# Networking Basics:
# IP, DNS, URL, MIME

Lecture 7

# Internet Protocol (IP) Addresses

- A unique 32-bit number
  - Assigned to device connected to internet
  - An address for delivery of packets
- Written in *dotted-decimal* notation
  - Divided into 4 fields separated by "."
  - Each field is 8 bits, ie 0-255 decimal

```
10100100011010110111101100000110
10100100.01101011.01111011.00000110
164.107.123.6
```

- Some are reserved: eg, 127.0.0.1

# Abstract Value vs Encoding

- Abstraction: 32-bit integer value
- Encodings
  - Dotted decimal
  - Dotted hex
  - Dotted octal
  - Hexadecimal
  - Decimal
  - Binary
  - Etc…
- Recall: abstraction, representation, *correspondence relation*

# Address Space

- Organizations are allocated blocks of contiguous address to use
- 32 bits means 4 billion addresses
  - Population of the earth: 7 billion
  - Not enough addresses to go around!
- The end is predictable
  - Techniques like NAT developed to help
- In fact, the end has come!
  - Feb 2011: Last block was allocated

THE
END
IS
NEAR

# IPv6

- 128 bits
  - ~$10^{40}$ addresses; we're good for a while
  - A growing fraction of IP traffic
    GoogleIPv6 statistics
- Recommended format (canonical):
  - Divide into 8 fields separated by ":"
  - Each field is 4 hex digits (0-FFFF), ie 16 bits
  - Omit *leading* 0's in a field
  - If there are *consecutive* fields with value 0, compress them as "::"
  - Compress *at most one* such set of 0's
    - Otherwise encoding could be ambiguous
    - Compress the longest sequence

# Canonical Format: Uniqueness

```
2001:0db8:0000:0000:0000:ff00:0042:8329
2001:0db8:0000:0000:0000:ff00:0042:8329

2001:db8:0:0:0:ff00:42:8329
2001:db8:0:0:0:ff00:42:8329

2001:db8::ff00:42:8329
```

# Domain Names

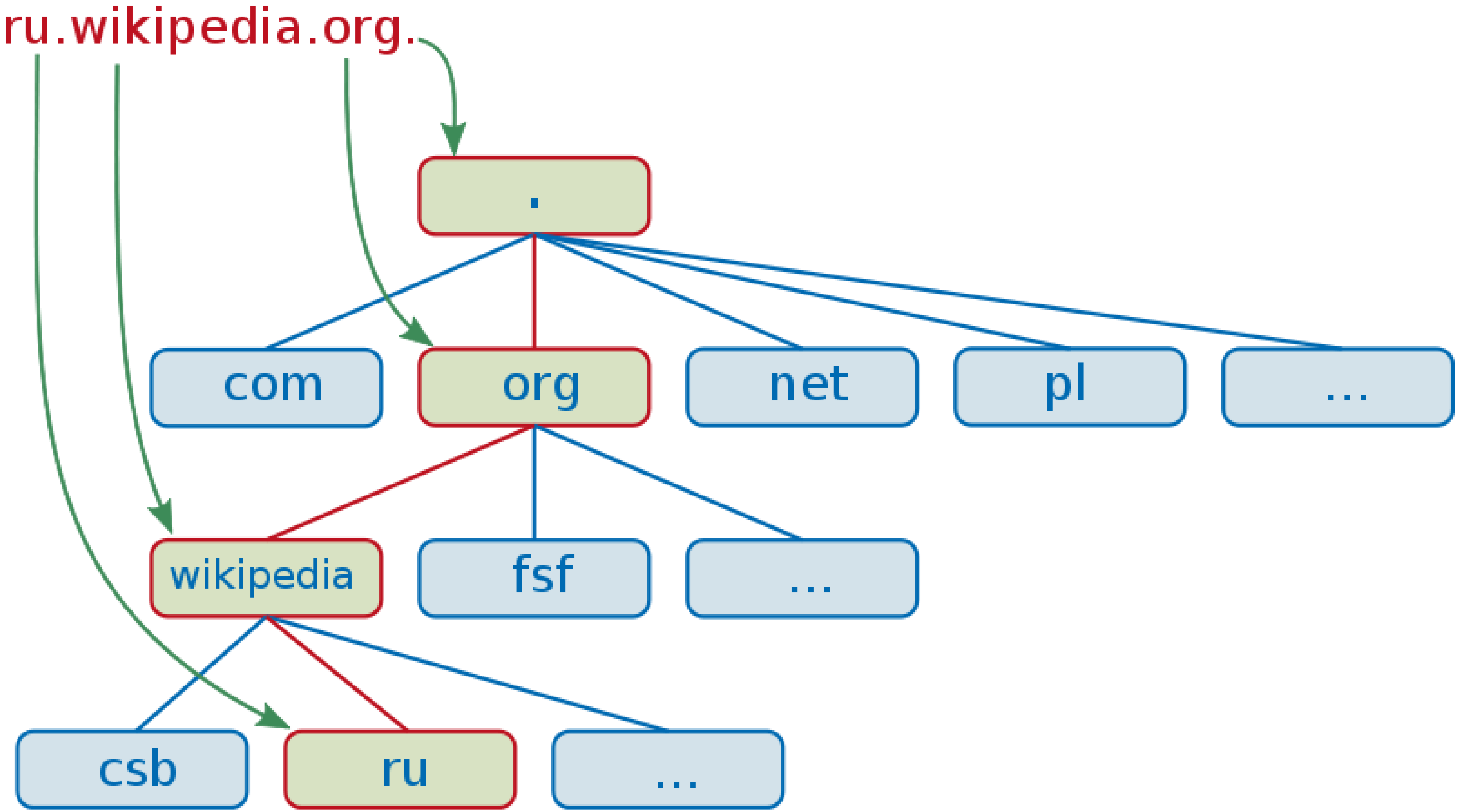
- String corresponds to an IP address
  - `web.cse.ohio-state.edu` is easier than `164.107.123.6`
- Case insensitive: Lower-case standard
- A partial map (almost)
  - DNS maps lower-case strings → IP addresses
  - Multiple strings can map to same address!
  - Some strings map to multiple addresses (unusual)!

# Domain Name Hierarchy

- Separated by .'s
  - Don't confuse with dotted decimal!
- Right-to-left hierarchy
  - Top-level domain is right-most field
    - **edu**, **com**, **net**, **gov**, countries (**ca**, **it**, …)
  - Second-level domain to its left
  - Then third, fourth, etc, no limit

    **www.sos.state.oh.us**
- Hostname + Domain Name = Fully Qualified Domain Name (FQDN)

  **stdlinux.cse.ohio-state.edu**


ru.wikipedia.org.
.
com
org
net
pl
...
wikipedia
fsf
...
csb
ru
...

