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Chapter 6:
Distributed Systems:
The Web

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Slides joint work with Jussi Kangasharju et al.

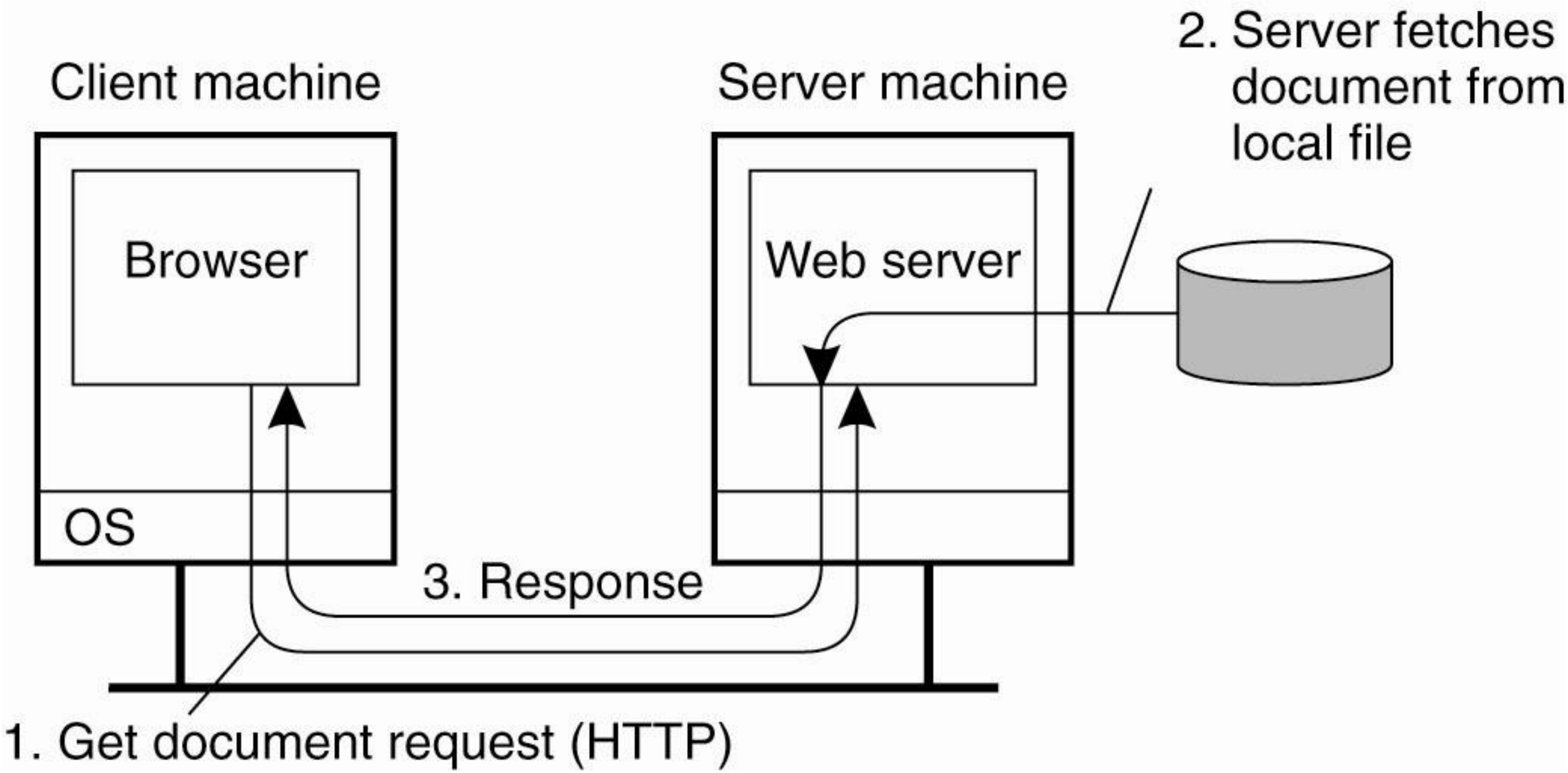
Chapter Outline

- Web as a distributed system
- Basic web architecture
- Content delivery networks
- Replication of web applications

Web: Distributed or Not?

