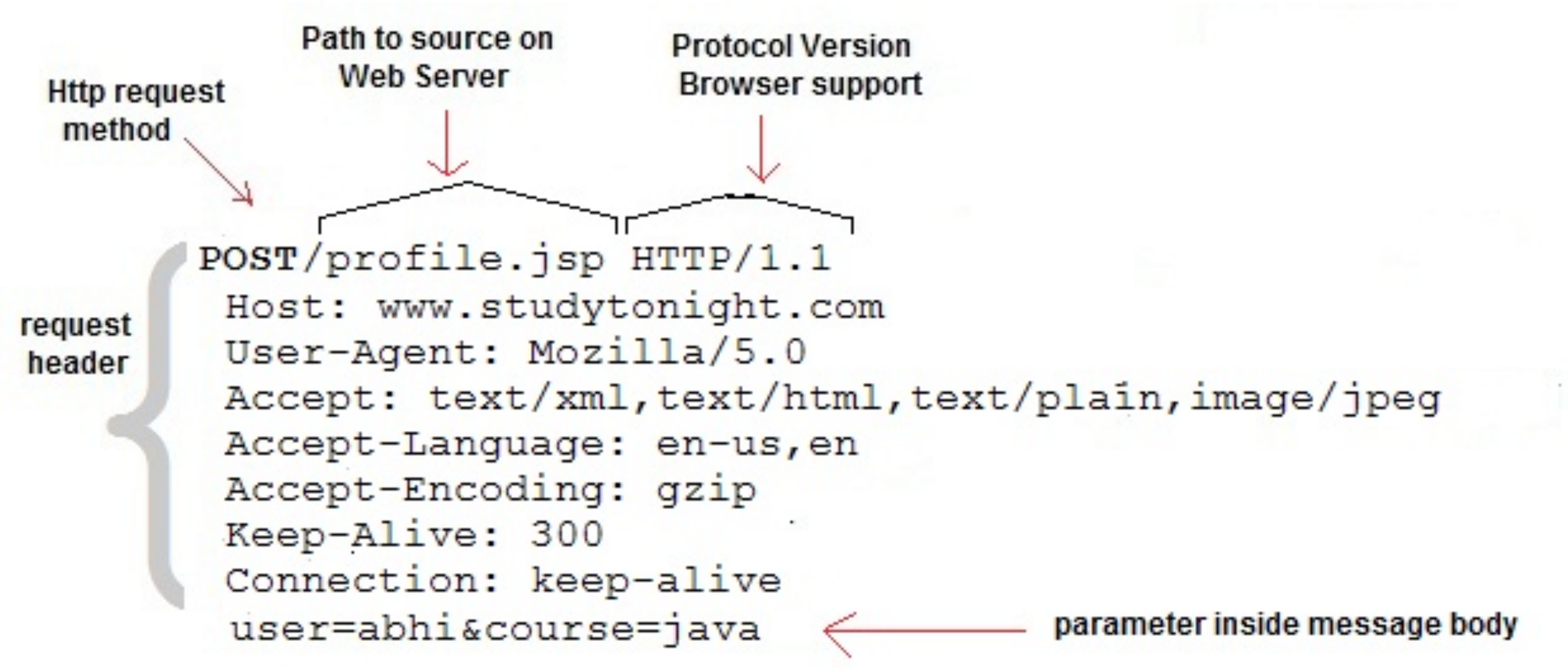
GET Request



```
GET/profile.jsp?user=abhi&course=java HTTP/1.1
Host: www.studytonight.com
User-Agent: Mozilla/5.0
Accept: text/xml,text/html,text/plain,image/jpeg
Accept-Language: en-us,en
Accept-Encoding: gzip
Keep-Alive: 300
Connection: keep-alive
```

