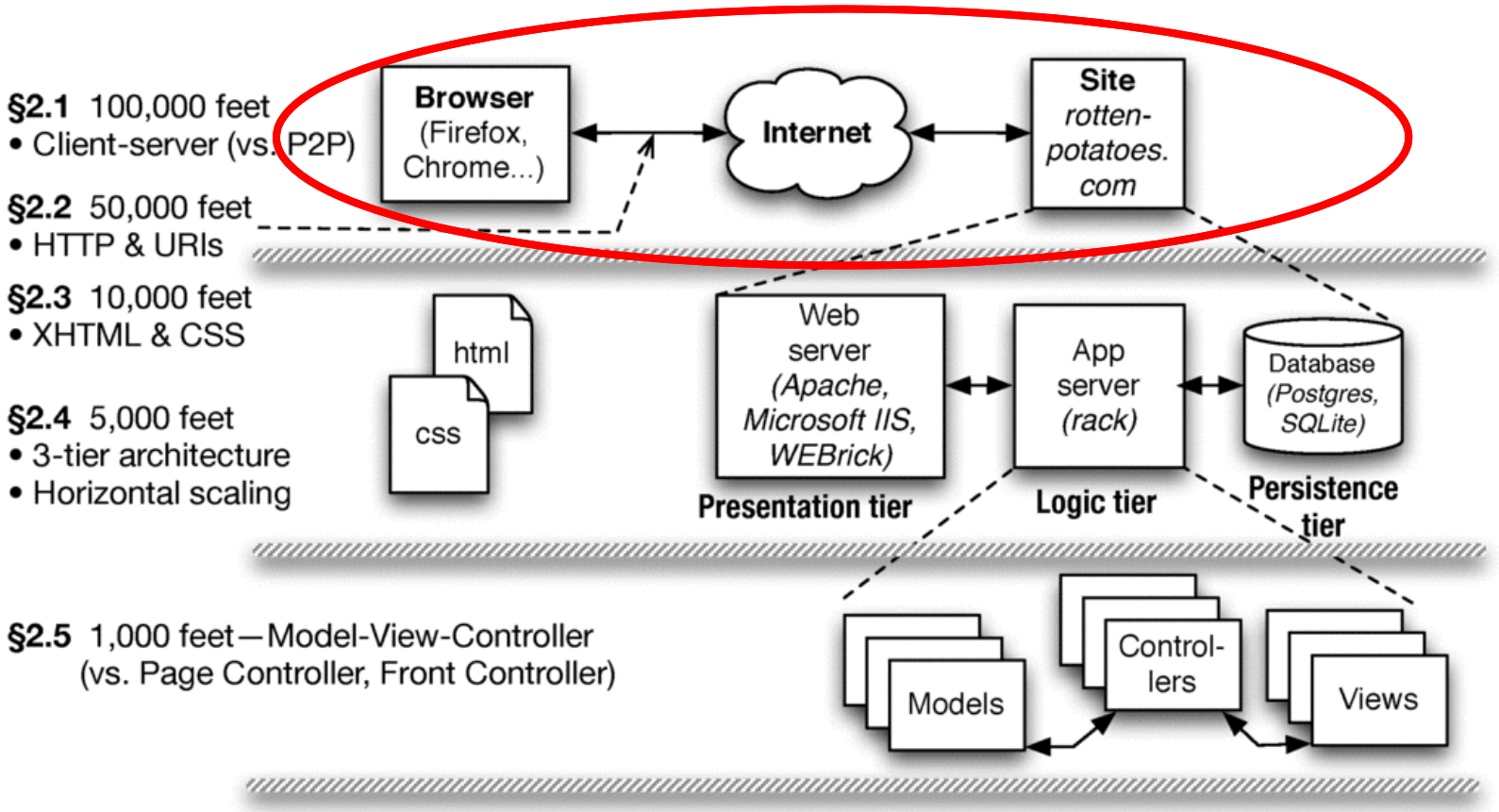
The Architecture of SaaS Applications

Chung-Kil Hur

(Credit: Byung-Gon Chun & Many Slides from UCB CS169 taught by Armando Fox and David Patterson)