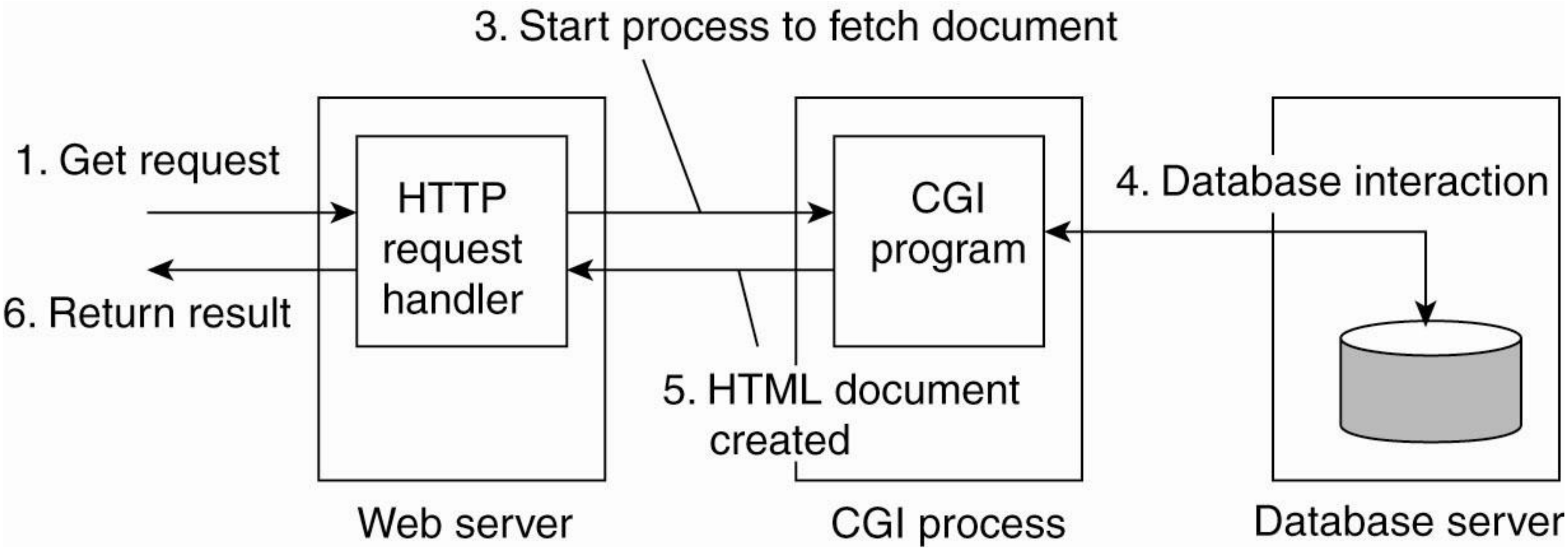
- Is the web a distributed system?
- Recall our definition:
  - Collection of independent computers → OK
  - Appears as single coherent system → ?!?
- Single coherent system = transparencies fulfilled?
- Sharing of resources → OK

Traditional Web-Based Systems



2. Server fetches document from local file
Client machine
Server machine
Browser
Web server
OS
3. Response
1. Get document request (HTTP)