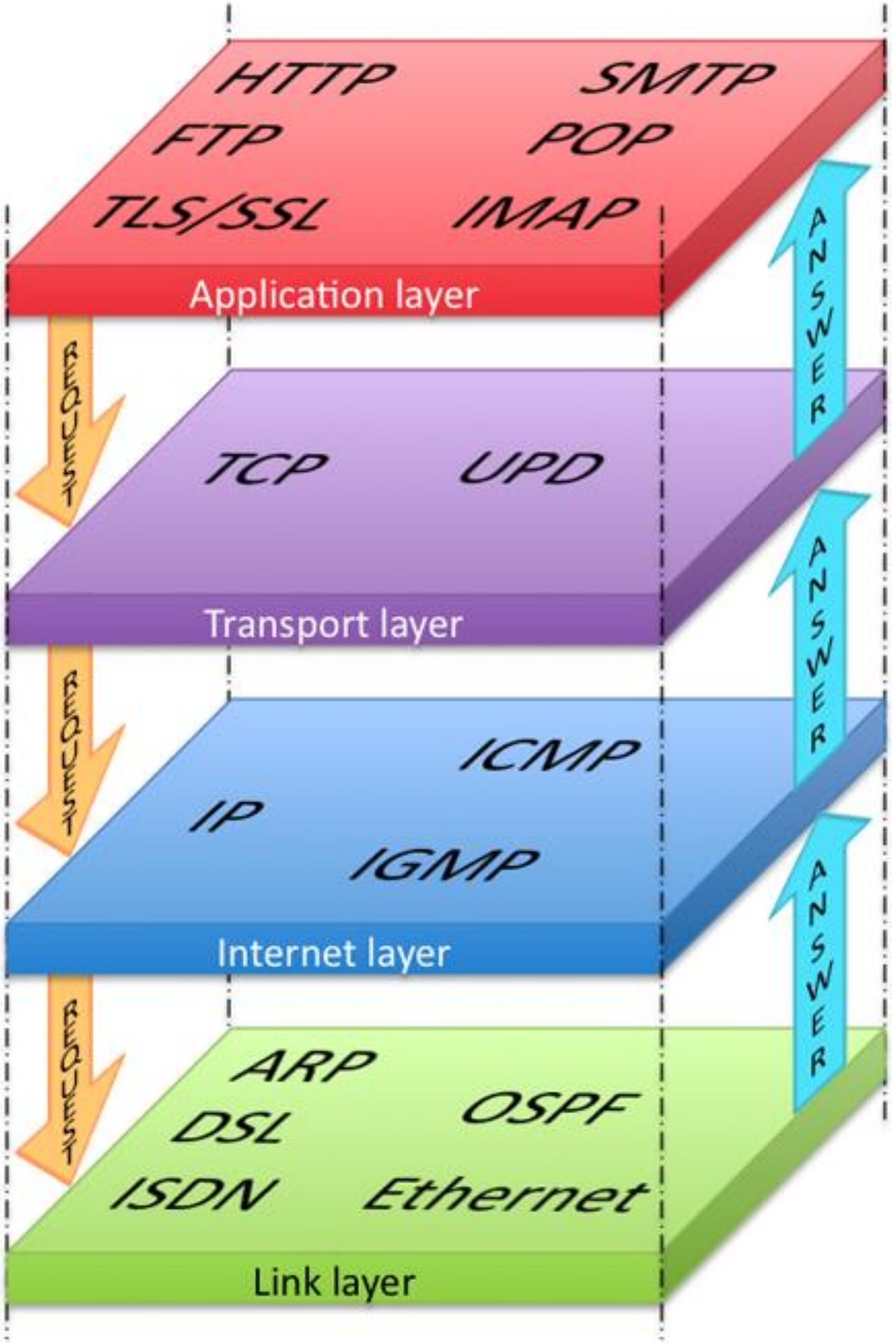
# Name Servers

- Act as a phonebook for lookup
- Client view:
  - Given a FQDN, return IP address
  - Partial map: FQDNs → IP addresses
  - See host, whois
- Implementation view:
  - Hierarchical by domain
  - Local caching for recently retrieved items
- Command line tools

```
$ host web.cse.ohio-state.edu
# web.cse.ohio-state.edu has address
      164.107.129.176
$ whois osu.com
```

# Protocols

- Systematic ordering of messages
  - Phone rings
  - Callee answers by saying “Hello”
  - Caller answers by saying “Hello”
- Different protocols use different messages, different sequencing, etc
  - In Italy, callee answers by saying “*Pronto*”



HTTP

SMTP

FTP

POP

TLS/SSL

IMAP

Application layer

TCP

UPD

Transport layer

ICMP

IP

IGMP

Internet layer

ARP

DSL

OSPF

ISDN

Ethernet

Link layer

REQUEST

REQUEST

REQUEST

ANSWER

ANSWER

ANSWER

# Network Layering: Abstraction

- One protocol is built on top of another
  - Application level: FTP, HTTP, SSH, SMTP, TELNET
  - Transport: TPC, UDP
  - Internet: IP
- Each protocol assumes certain behavior from layer below
  - IP routes packets to destination (unreliable)
  - TCP creates a reliable, in-order channel
  - HTTP delivers web pages

# Network Ports

- A single host has many ports
- Application-level protocols have default port
  - ftp -> 20
  - http -> 80
  - imap ->143
  - ssh -> 22
  - smtp -> 25
  - telnet-> 23
- A "web server" is just a program, running, waiting, listening for a call (on port 80)
  - See telnet

# URL

- Uniform Resource Locator

  ```
  scheme://FQDN:port/path?query#fragment
  ```

- Schemes include http, ftp, mailto, file…
  - Case insensitive, but prefer lower case
- Port is optional (each scheme has default)
  - 80 for http
- Variety of formats, depending on scheme

  ```
  http://www.osu.edu/news/index.php
  ftp://doe@ftp.cse.ohio-state.edu
  mailto://brutus.1@osu.edu
  ```

- FQDN is case insensitive, prefer lower case

# Document Root

- Web server configured to serve documents from a location in file system
  - "document root": `/class/3901`
  - File: `/class/3901/labs/lab2.html`
  - URL: `http://www.cse.osu.edu/labs/lab2.html`
- Slashes in path should be for server's OS (but forward slashes are common)
- Virtual servers: multiple doc roots
- Proxy servers: remote doc roots

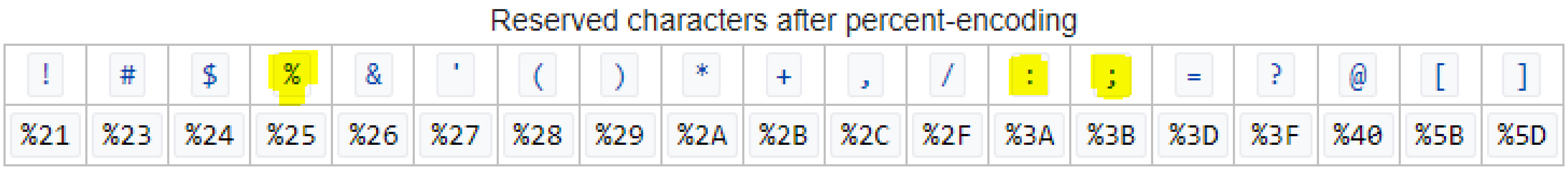
# Encoding (and Decoding)

- A single value can be viewed at two levels, eg:
  - `HELLO`
  - `.... . .-.. .-.. ---`
- Different uses: reading vs transmission
- Different alphabets (letters vs dot-dash) and/or requirements
  - Eg. Message has only upper case letters
- Encoding/decoding is the translation between these levels
  - c.f. encrypting/decrypting
- Abstract value vs concrete representation
  - Correspondence maps between the two

# Example: URL Encoding

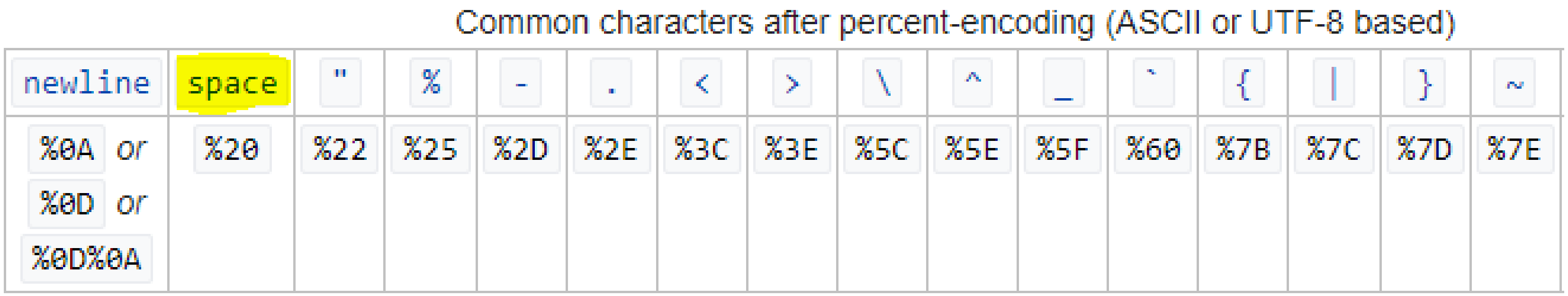
- Invariant on abstract value (constraint)
  - Reserved metacharacters (`;`, `:`, `&`, `#`, `@`…)
- Invariant on encoding (convention)
  - Small set of valid characters, others (eg space, `~`, newline…) are not allowed
- So some characters in abstract value are encoded as `%hh` (ASCII code in hex)
  - `%3B` for `;`, `%40` for `@`
  - `%20` for space, `%7E` for `~`
- Q: What about `%` in abstract value?
  - A: Encode it too! `%25`
- aka "percent encoding"

# URL Encoding



Reserved characters after percent-encoding

| ! | # | $ | % | & | ' | ( | ) | * | + | , | / | : | ; | = | ? | @ | [ | ] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| %21 | %23 | %24 | %25 | %26 | %27 | %28 | %29 | %2A | %2B | %2C | %2F | %3A | %3B | %3D | %3F | %40 | %5B | %5D |



Common characters after percent-encoding (ASCII or UTF-8 based)

| newline | space | " | % | - | . | < | > | \ | ^ | _ | ` | { | \| | } | ~ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| %0A *or*<br>%0D *or*<br>%0D%0A | %20 | %22 | %25 | %2D | %2E | %3C | %3E | %5C | %5E | %5F | %60 | %7B | %7C | %7D | %7E |

| | |
|---|---|
| Value | `Mascot "address": brutus@osu.edu` |
| Encoding | `Mascot%20%22address%22%3A%20brutus%40osu.edu` |

# MIME

- Multipurpose Internet Mail Extensions
  - Originally for email attachments
- Content Type: How to interpret a file
  - File is a blob of bits (encoding)
  - How should we decode this blob into an (abstract) value? Colors, sounds, characters?
  - Recall: *correspondence relation*
- Syntax: type/subtype
  - text/plain, text/html, text/css, text/javascript
  - image/gif, image/png, image/jpeg
  - video/mpeg, video/quicktime
- Transfer Encoding: How to interpret a msg
  - How to decode the blob of bits that arrived
  - A *layered* encoding
  - Examples: quoted-printable, base64

