Distributed Systems
COMP 212

Lecture 16

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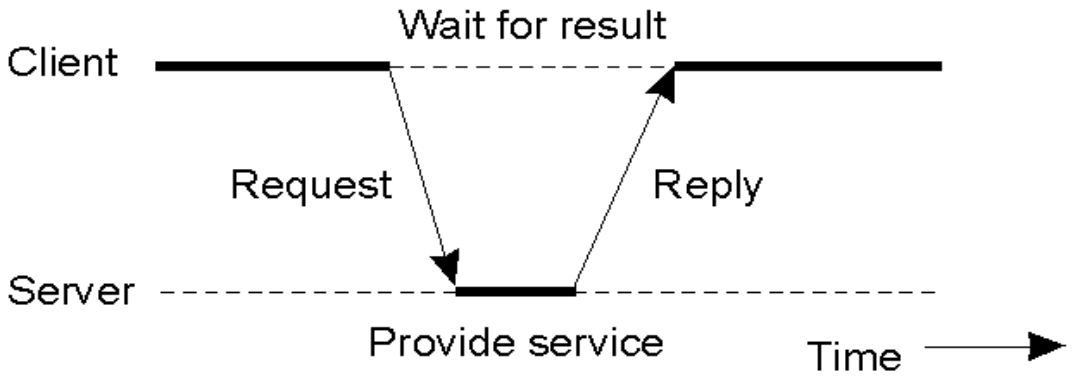
Architectures & Processes

Client-Server Model

Clients and Servers

Processes are divided into

- Servers: implementing a specific service
  - e.g., file system, database
- Clients: requesting a service from a server by sending it a request and subsequent waiting for the server's reply
- Distributed across different machines
- Follow a request-reply behaviour



What's a Server?

Definition: "A process that implements a specific service on behalf of a collection of clients".

Typically, servers are organised to do one of two things:

1. Wait
2. Service

- … wait … service … wait … service … wait …

Servers: Iterative and Concurrent

- Iterative: server handles request, then returns results to the client; any new client requests must wait for previous request to complete (also useful to think of this type of server as sequential).

- Concurrent: server does not handle the request itself; a separate thread or sub-process handles the request and returns any results to the client; the server is then free to immediately service the next client (i.e., there's no waiting, as service requests are processed in parallel).

Server "States"

- Stateless server – does not keep information on the state of its clients
  - Classic example: the web
  - This type of server is easy to implement

- Stateful server – generally maintains persistent information on its clients
  - Example: file server that allows clients to keep local copies of files
    - Server must maintain (*client*, *file*) entries to keep track of the distribution and access rights
  - These are more difficult to implement
  - Improves performance but if e.g. crashes has to recover its entire state just before the crash