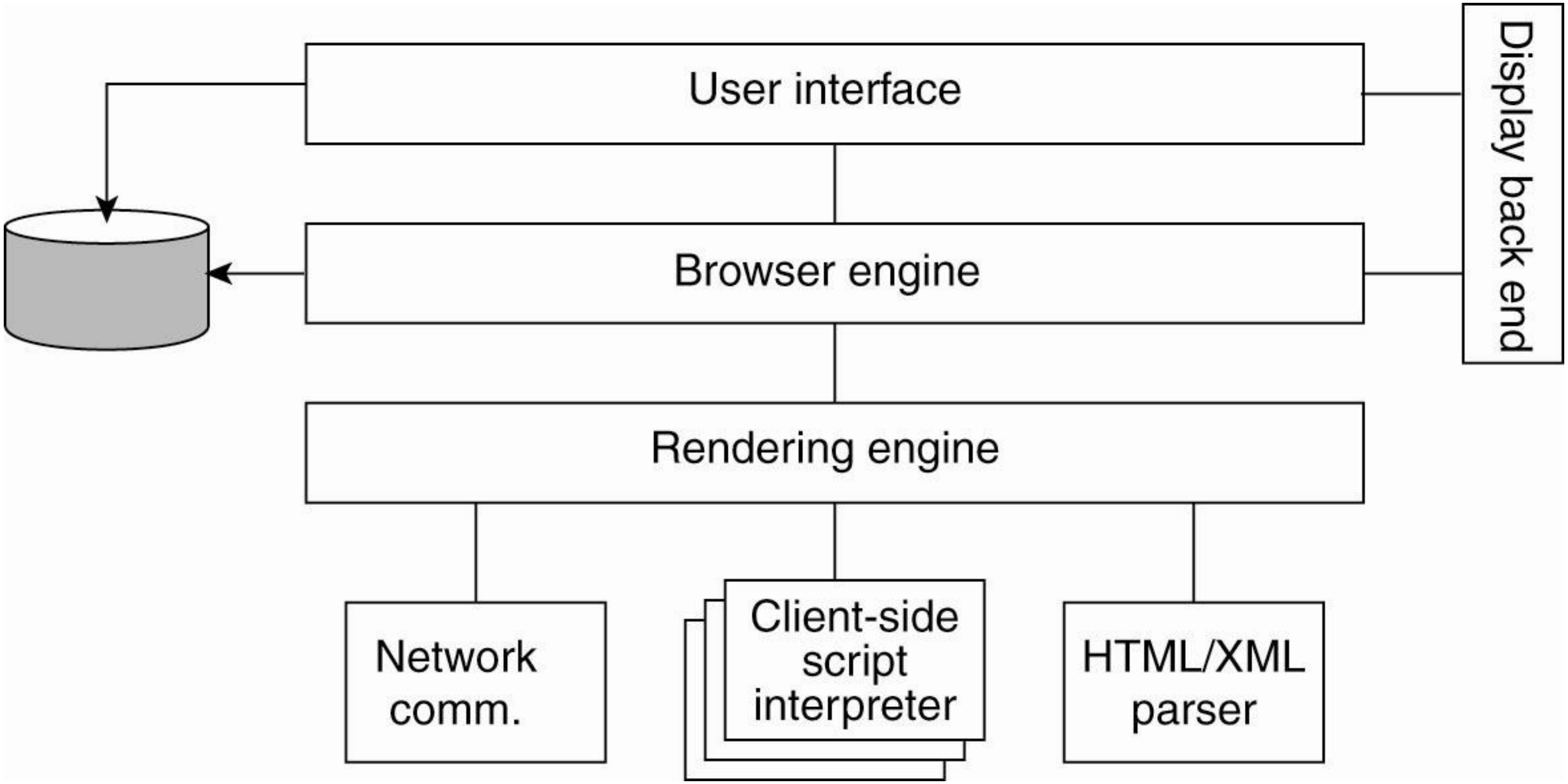
Multitiered Architectures



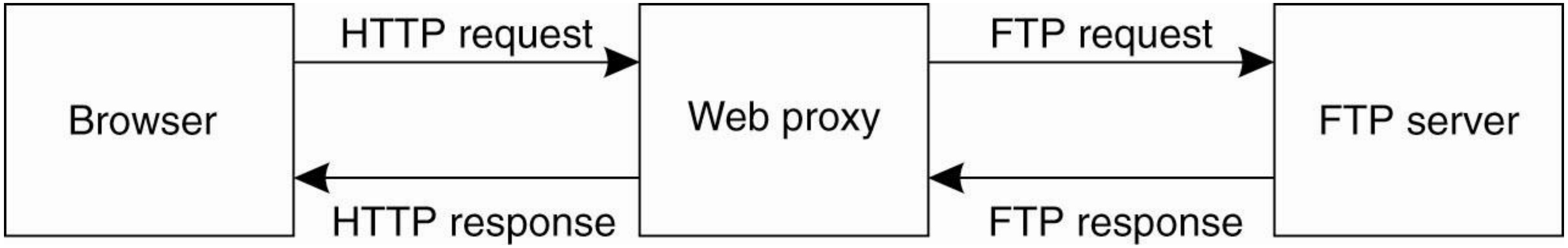
Important Elements

- Browser
- Servers and server farms
- Proxies
- Caching proxies

Browsers – the stereotypical Web Clients



