

Application layer

# HTTP

- URL
- HTTPS
- DNS used to resolve hosts in URLs to IP addresses
- Request/Response based protocol
- HTTP 1.0
  - New TCP connection per request/response
- HTTP 1.1
  - Pipelining for multiple request/response pairs per TCP connection
  - WebSockets for bidirectional communication
- HTTP 2.0
  - Binary
  - Request multiplexing over a single TCP connection

# HTML

- Structured documents with links and custom rendering.
- HTML elements are delineated by tags, which can be nested.
- Cascading Style Sheets (CSS) - used to abstract away “presentation”

# DNS

- Human readable domain names  $\Rightarrow$  IP addresses
- UDP as opposed to TCP
- Distributed database
- Authoritative nameserver
- Root nameserver
- Recursive resolution
- Resource records: A, AAAA, CNAME, MX, NS

# Mail

- Mailserver at sender's end, receiver's end
- MX record
- SMTP over TCP
- Port 25 for plaintext, Port 465 for encrypted text
- MIME standard
- POP3 over TCP, client downloads email, deletes from server
- IMAP over TCP, client has a view into the email in the server
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# Sockets

- Endpoints of a connection, usually a (host, port) pair
- TCP, UDP, or other protocols are used

# Protocol Layers

- Abstraction allows for independent improvements
- Application, Transport, Network, and Link layers form the TCP/IP stack
- Header/Payload, all the way down