SWPP, CSE, SNU

The Web as a Client-Server System; TCP/IP intro



§2.6 500 feet: Active Record models (vs. Data Mapper)
§2.7 500 feet: RESTful controllers (Representational State Transfer for self-contained actions)
§2.8 500 feet: Template View (vs. Transform View)

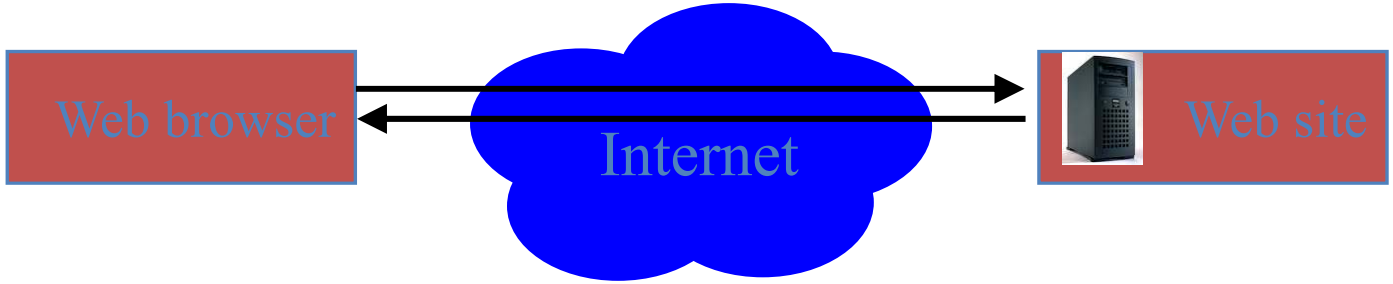
• **Active Record**
• Data Mapper

• **REST**

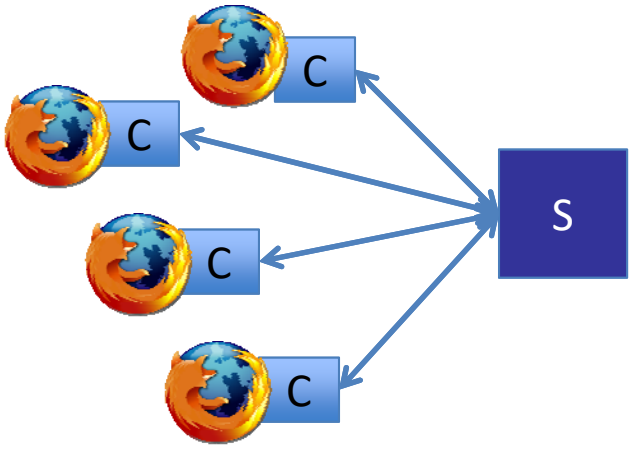
• **Template View**
• Transform View

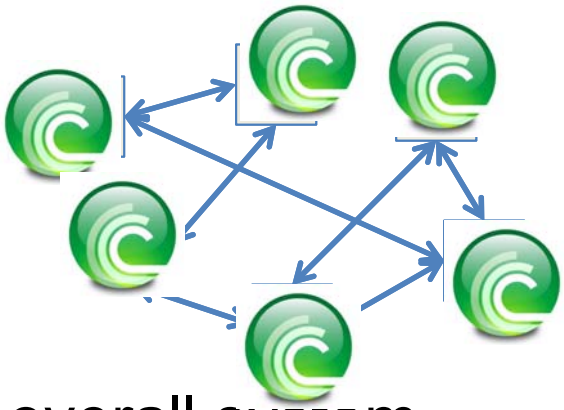
Web at 100,000 feet

- The web is a c*lient/server* architecture
- It is fundamentally *request/reply oriented*