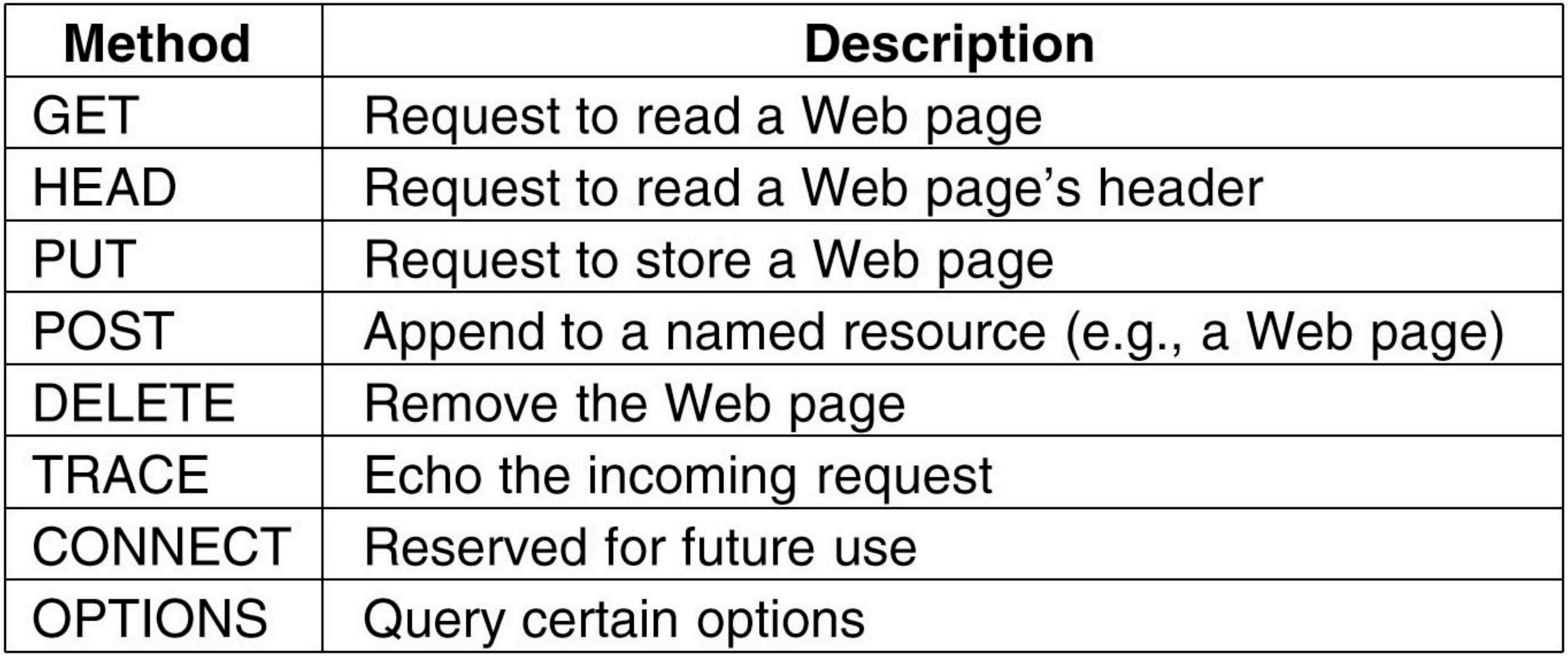
Http request method
Path to source on Web Server
Parameters
Protocol Version Browser support
request header

POST Request


Http request method
Path to source on Web Server
Protocol Version Browser support
request header
parameter inside message body

```
POST/profile.jsp HTTP/1.1
 Host: www.studytonight.com
 User-Agent: Mozilla/5.0
 Accept: text/xml,text/html,text/plain,image/jpeg
 Accept-Language: en-us,en
 Accept-Encoding: gzip
 Keep-Alive: 300
 Connection: keep-alive
 user=abhi&course=java
```

HTTP Methods



Method	Description
GET	Request to read a Web page
HEAD	Request to read a Web page’s header
PUT	Request to store a Web page
POST	Append to a named resource (e.g., a Web page)
DELETE	Remove the Web page
TRACE	Echo the incoming request
CONNECT	Reserved for future use
OPTIONS	Query certain options

HTTP Headers

Define the operating parameters of the HTTP transaction

There are tons “official” ones:

- https://en.wikipedia.org/wiki/List_of_HTTP_header_fields

Colon separated

Ultimately they can be whatever you want

No limit on size of name or value

Burp Suite

Demo