# Example: Multiple Parts

```
MIME-Version: 1.0
Content-Type: multipart/mixed; boundary=aFrontierString

This is a message with multiple parts in MIME format.
--aFrontierString
Content-Type: text/plain

This is the body of the message.
--aFrontierString
Content-Type: application/octet-stream
Content-Transfer-Encoding: base64

PGh0bWw+CiAgPGhlYWQ+CiAgPC9oZWFkPgogIDxib2R5PgogICAgPHA
+VGhpcyBpcyB0aGUg
Ym9keSBvZiB0aGUgbWVzc2FnZS48L3A+CiAgPC9ib2R5Pgo8L2h0bWw
+Cg==
--aFrontierString--
```

# Example: Content Type

```
MIME-Version: 1.0
Content-Type: multipart/mixed; boundary=aFrontierString

This is a message with multiple parts in MIME format.
--aFrontierString
Content-Type: text/plain

This is the body of the message.
--aFrontierString
Content-Type: application/octet-stream
Content-Transfer-Encoding: base64

PGh0bWw+CiAgPGhlYWQ+CiAgPC9oZWFkPgogIDxib2R5PgogICAgPHA
+VGhpcyBpcyB0aGUg
Ym9keSBvZiB0aGUgbWVzc2FnZS48L3A+CiAgPC9ib2R5Pgo8L2h0bWw
+Cg==
--aFrontierString--
```

# Example: Transfer Encoding

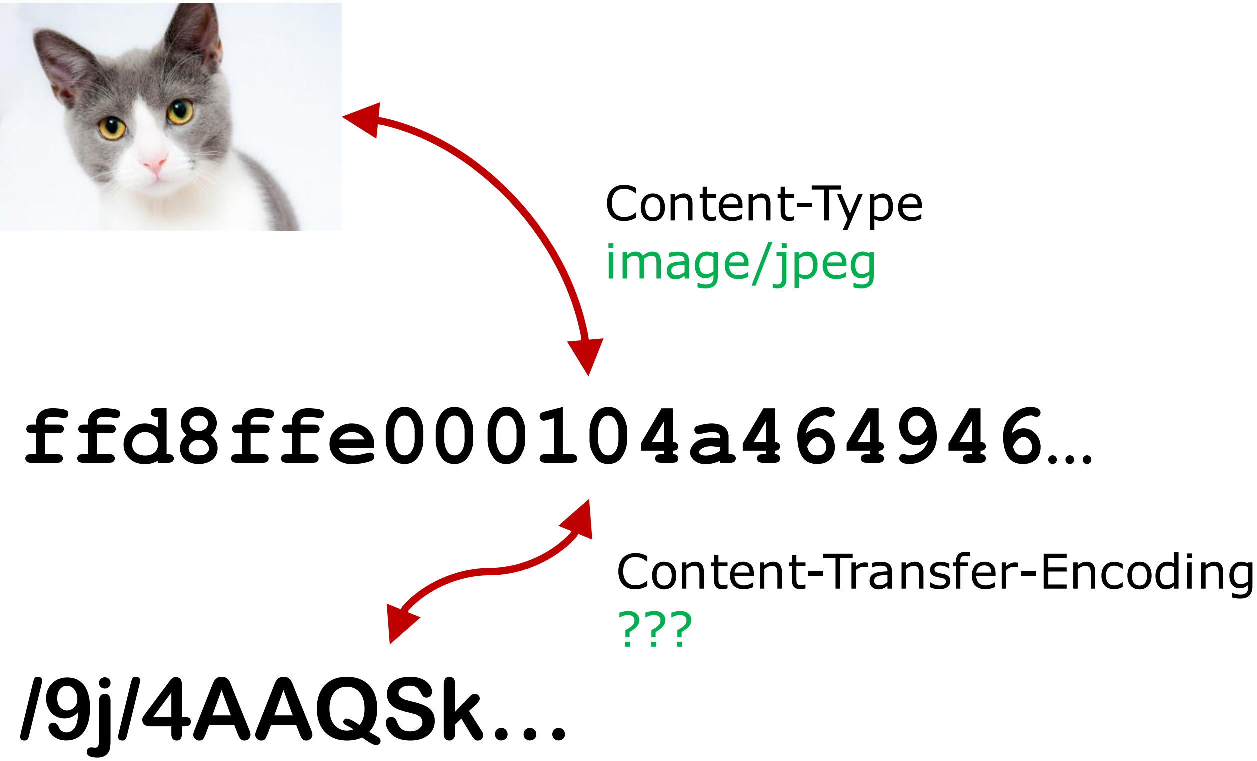
```
MIME-Version: 1.0
Content-Type: multipart/mixed; boundary=aFrontierString

This is a message with multiple parts in MIME format.
--aFrontierString
Content-Type: text/plain

This is the body of the message.
--aFrontierString
Content-Type: application/octet-stream
Content-Transfer-Encoding: base64

PGh0bWw+CiAgPGhlYWQ+CiAgPC9oZWFkPgogIDxib2R5PgogICAgPHA
+VGhpcyBpcyB0aGUg
Ym9keSBvZiB0aGUgbWVzc2FnZS48L3A+CiAgPC9ib2R5Pgo8L2h0bWw
+Cg==
--aFrontierString--
```

# Layered Encoding



source
(image)

Content-Type
image/jpeg

content
(bits)

**`ffd8ffe000104a464946…`**

Content-Transfer-Encoding
???

transfer encoded
(channel)
ASCII

**/9j/4AAQSk…**

# Encoding (Binary) Data in ASCII

- Binary data: Any byte value is possible
  - 00 to FF (*i.e.* xxxx xxxx)
- ASCII data: bytes start with 0
  - 00 to 7F (*i.e.* 0xxx xxxx)
- Problem: a channel that needs ASCII
  - Encoding must use ASCII alphabet
- Hex: 4 bits becomes 1 ASCII character

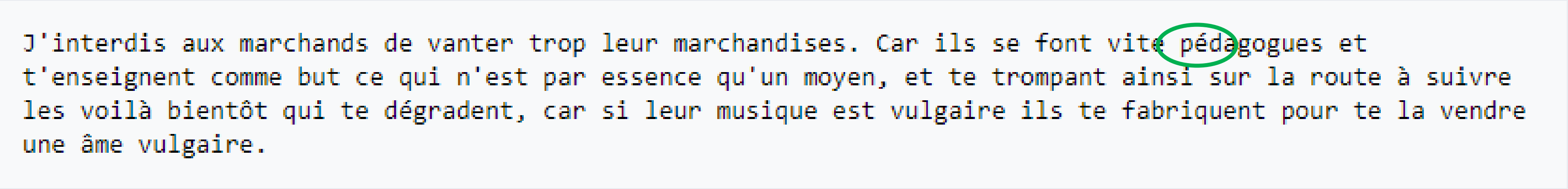
```
1101 0110 1100 1111 0011 1001
   D    6    A    F    2    5
```

  - Problem?

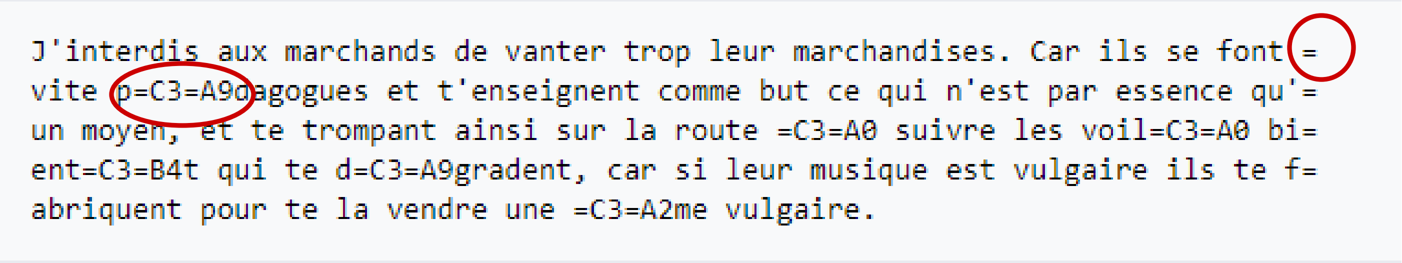
# Quoted-Printable Encoding

- Observation: bytes that happen to be ASCII do not need to be encoded
  - If most data is text, savings are significant
- For each byte:
  - If first bit is 0, do nothing
  - If first bit is 1, encode with 3 bytes: **`=XY`** where XY is the hex value of byte
- Limit line length to 76 characters
- Finish lines with "="
- Q: What if data contains the byte "="?