Client-Server vs. Peer-to-Peer

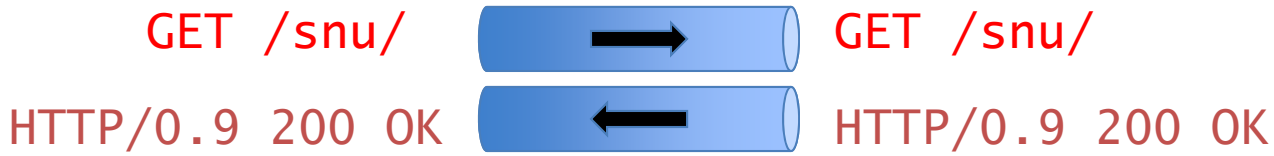




- High-level architecture of the overall system
  - Soon we'll talk about architecture "inside" boxes
- Client & server each *specialized* for their tasks
  - Client: ask questions on behalf of users
  - Server: wait for & respond to questions, serve many clients
- Design Patterns capture common structural solutions to recurring problems
  - Client-Server is an *architectural pattern*

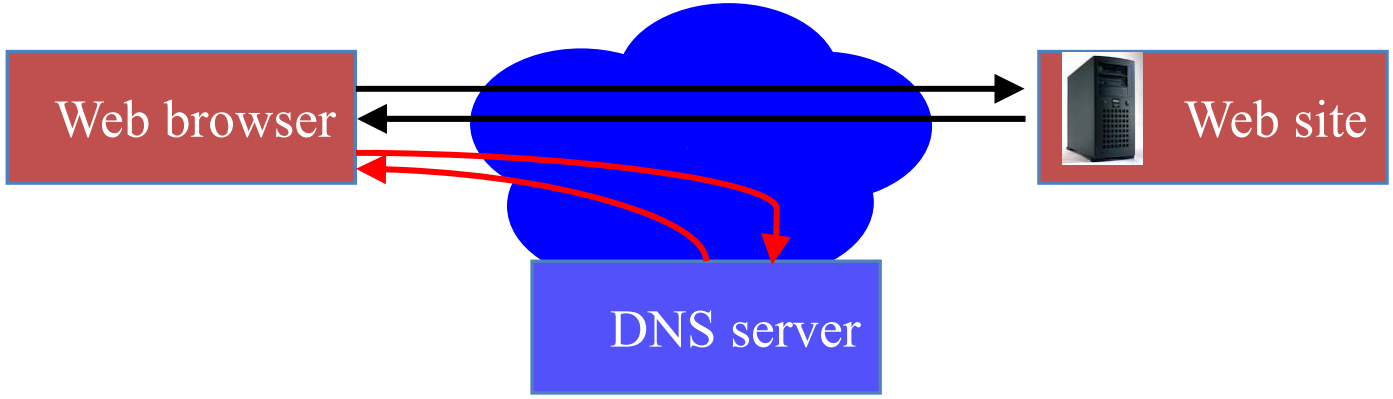
Nuts and bolts: TCP/IP protocols

- IP (Internet Protocol) *address* identifies a physical network interface with four *octets,* e.g. `128.32.244.172`
  - Special address `127.0.0.1` is "this computer", named `localhost`, even if not connected to the Internet!
- TCP/IP (Transmission Control Protocol/Internet Protocol)
  - IP: no-guarantee, best-effort service that delivers *packets* from one IP address to another
  - TCP: make IP reliable by detecting "dropped" packets, data arriving out of order, transmission errors, slow networks, etc., and respond appropriately
  - TCP *ports* allow multiple TCP apps on same computer
- Vint Cerf & Bob Kahn: 2004 Turing Award for Internet architecture & protocols, incl. TCP/IP



Web at 100,000 feet

- The web is a *client/server* architecture
- It is fundamentally *request/reply oriented*
- Domain Name System (DNS) is another kind of server that maps *names* to *IP addresses*



Now that we're talking, what do we say?