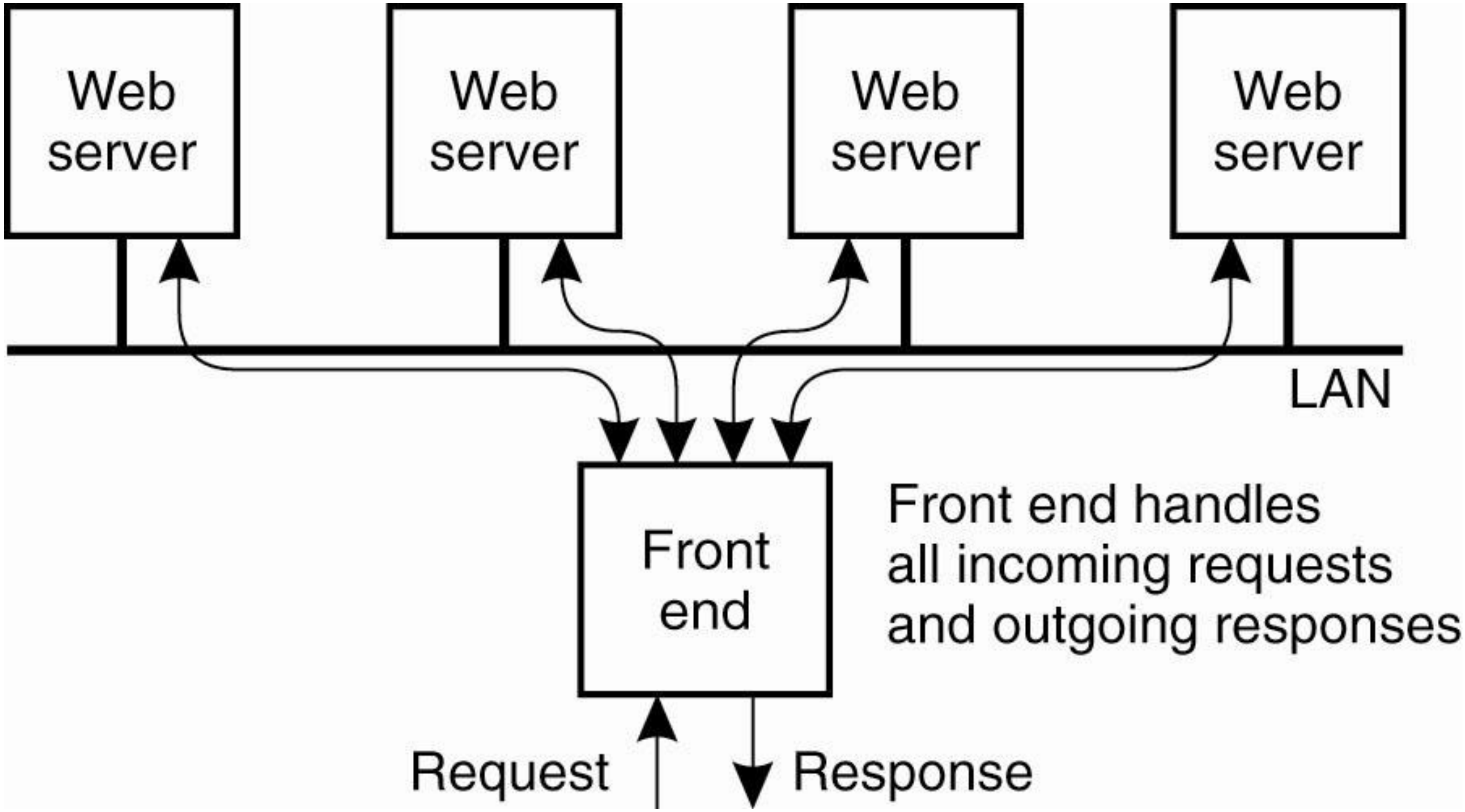
Clients With a Proxy



Terminology:
Proxy = simply proxying of requests and responses
Caching proxy = proxy with a cache

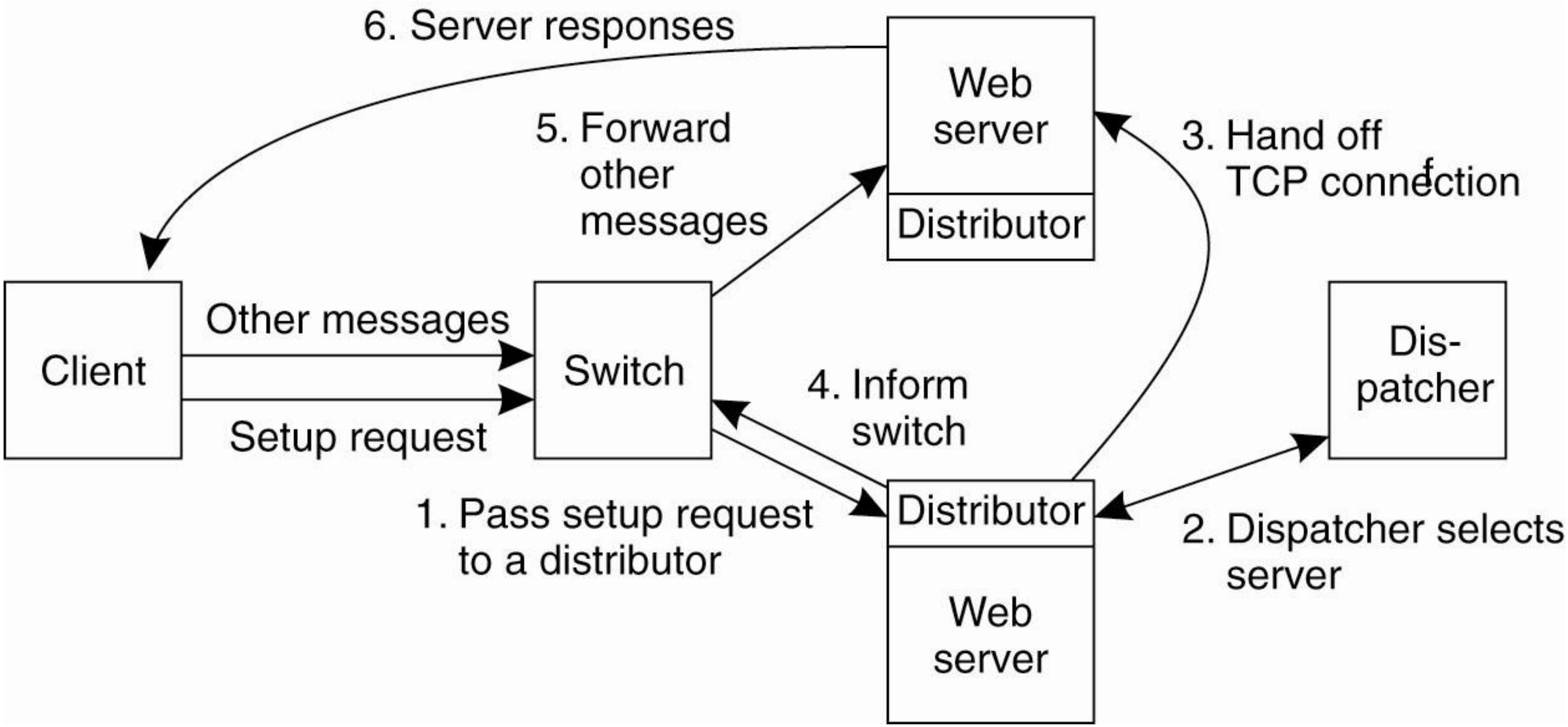
Commonly “proxy” = “caching proxy”