# Example



```
J'interdis aux marchands de vanter trop leur marchandises. Car ils se font vite pédagogues et
t'enseignent comme but ce qui n'est par essence qu'un moyen, et te trompant ainsi sur la route à suivre
les voilà bientôt qui te dégradent, car si leur musique est vulgaire ils te fabriquent pour te la vendre
une âme vulgaire.
```



```
J'interdis aux marchands de vanter trop leur marchandises. Car ils se font =
vite p=C3=A9dagogues et t'enseignent comme but ce qui n'est par essence qu'=
un moyen, et te trompant ainsi sur la route =C3=A0 suivre les voil=C3=A0 bi=
ent=C3=B4t qui te d=C3=A9gradent, car si leur musique est vulgaire ils te f=
abriquent pour te la vendre une =C3=A2me vulgaire.
```

# Encoding Binary Data

- What if most data is *not* ASCII?
  - Raw (base 256): 8 bits are a digit (byte)

```
1101 0110 1100 1111 0010 0101
?         ?         %
```

  - Hex (base 16): 4 bits → digit (byte)

```
1101 0110 1100 1111 0011 1001
D    6    A    F    2    5
```

  - Quoted-Printable: 8 bits → 3 bytes

```
1101 0110 1100 1111 0011 1001
=D   6    =A   F    %
```

  - Can we do better?

# Encoding Binary Data

- What if most data is *not* ASCII?
  - Raw (base 256): 8 bits are a digit (byte)

```
1101 0110 1100 1111 0010 0101
?         ?         %
```

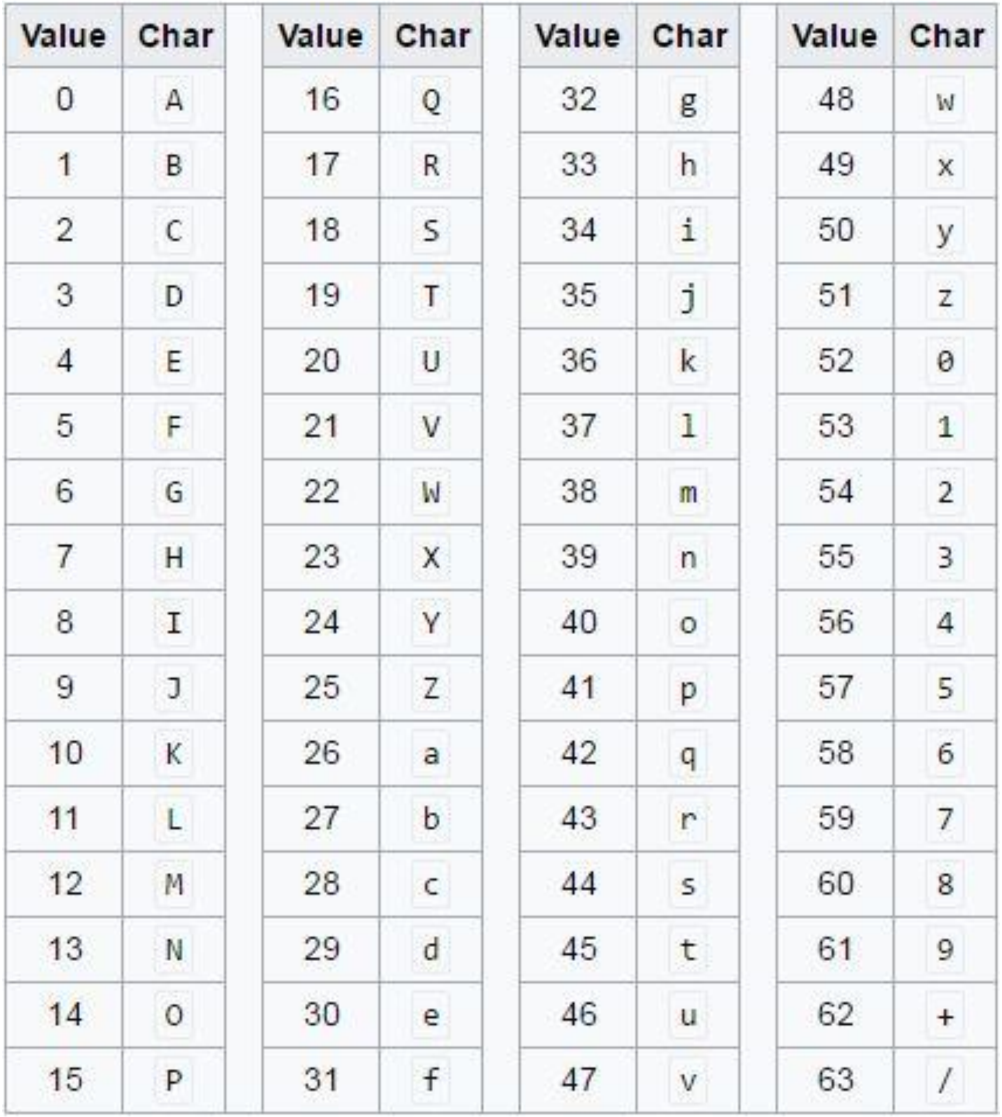
  - Hex (base 16): 4 bits → digit (byte)

```
1101 0110 1100 1111 0011 1001
D    6    A    F    2    5
```

  - Base 64: 6 bits → 3 digit (byte)

```
1101 0110 1100 1111 0011 1001
1      s       8      5
```

# Base64 Alphabet



| Value | Char | Value | Char | Value | Char | Value | Char |
|---|---|---|---|---|---|---|---|
| 0 | A | 16 | Q | 32 | g | 48 | w |
| 1 | B | 17 | R | 33 | h | 49 | x |
| 2 | C | 18 | S | 34 | i | 50 | y |
| 3 | D | 19 | T | 35 | j | 51 | z |
| 4 | E | 20 | U | 36 | k | 52 | 0 |
| 5 | F | 21 | V | 37 | l | 53 | 1 |
| 6 | G | 22 | W | 38 | m | 54 | 2 |
| 7 | H | 23 | X | 39 | n | 55 | 3 |
| 8 | I | 24 | Y | 40 | o | 56 | 4 |
| 9 | J | 25 | Z | 41 | p | 57 | 5 |
| 10 | K | 26 | a | 42 | q | 58 | 6 |
| 11 | L | 27 | b | 43 | r | 59 | 7 |
| 12 | M | 28 | c | 44 | s | 60 | 8 |
| 13 | N | 29 | d | 45 | t | 61 | 9 |
| 14 | O | 30 | e | 46 | u | 62 | + |
| 15 | P | 31 | f | 47 | v | 63 | / |

en.wikipedia.org/wiki/Base64

# Layered Encoding: Base64

source
(image)

Content-Type
image/jpeg

content
(bits)

ffd8ffe000104a464946...

Content-Transfer-Encoding
base64

encoded
(alphabet)

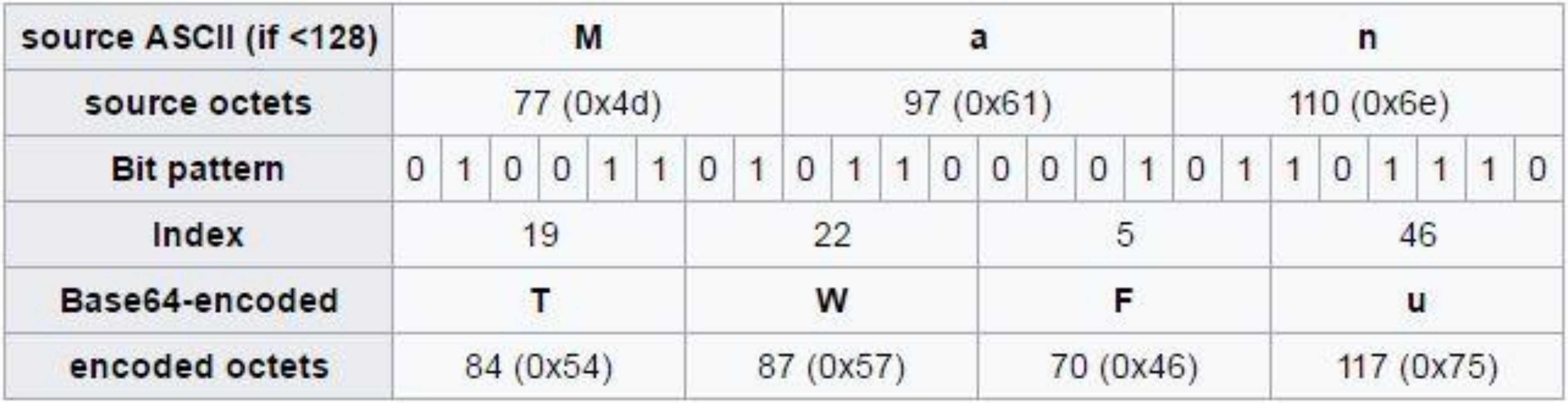
/9j/4AAQSk...