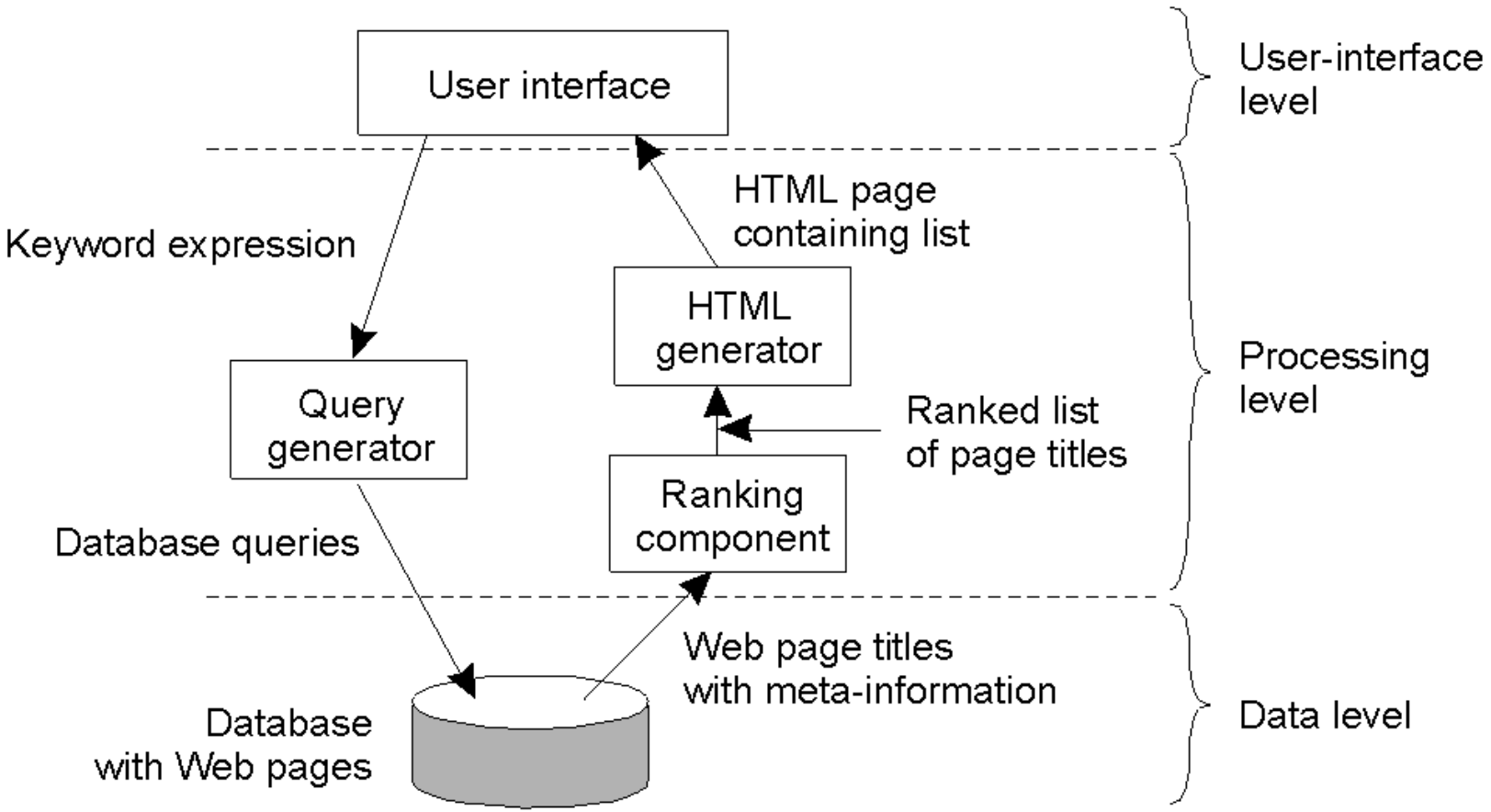
- Cookies?