Web Server Clusters: Against Overload (1)



Redirection independent of requested content

Web Server Clusters (2)



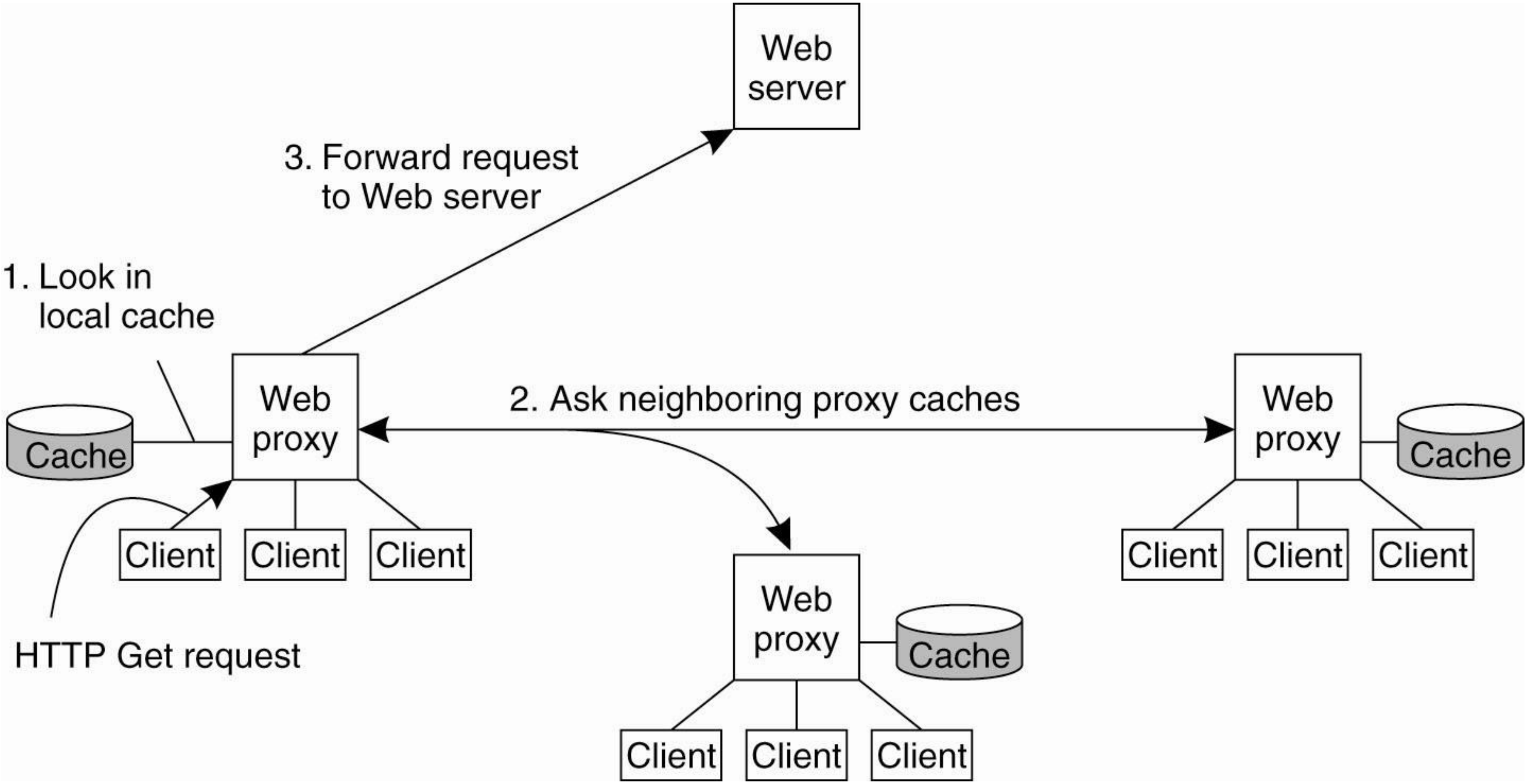
A content-aware cluster redirecting requests selectively.