ASCII

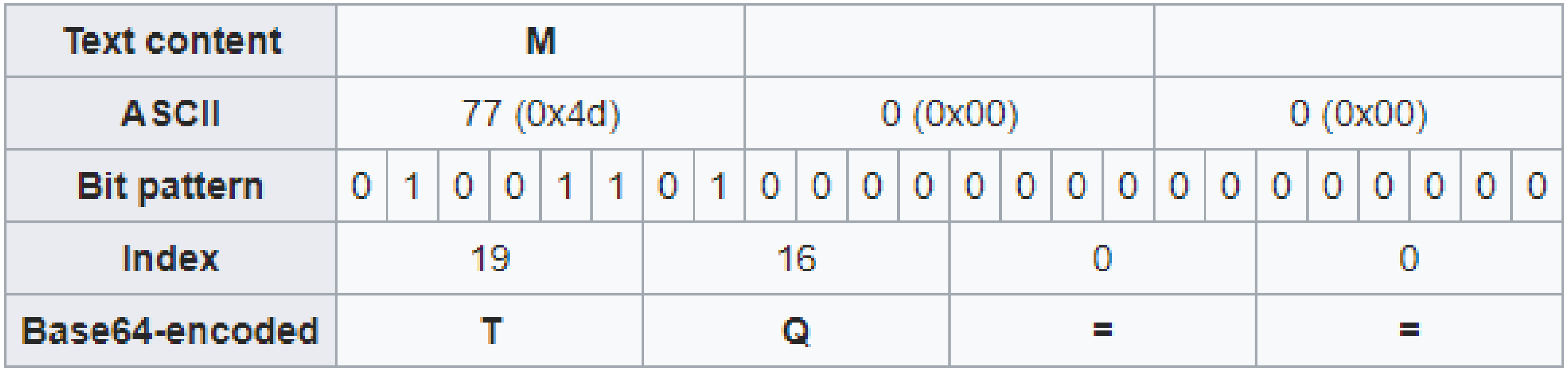
transmission
(bits)

2f396a2f344141536b...

# Base64 Encoding



| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **source ASCII (if <128)** | **M** | | | | | | | | **a** | | | | | | | | **n** | | | | | | | |
| **source octets** | 77 (0x4d) | | | | | | | | 97 (0x61) | | | | | | | | 110 (0x6e) | | | | | | | |
| **Bit pattern** | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 0 |
| **Index** | 19 | | | | | | 22 | | | | | | 5 | | | | | | 46 | | | | | |
| **Base64-encoded** | **T** | | | | | | **W** | | | | | | **F** | | | | | | **u** | | | | | |
| **encoded octets** | 84 (0x54) | | | | | | 87 (0x57) | | | | | | 70 (0x46) | | | | | | 117 (0x75) | | | | | |



| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Text content** | **M** | | | | | | | | | | | | | | | | | | | | | | | |
| **ASCII** | 77 (0x4d) | | | | | | | | 0 (0x00) | | | | | | | | 0 (0x00) | | | | | | | |
| **Bit pattern** | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Index** | 19 | | | | | | 16 | | | | | | 0 | | | | | | 0 | | | | | |
| **Base64-encoded** | **T** | | | | | | **Q** | | | | | | **=** | | | | | | **=** | | | | | |

en.wikipedia.org/wiki/Base64

# Determining MIME Content Type

- The sender (web server) determines MIME (content) type of document being sent
  - Rules map file extensions to MIME types
- If file arrives without MIME info, receiver has to guess (see `file` command)
  - File extension *may* help
  - Contents *may* help: magic number at start
    - JPG: `ff d8`…
    - PDF: `25 50 44 46`… (ie %PDF)
    - PNG: `89 50 4e 47 0d 0a 1a 0a`… (ie .PNG…)
- Some types handled by browser itself
- Others require plugin or application
- Experimental MIME subtypes: x-
  - application/x-gzip

# Summary

- IP address are unique on network
  - IPv4 vs IPv6
- DNS maps strings to IP addresses
  - Domains nested hierarchically
- URLs identify resources on network
  - Scheme, host, path
- MIME type defines a file’s encoding
  - Correspondence
  - Layered encodings are possible too

# HTTP:
# Hypertext Transfer Protocol

# HTTP

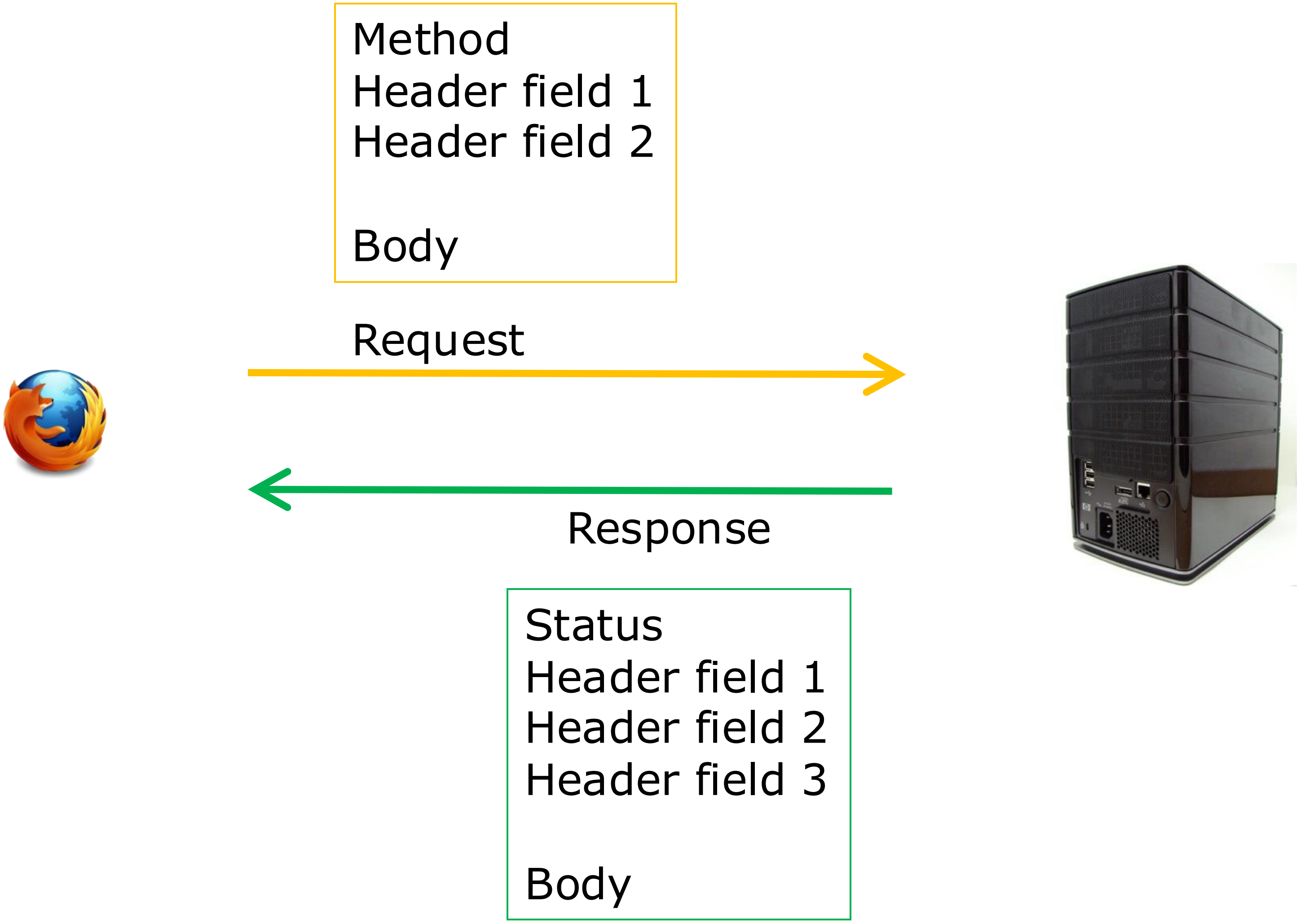
- Hypertext Transfer Protocol
- History
  - Early 90's: developed at CERN, Tim Berners-Lee
  - 1996: version 1.0
  - 1999: version 1.1 (ubiquitous today!)
  - 2015: version 2
    - Performance improvements: binary, server push…
    - Backwards compatible
  - 2022: version 3
    - Performance improvements, same semantics

  w3techs.com/technologies/overview/site_element
- Simple request/response (client/server)
  - Client sends request to (web) server
  - (Web) server responds
  - Protocol itself is stateless

# Anatomy of a Request/Response

- An HTTP request/response consists of
  1. Method (request) / status (response)
  2. Header fields: meta information
  3. A blank line
  4. Body (sometimes): payload
- The header (parts 1-3) is ASCII text
  - Newline is CRLF (typical of IETF protocols)
  - Method/status is 1 line
  - Each header field is on its own line
  - Blank line separates header from body

# Protocol: Request, Response



Method
Header field 1
Header field 2

Body

Request

Response

Status
Header field 1
Header field 2
Header field 3

Body

# Request Header: Method

- Syntax of first line:

  ***`verb path version`***

  - Verb: **`GET, HEAD, POST, PUT, DELETE,`**…
  - Path: part of URL (path and query)

    **`scheme://FQDN:port/path?query#fragment`**
  - Version: **`HTTP/1.1, HTTP/2, HTTP/3`**
- Example:
  - For URL

    **`http://www.osu.edu/academics#content`**
  - First line of HTTP request is

    **`GET /academics HTTP/1.1`**

# Request Header: Header Fields

- □ Each field is on its own line:

  ```
  name: value
  ```

- □ Examples

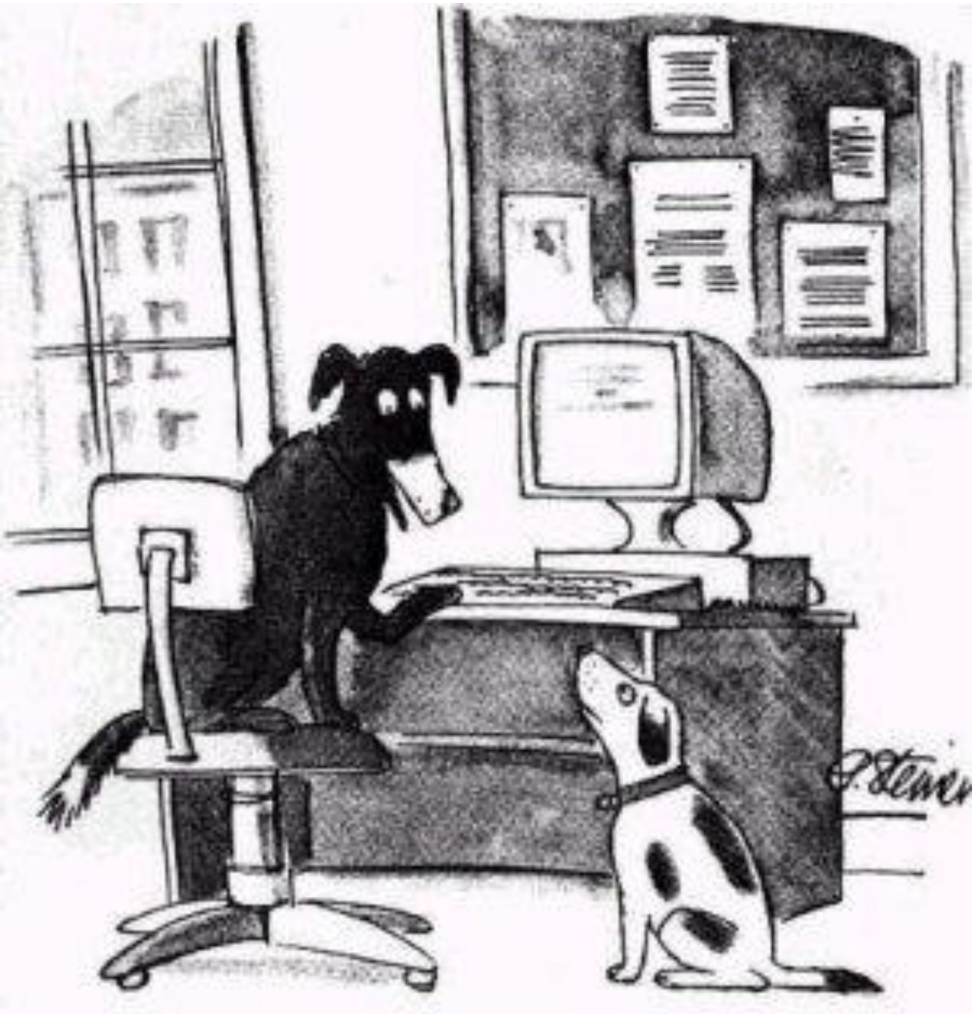
  ```
  Host: cse.ohio-state.edu
  Accept: text/*,image/apng
  Accept-Language: en-US,en;q=0.9
  If-Modified-Since: Sat, 12 May 2021 19:43:31 GMT
  Content-Length: 349
  User-Agent: Mozilla/5.0 (X11; Linux x86_64) Chrome116.0.0.0 Safari/537.36
  ```

- □ Header names are case insensitive

# Some Common Header Fields

- Host
  - The only required field
  - Q: Why is host field even needed?
- Accept, Accept-Language, Accept-Encoding
  - List of browser preferences for response
  - MIME types, language locales, transfer encodings
  - Priority based on order and q-value weight (0-1)
- User-Agent
  - Identifies application making request
- If-Modified-Since
  - Send payload only if changed since date
  - Date must be GMT
- Content-Length
  - Required if request has a body
  - Number of bytes in body
- Referer (misspelled in spec)
  - Previous web page, ie source of this request

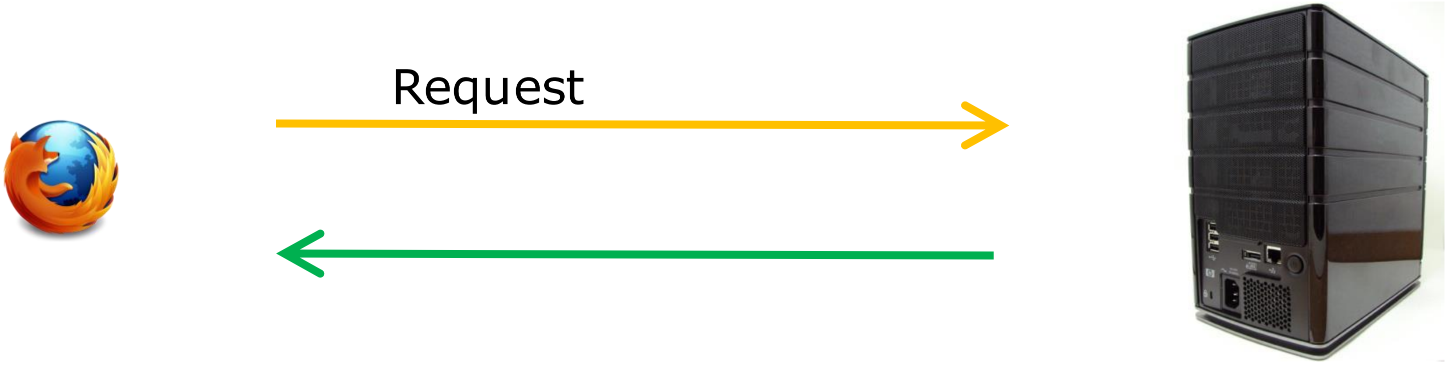
# Steiner, The New Yorker (1993)



"On the Internet, nobody knows you're a dog."

# "Nobody knows you're a dog"

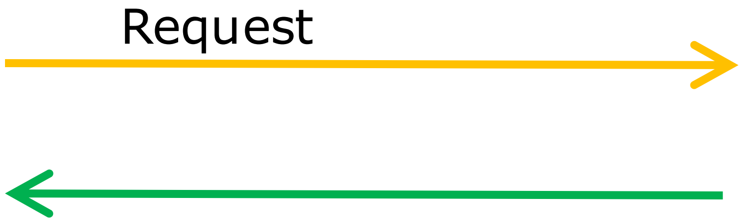
```
GET / HTTP/1.1
Host: www.osu.edu
User-Agent: Mozilla/5.0 (X11; Ubuntu;…etc
```



# "Nobody knows you're a dog"

```
$ telnet
```

```
GET / HTTP/1.1
Host: www.osu.edu
User-Agent: Mozilla/5.0 (X11; Ubuntu;…etc
```



```
$ curl -A "Mozilla/5.0" http://www.osu.edu
```

```
require 'mechanize'
agent = Mechanize.new
page = agent.get 'http://www.osu.edu'
```

# Demo: HTTP Request with telnet

- Example URL
  - cse3901-2025sp-giles.github.io/osu-cse3901-sp2025-giles.github.io/