Application Layering

- A three-layered (or level) view from database applications

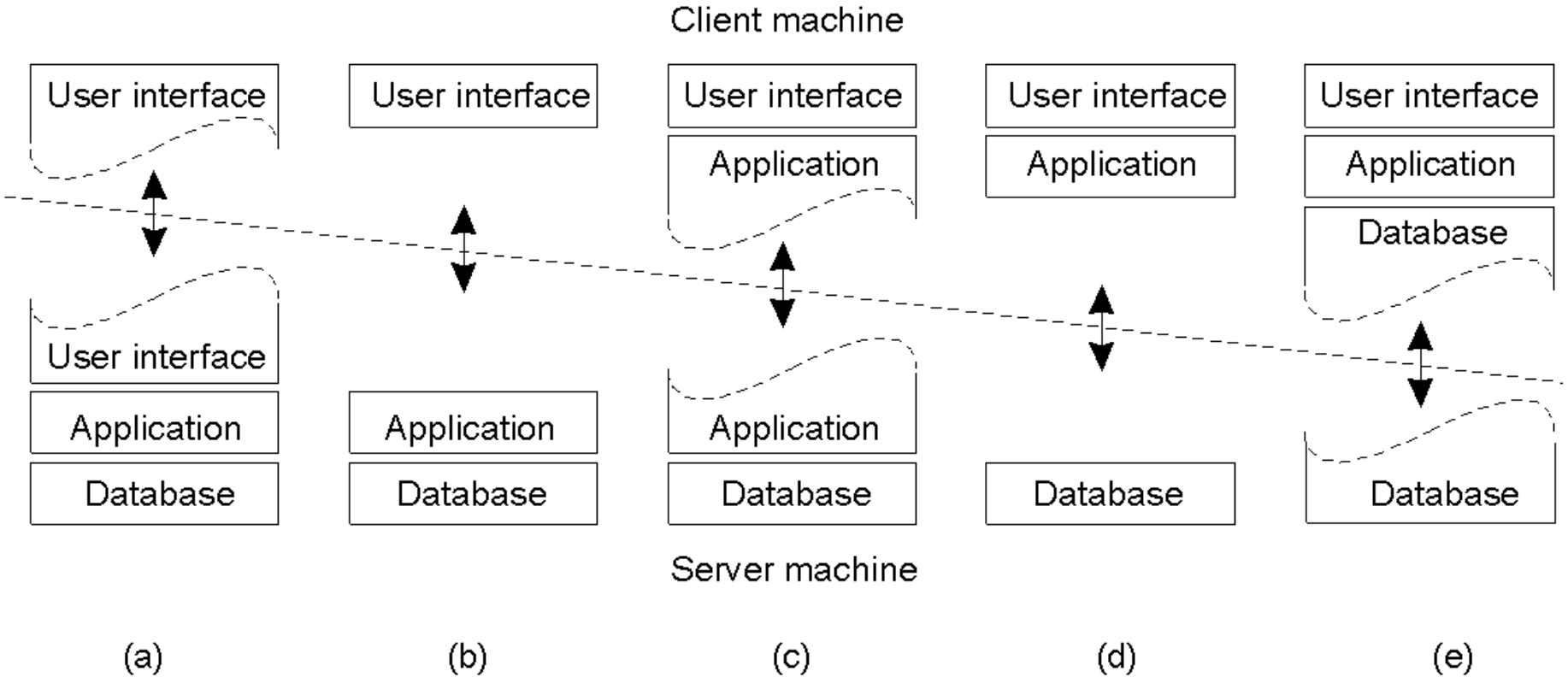
1. User-interface level
   - All necessary to directly interface with the user
   - e.g., a webpage with forms
   - Clients typically implement this
2. Processing level
   - Contains the core functionality of the application
3. Data level
   - Contains the programs that maintain the actual data on which the applications operate
   - Servers typically implement this
   - Data may be persistent (i.e., maintained even when no client is operating on them)

A Three-layered Example



- The general organisation of an Internet search engine into three different layers
  - Often referred to as tiers