Content-aware vs. Content-agnostic

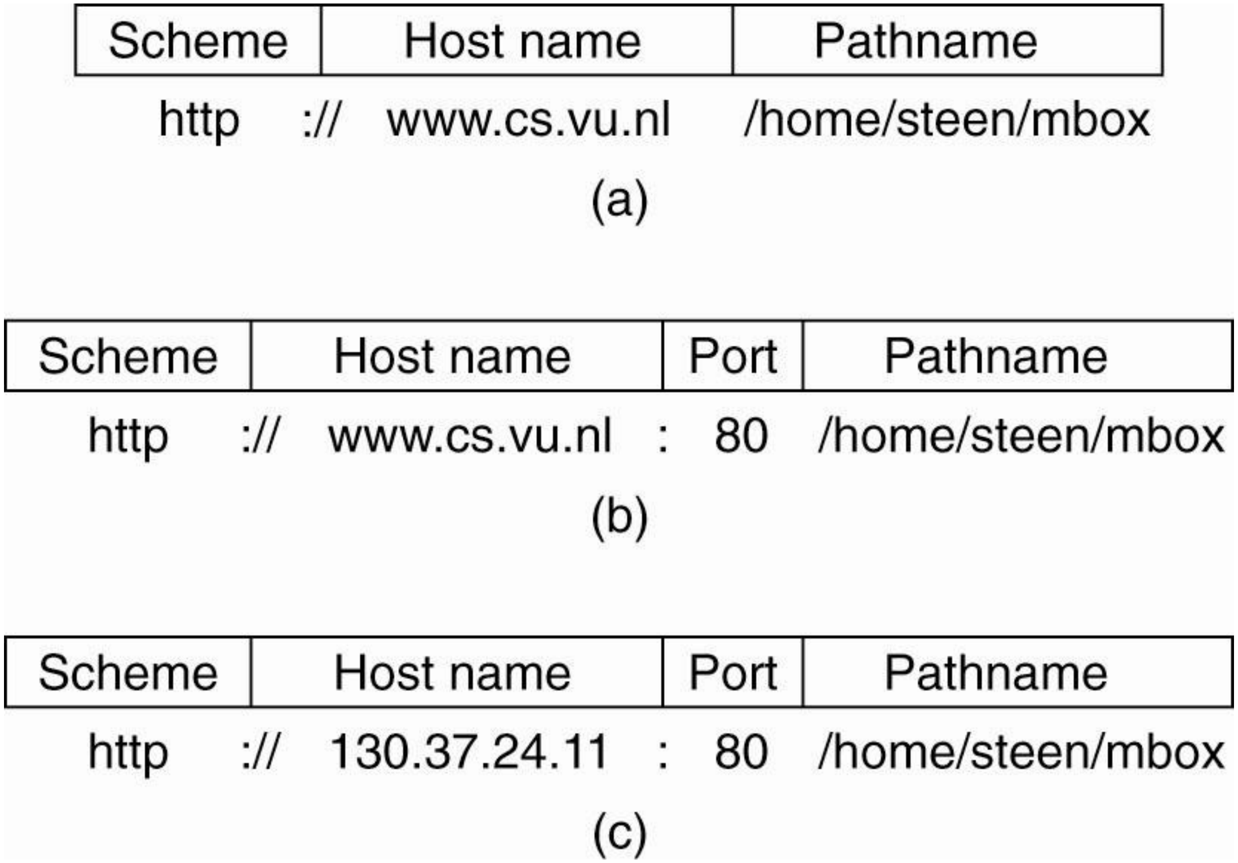
- Content-aware server selection:
  - Allows fine-grained selection and allocation of resources
  - Higher overhead at redirection point
  - No need to replicate all content on all servers

- Content-agnostic server selection:
  - Typically DNS load balancing
  - All servers must have identical content
  - Very high traffic → Even load distribution

Web Proxy Cooperative Caching



Refresher: Names in the Web



Scheme	Host name	Pathname

http :// www.cs.vu.nl /home/steen/mbox

(a)

Scheme	Host name	Port	Pathname

http :// www.cs.vu.nl : 80 /home/steen/mbox

(b)

Scheme	Host name	Port	Pathname

http :// 130.37.24.11 : 80 /home/steen/mbox

(c)

Why Are Names Important? (1)