Hypertext Transfer Protocol

- an *ASCII-based request/reply protocol* for transferring information on the Web
- *HTTP request* includes:
  - *request method* (`GET`, `POST`, etc.)
  - Uniform Resource Identifier (URI)
  - HTTP protocol version understood by the client
  - *headers*—extra info regarding transfer request
- *HTTP response* from server
  - Protocol version & Status code =>
  - Response headers
  - Response body

HTTP status codes:
2xx — *all is well*
3xx — *resource moved*
4xx — *access problem*
5xx — *server error*

Cookies

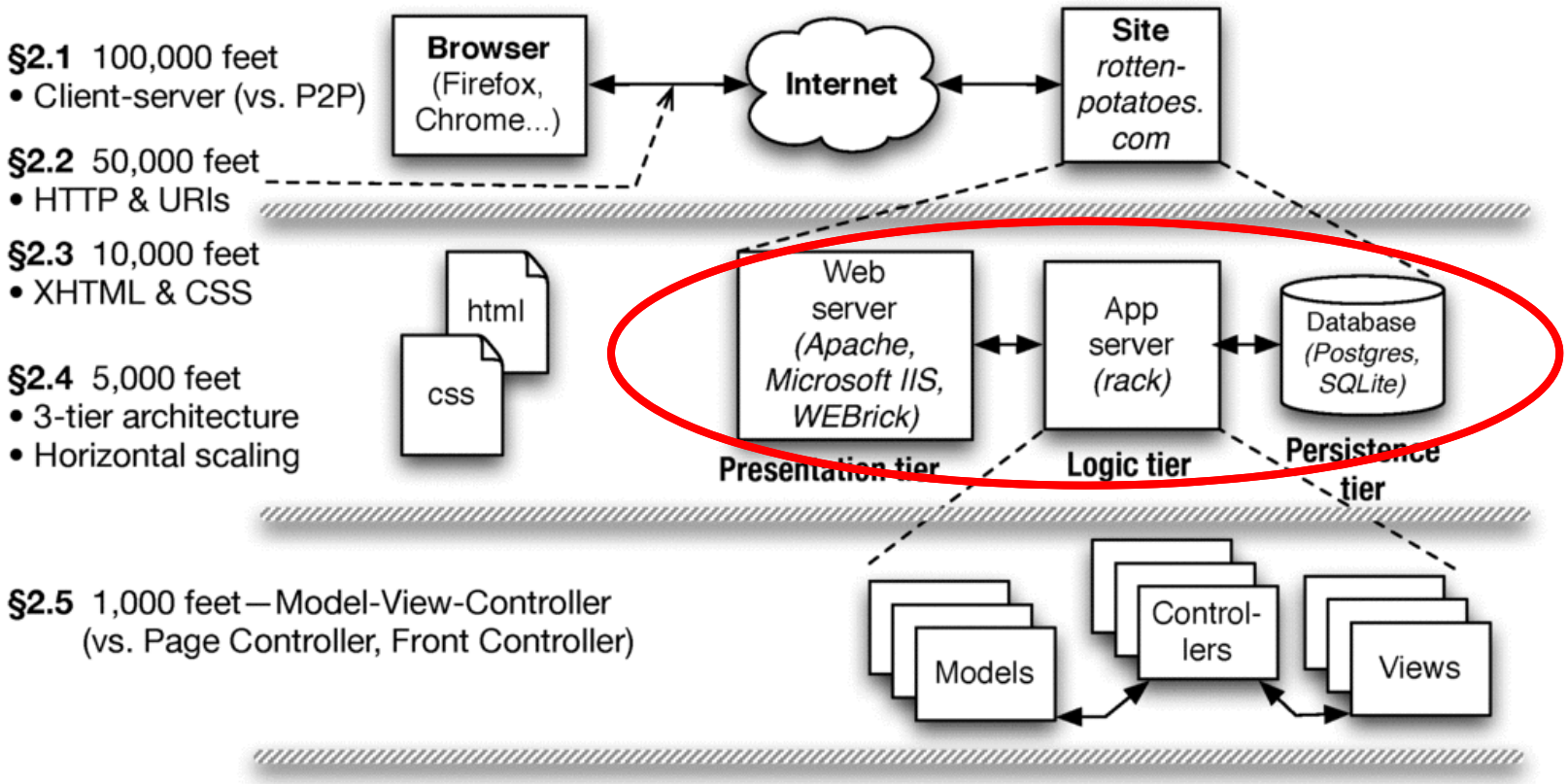
- Observation: *HTTP is stateless*
- Early Web 1.0 problem: how to guide a user "through" a flow of pages?
  - use IP address to identify returning user?
    - ✖ public computers, users sharing single IP
  - embed per-user junk into URI query string?
    - ✖ breaks caching
- Quickly superseded by *cookies*
- Note. Rails manages tamper-evident cookies for you