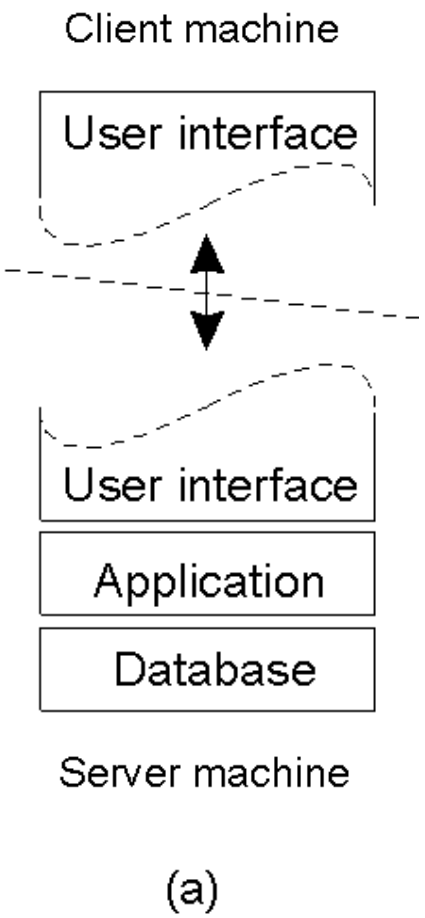
Two-tiered Architectures



Alternative client-server organisations in the two-tiered architecture

- 2 kinds of machines: clients and servers

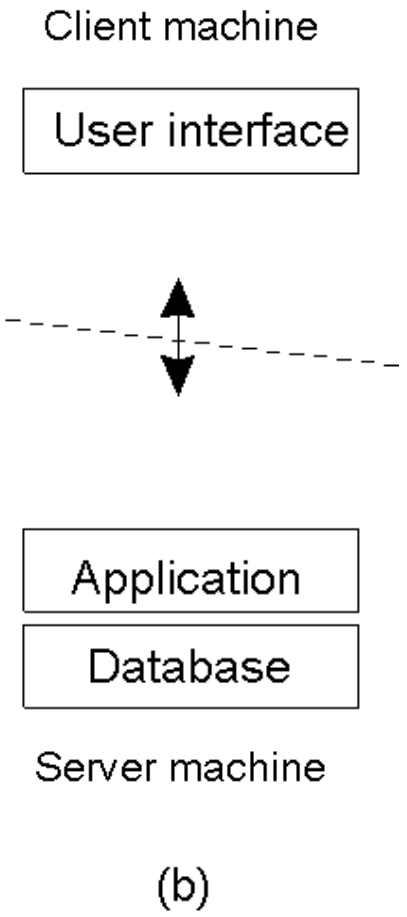
Two-tiered Architectures



(a)

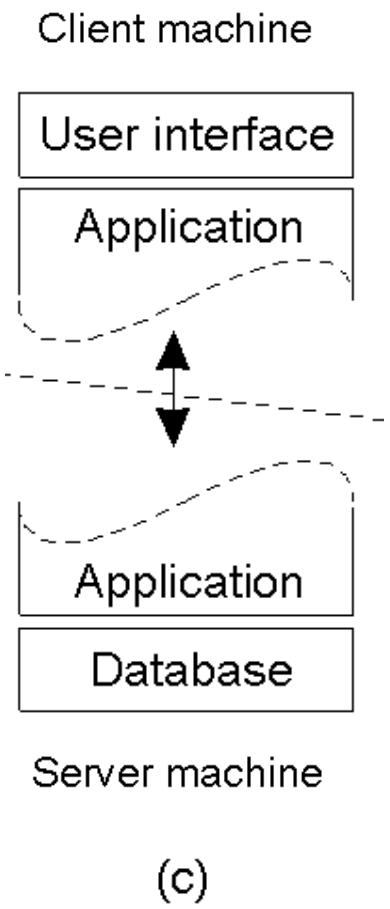
- Client:
  - Only terminal-dependent part of the user interface
- Give the applications remote control over the presentation of their data

Two-tiered Architectures



- Client:
  - Graphical front end
- Communicates with the rest of the application (at the server) through an application-specific protocol
- Client software only proceses what is necessary for presenting the interface

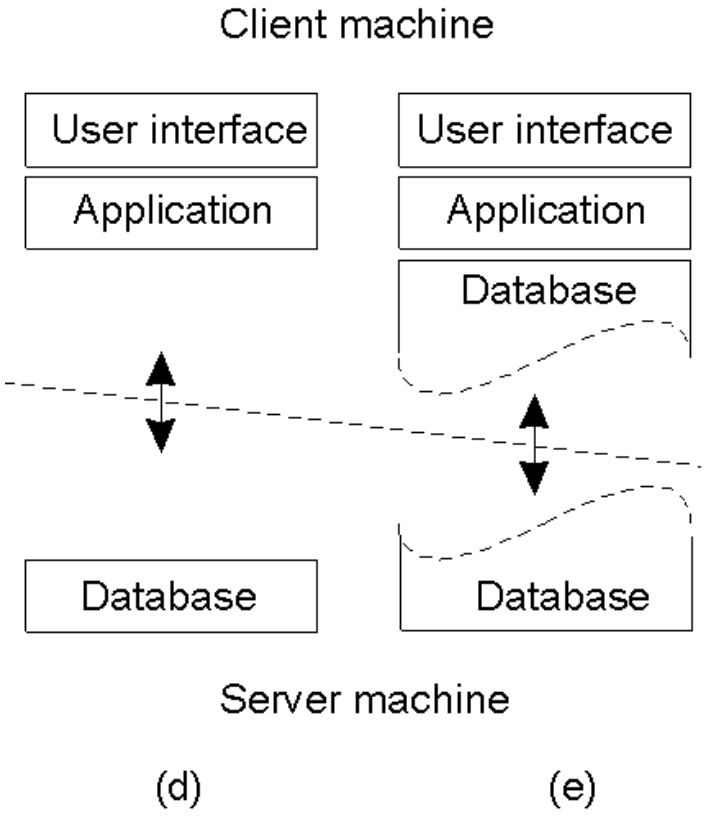
Two-tiered Architectures



(c)