- URLs identify content on the web
- URL is location-based: data lives on a server
- URL typically identifies origin server by name → DNS
- Can do many tricks with DNS
  - DNS load balancing for server farms
  - DNS redirection for Content Delivery Networks (CDN)

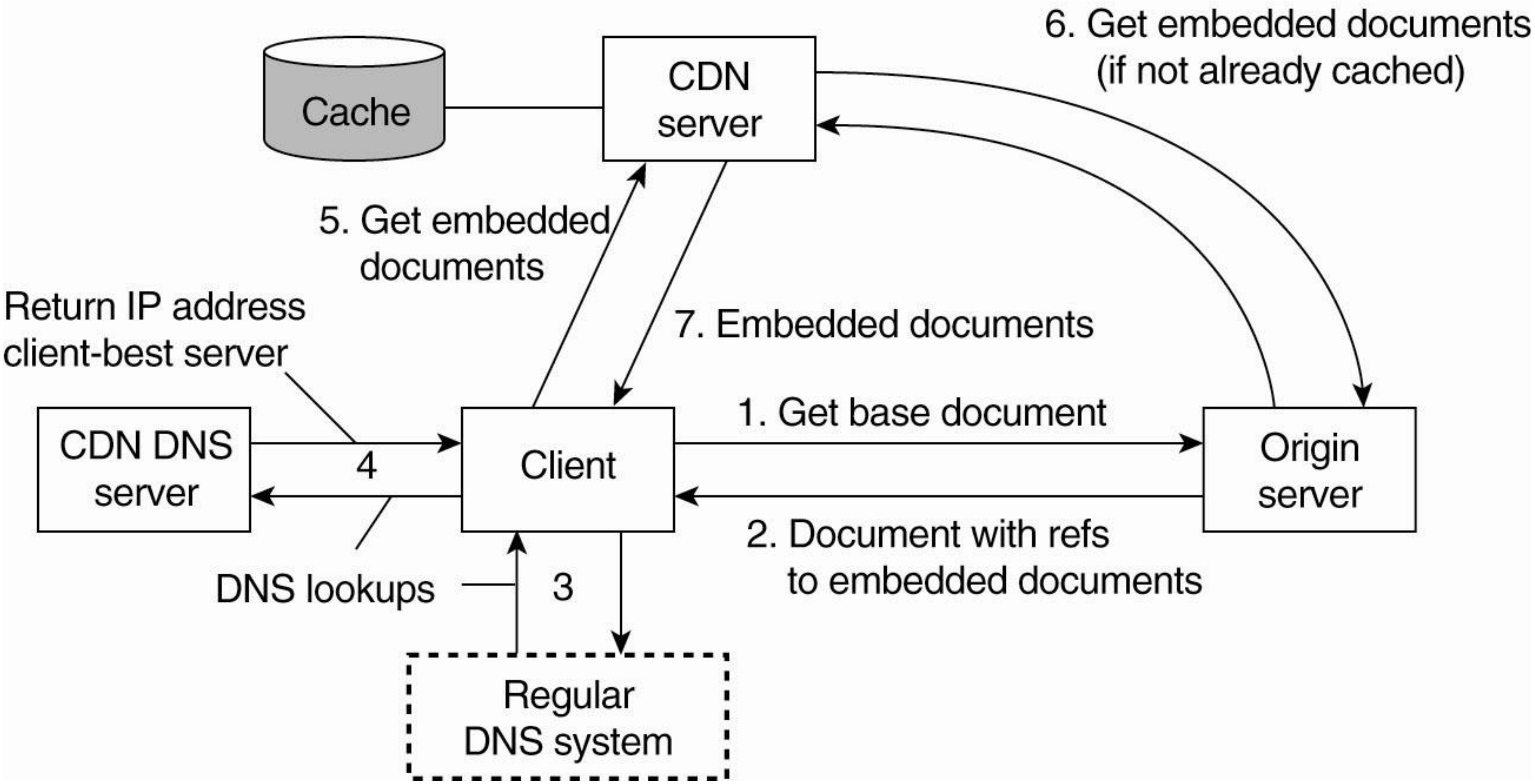
Why Are Names Important? (2)

- DNS as a distributed system: See homework 3.

- Alternative approach: Content-Centric Networking
  - Content floats around in the web
  - Location-independent names: e.g. URNs, DOIs (cf. ISBN)
  - Identify content by name, not the server it is on
  - Need a tracking service to find a server for a document

- Current research topic: how to route content effectively
  - E.g. “multicast” for a video stream instead of 10k separate connections – one for each concurrent viewer

Web Hosting With a Cloudful of Servers


6. Get embedded documents (if not already cached)
Cache
CDN server
5. Get embedded documents
Return IP address client-best server
7. Embedded documents
1. Get base document
CDN DNS server
4
Client
Origin server
2. Document with refs to embedded documents
DNS lookups
3
Regular DNS system

- The principal working of the Akamai Content Delivery Network.