Client Pull vs. Server Push

- WebSockets and HTML5 have some support for allowing the server to push updated content to the client
  - Periodic polling

- True server push – allow the server to initiate connection to the client to wake it up when new information is available

3-tier shared-nothing architecture & scaling

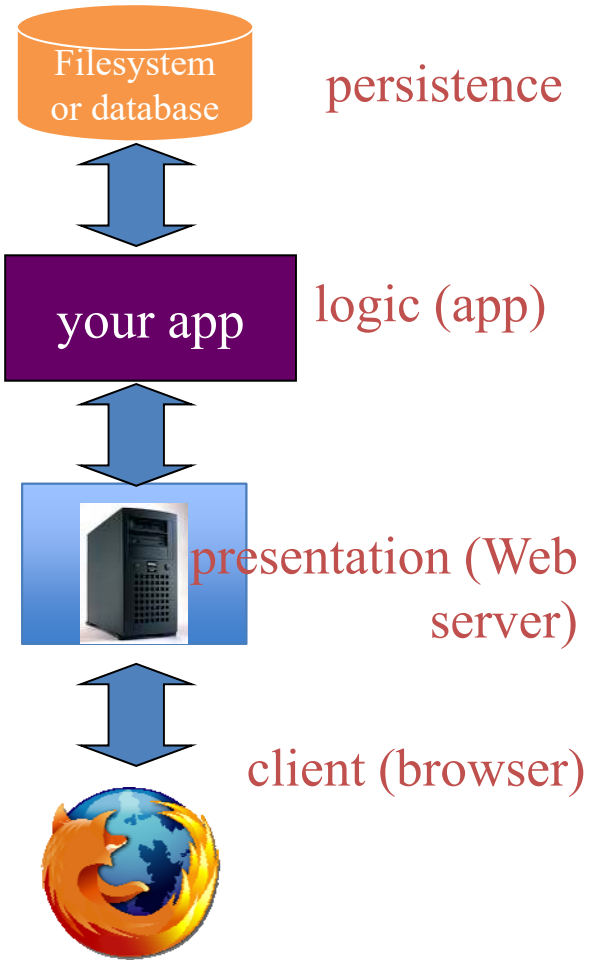

§2.1 100,000 feet
• Client-server (vs. P2P)
§2.2 50,000 feet
• HTTP & URIs
§2.3 10,000 feet
• XHTML & CSS
§2.4 5,000 feet
• 3-tier architecture
• Horizontal scaling
Browser
(Firefox, Chrome...)
Internet
Site
rotten-potatoes.com
html
css
Web server
(Apache, Microsoft IIS, WEBrick)
App server
(rack)
Database
(Postgres, SQLite)
Presentation tier
Logic tier
Persistence tier
§2.5 1,000 feet—Model-View-Controller
(vs. Page Controller, Front Controller)
Models
Control-lers
Views
§2.6 500 feet: Active Record models (vs. Data Mapper)
§2.7 500 feet: RESTful controllers (Representational State Transfer for self-contained actions)
§2.8 500 feet: Template View (vs. Transform View)
• Active Record
• Data Mapper
• REST
• Template View
• Transform View