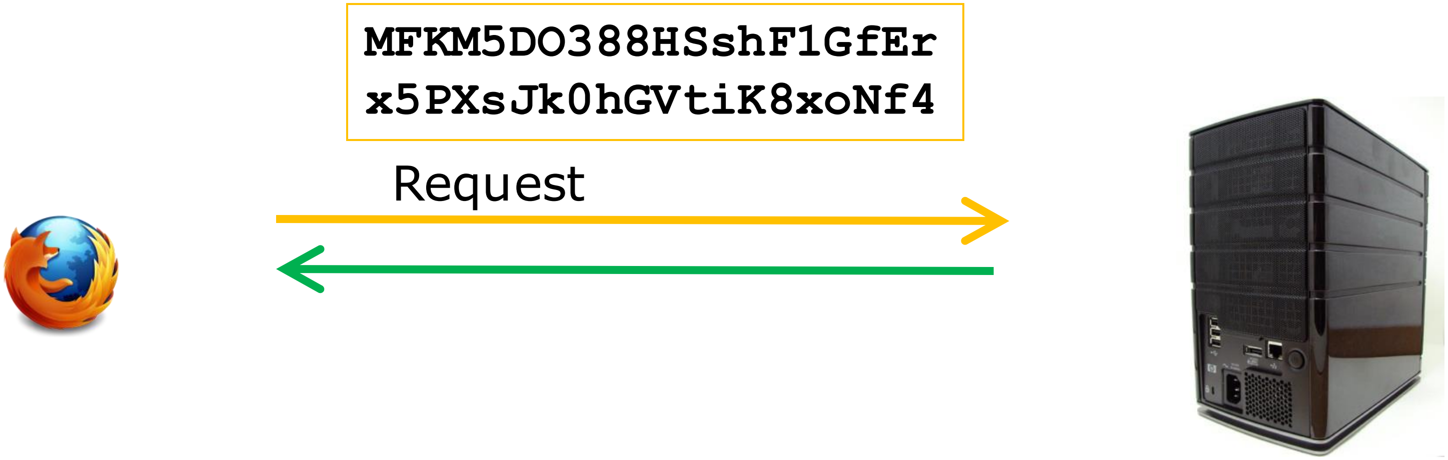
```
$ telnet cse3901-2025sp-giles.github.io/osu-cse3901-sp2025-giles.github.io/ 80
```

  - Opens connection to port 80, where a web server is listening
- Send the following HTTP request:

```
GET /news HTTP/1.1
Host: osu.edu
<blank line>
```

# HTTP Traffic Transparency

- Everything is visible to an eavesdropper
  - HTTP headers are plain text
  - HTTP payload may be binary
- To protect communication, use encryption
  - SSL, TLS: protocols to create secure channel
  - Initial handshake between client and server
  - Subsequent communication is encrypted
- HTTP over secure channel = HTTPS
  - Default port: 443



```
MFKM5DO388HSshF1GfEr
x5PXsJk0hGVtiK8xoNf4
```

Request

# Demo: HTTPS with openssl

- Use openssl instead of telnet
  - Negotiates initial handshake with server
  - Handles encryption/decryption of traffic
- Example URL
  - https://www.osu.edu/
- At console

```
$ openssl s_client -connect www.osu.edu:443
```

  - Note connection to port 443 (ie https)
- Syntax of subsequent request is the same
- Send the following HTTP request:

```
GET / HTTP/1.1
Host: www.osu.edu
<blank line>
```

# HTTP Response Anatomy

- Recall, four parts
  1. Status (one line)
  2. Header fields (separated by newlines)
  3. Blank line
  4. Body (*i.e.*, payload)
- Parts 1-2 collectively are the header
- Status line syntax:

```
http-version status-code text
```

  - Examples

```
HTTP/1.1 200 OK
HTTP/1.1 301 Moved Permanently
HTTP/1.1 404 Not Found
```

# Taxonomy of Status Codes

| Code | Meaning |
|---|---|
| 1xx | Informational |
| 2xx | Success |
| 3xx | Redirection |
| 4xx | Client Error |
| 5xx | Server Error |

# Some Common Status Codes

- 200 Success/OK
  - All is good!
  - Response body is the requested document
- 301 Permanent Redirect / 302 Temporary Redirect
  - Requested resource is found somewhere else
  - 301 means please go to new location in the future
- 304 Not Modified
  - Document hasn’t changed since date/time in If-Modified-Since field of request
  - No response body
- 404 Not Found
  - Server could not satisfy the request
  - It is the client’s fault (design-by-contract?)
- 500 Internal Server Error
  - Server could not satisfy the request
  - It is the server’s fault (design-by-contract?)

# Response Header: Header Fields

- □ Each field on its own line, syntax:

  ```
  name: value
  ```

- □ Examples

  ```
  Date: Tue, 19 Sep 2023 17:31:18 GMT
  Server: Apache/2.4.6 (Red Hat)
  Content-Type: text/html; charset=UTF-8
  Content-Encoding: gzip
  Content-Length: 333
  ```

- □ Blank line indicates end of headers

# Demo: Using Terminal

- Telnet is cumbersome
  - Requesting the following by telnet fails (why?)

    http://cse3901-2025sp-giles.github.io/osu-cse3901-sp2025-giles.github.io/

    Try:

    https://cse3901-2025sp-giles.github.io/osu-cse3901-sp2025-giles.github.io/
  - Body is incomplete (no images)
  - Body is chunked
- Better command-line tool: cURL
  - Handles redirection, chunking, https, headers, …

    ```
    $ curl -Li cse3901-2025sp-giles.github.io/osu-cse3901-sp2025-giles.github.io/
    ```
  - Can explicitly set request headers (-H)

    ```
    $ curl https://www.osu.edu \
        -A "Mozilla/5.0"
        -H "accept: text/html"
    ```

# Demo: Chrome Developer Tools

- Powerful inspection tool for the web
  - Kabob > More Tools… > Developer Tools, then see the Network tab
- One GET results in many requests

  `https://cse3901-2025sp-giles.github.io/osu-cse3901-sp2025-giles.github.io/`

- For each request, see:
  - Request method, headers
  - Response status code, and headers
  - Response body (and preview)
- To reproduce a request:
  - Right click, Copy > Copy as cURL

# Demo: Using Ruby

- □ Mechanize: A Ruby gem for HTTP

```
require 'mechanize'
```

- □ Create an agent to send requests

```
agent = Mechanize.new do |a|
  a.user_agent_alias = 'Mac Safari'
end
```

- □ Use agent to issue a request

```
page = agent.get 'https://news.osu.edu'
```

- □ Follow links, submit forms, etc

```
h = page.link_with(text: /Top/).click
f = page.forms[0]
f.field_with(name: 'q').value = 'CSE'
s = f.submit
```

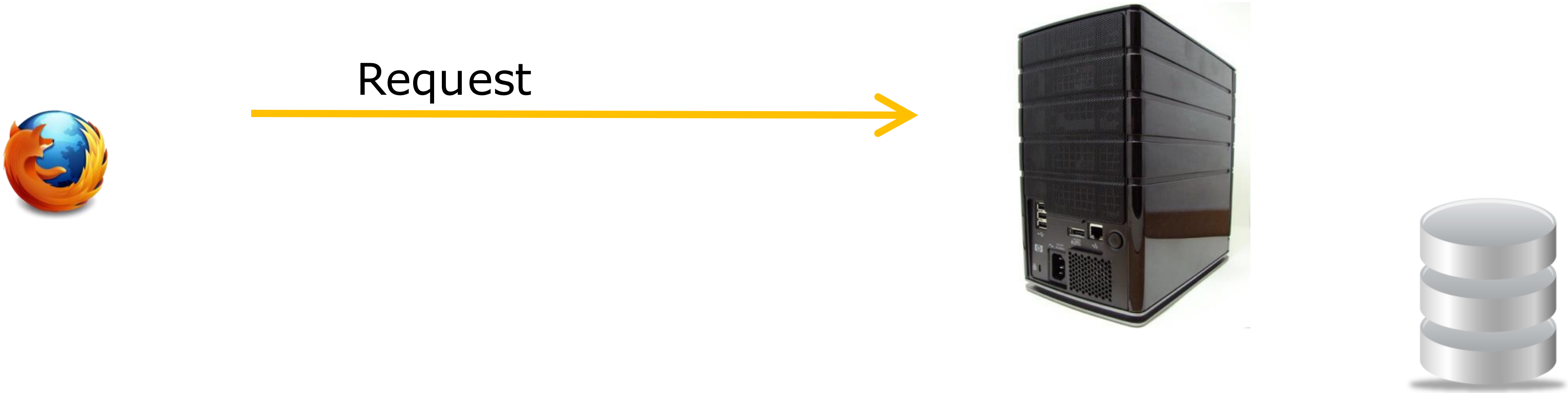
# Request Methods

- GET, HEAD
  - Request: should be *safe* (no side effects)
  - Request has header only (no body)
- PUT
  - Update (or create): should be *idempotent*
- DELETE
  - Delete: should be *idempotent*
- POST
  - Create (or update): changes server state
  - Beware re-sending!
- HTTP does not enforce these semantics