Total Redirection in Content Delivery Networks

- Any request for origin server is redirected to CDN
- CDN takes control of content provider’s DNS zone
- Benefit: All requests are automatically redirected
- Disadvantage: May send lots of traffic to CDN, hence expensive for the content provider

Selective Redirection

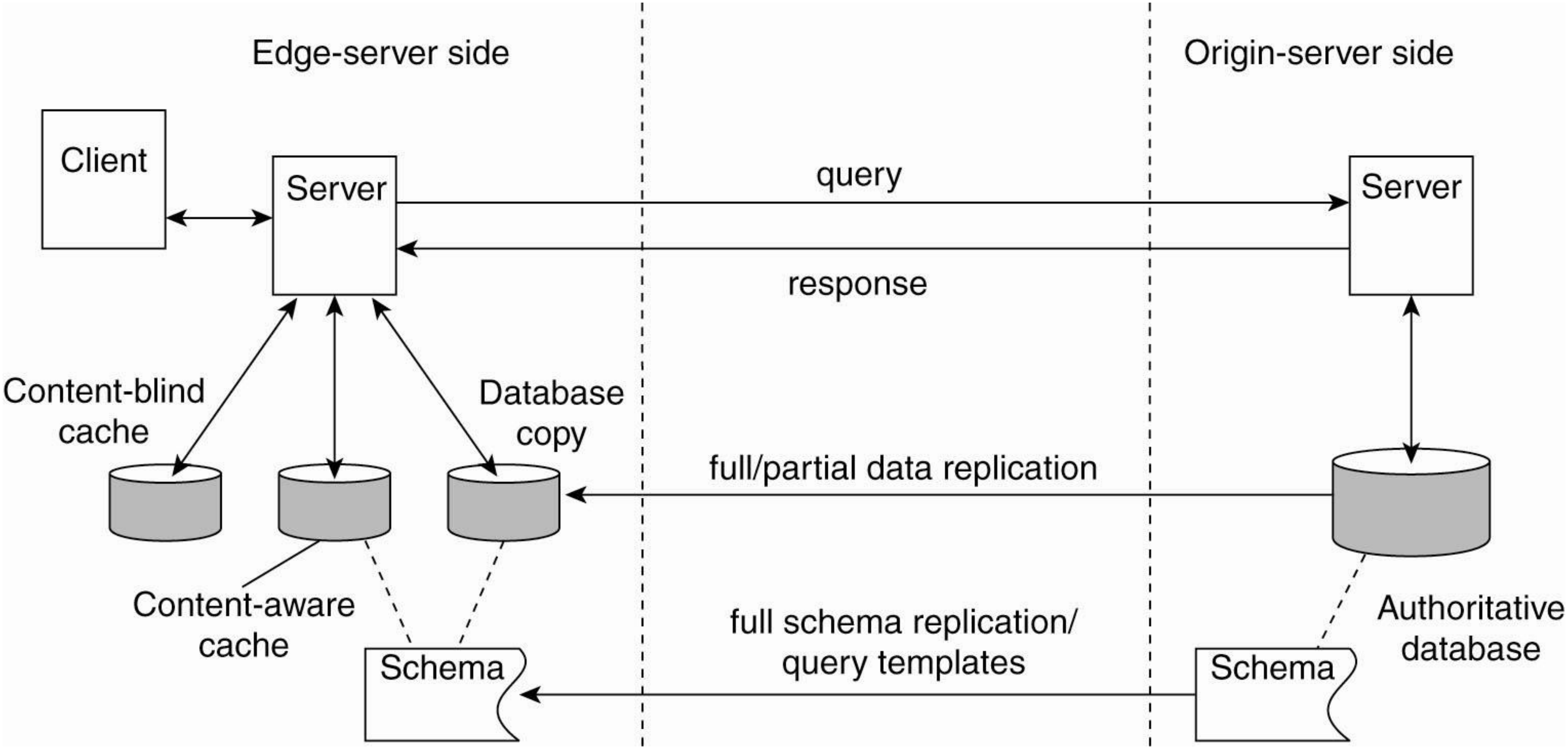
- Content provider marks which objects are to be served from CDN
  - Typically, larger objects like images are selected
- Refer to images as: <img src=http://cdn.com/foo/bar/img.gif>
- When client wants to retrieve image, DNS request for cdn.com gets resolved by CDN and image is fetched from the selected content server

- Pro: Fine-grained control over what gets delivered
- Con: Have to (manually) mark content for CDN

Replication of Applications

- Originally only replication of static content
- Can also replicate applications
- Recall: Application = Server + Database
- Replication of applications = Replication of database
- Full or partial replication of database?
  - Amount of data? Updates? Query containment?
- Warehouse-scale computing (see next chapter)

Replication of Applications



Chapter Summary

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