Dynamic content generation

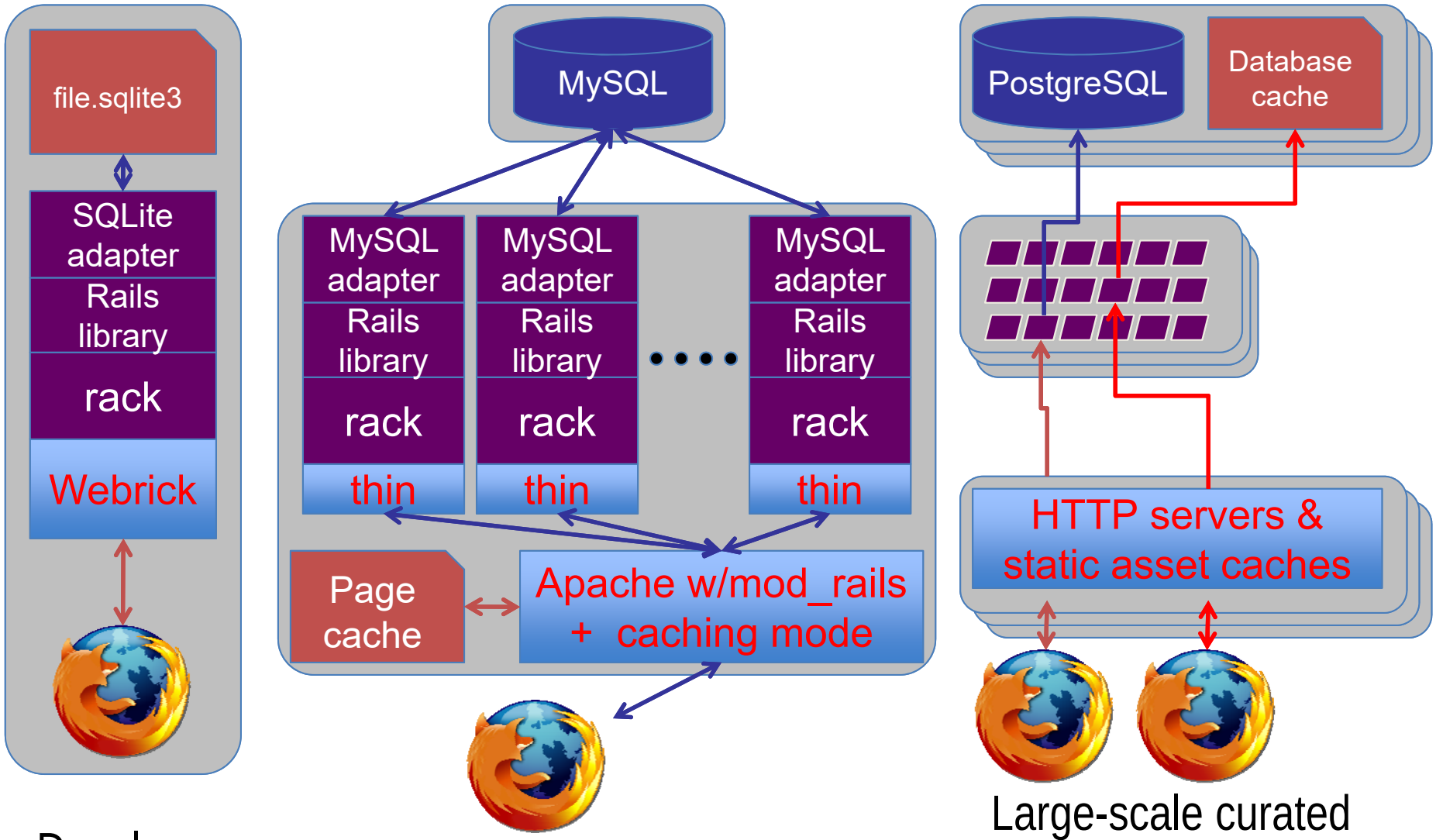
- In the Elder Days, most web pages were (collections of) plain old files
- But most interesting Web 1.0/e-commerce sites *run a program* to generate each "page"
- Originally: templates with embedded code "snippets"
- Eventually, code became "tail that wagged the dog" and moved out of the Web server