# HTTP is Stateless

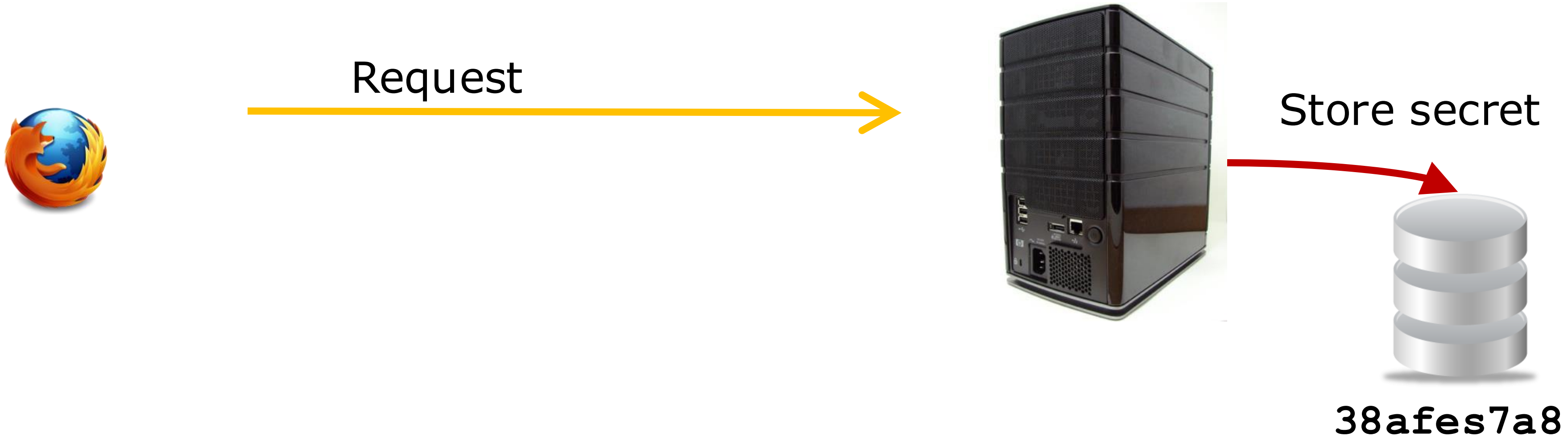
- Every request looks the same
- But maintaining state between requests is really useful:
  - User logs in, then can GET account info
  - Shopping cart “remembers” contents
- Solution: Keep a shared secret
  - Server's first response contains a unique session identifier (a long random value)
  - Subsequent requests from this client include this secret value
  - Server recognizes the secret value, request must have come from original client

# HTTP Session



Request

# HTTP Session

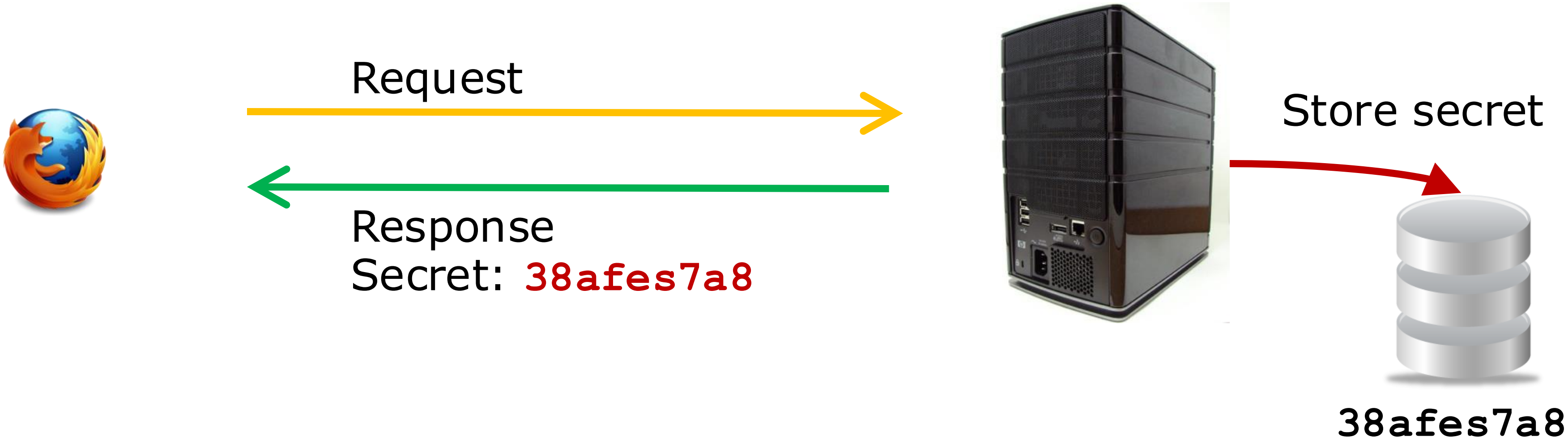


Request

Store secret

**38afes7a8**

# HTTP Session



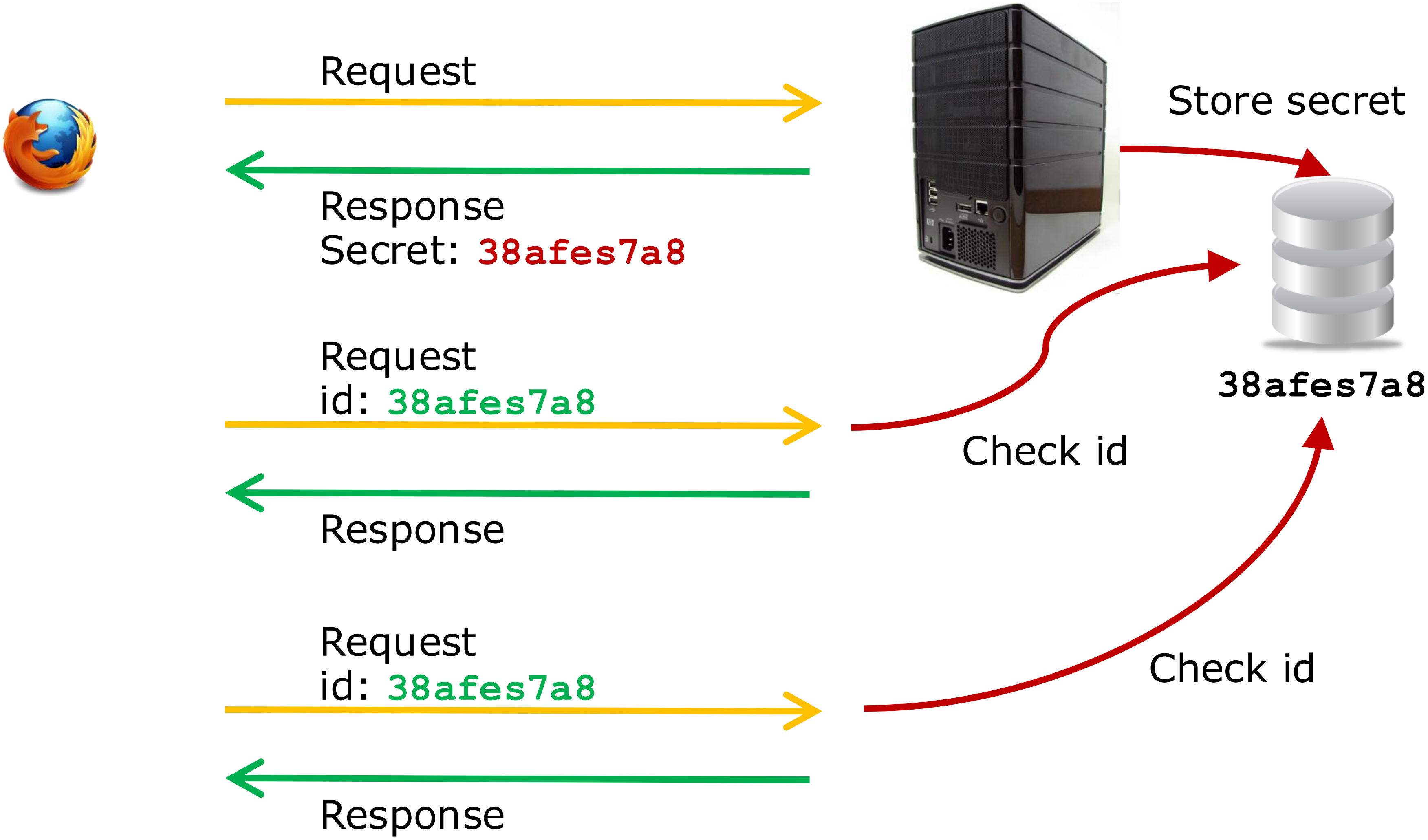
Request

Response
Secret: 38afes7a8

Store secret

38afes7a8

# HTTP Session



Request

Response
Secret: 38afes7a8

Store secret

38afes7a8

Request
id: 38afes7a8

Check id

Response

Request
id: 38afes7a8

Check id

Response

# HTTP Cookies

- Popular mechanism for session manag'nt
- Set in *response* header field

  ```
  Set-Cookie: session=38afes7a8
  ```

  - Any name/value is ok
  - Options: expiry, require https
- Client then includes cookie(s) in any subsequent request to that domain
- Sent in *request* header field:

  ```
  Cookie: session=38afes7a8
  ```

- Cookies also used for
  - Tracking/analytics: What path did they take?
  - Personalization

# Summary

- HTTP: request/response
- Anatomy of request
  - Methods: GET, PUT, DELETE, POST
  - Headers
  - Body: arguments of POST
- Anatomy of response
  - Status Codes: 200, 301, 404, etc
  - Headers
  - Body: payload
- Tools
  - Curl, Developer Tools, Mechanize