Sites that are really programs (SaaS)

- How do you:
  - "map" URI to correct program & function?
  - pass arguments?
  - invoke program on server?
  - handle persistent storage?
  - handle cookies?
  - handle errors?
  - package output back to user?
- *Frameworks* support these common tasks



Developer environment vs. medium-scale deployment

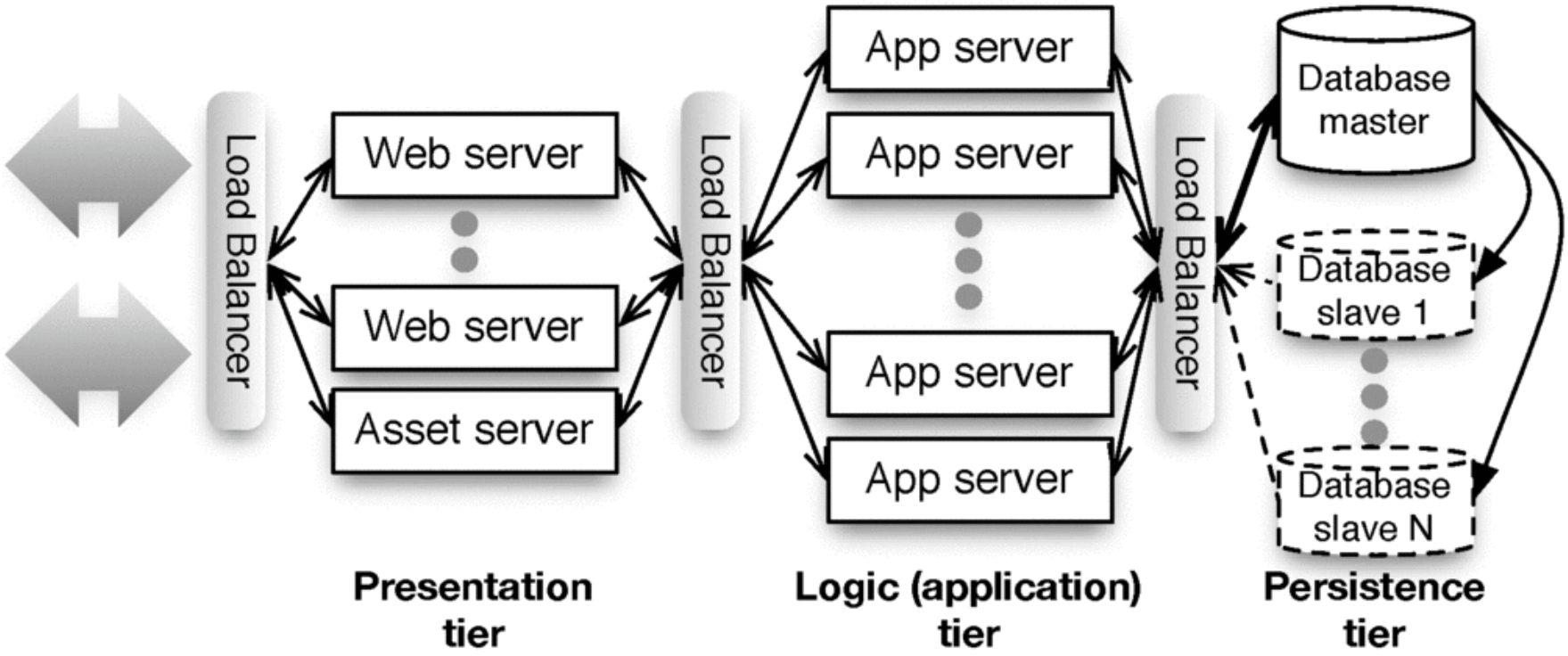


Developer

Medium-scale deployment

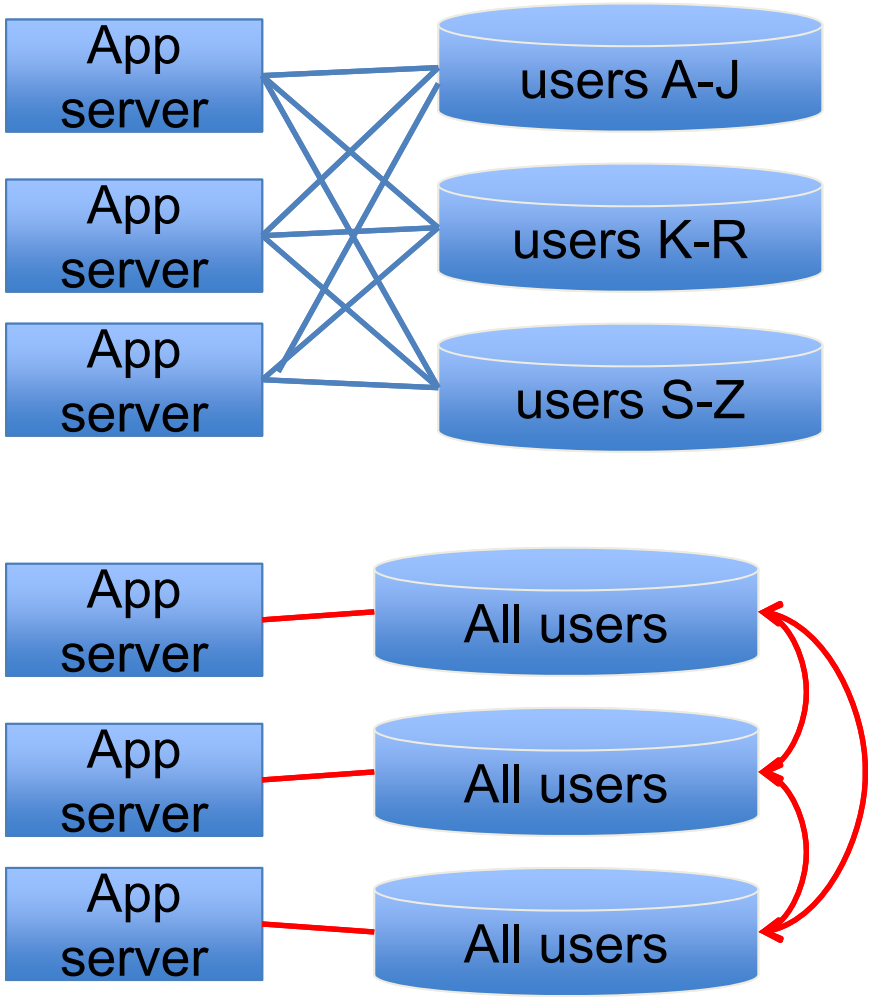
Large-scale curated deployment, e.g. Heroku

“Shared nothing”



Sharding vs. Replication

- Partition data across independent “shards”?
  - + Scales great
  - – Bad when operations touch >1 table
  - – Example use: user profile
- Replicate all data everywhere?
  - + Multi-table queries fast
  - – Hard to scale: writes must propagate to all copies => temporary *inconsistency* in data values
  - – Example: Facebook wall posts/“likes”



Summary: Web 1.0 SaaS

- Browser *requests* web resource (URI) using HTTP
  - HTTP is a simple request-reply protocol that relies on TCP/IP
  - In SaaS, most URI's cause a program to be run, rather than a static file to be fetched
- *HTML* is used to encode content, *CSS* to style it visually
- *Cookies* allow server to track client
  - Browser automatically passes cookie to server on each request
  - Server may change cookie on each response
  - Typical usage: cookie includes a *handle* to server-side information
  - That's why some sites don't work if cookies are completely disabled
- *Frameworks* make all these abstractions convenient for programmers to use, without sweating the details
- ...and help map SaaS to 3-tier, shared-nothing architecture