- Client:
  - Has also part of the application
  - e.g., filling in forms
  - filled in, checked, interact with user
  - Also word processors, where more advanced checking, e.g. grammar, may occur at the server

Two-tiered Architectures

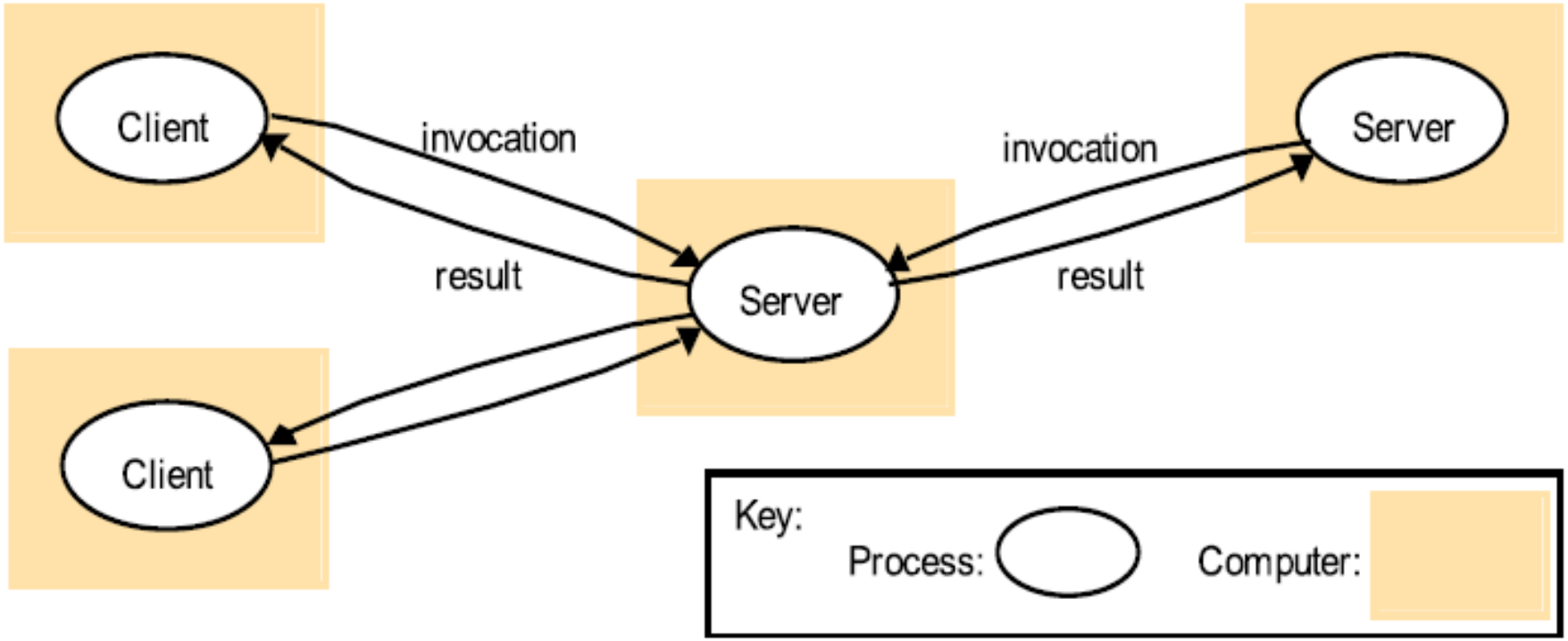


- Popular organisations
- Client:
  - PC or workstation
  - Connected to a distributed file system or database
  - Running most of the application
- Server:
  - Operations on files and database entries
- e.g., banking applications
- (e) : e.g., caching at the client

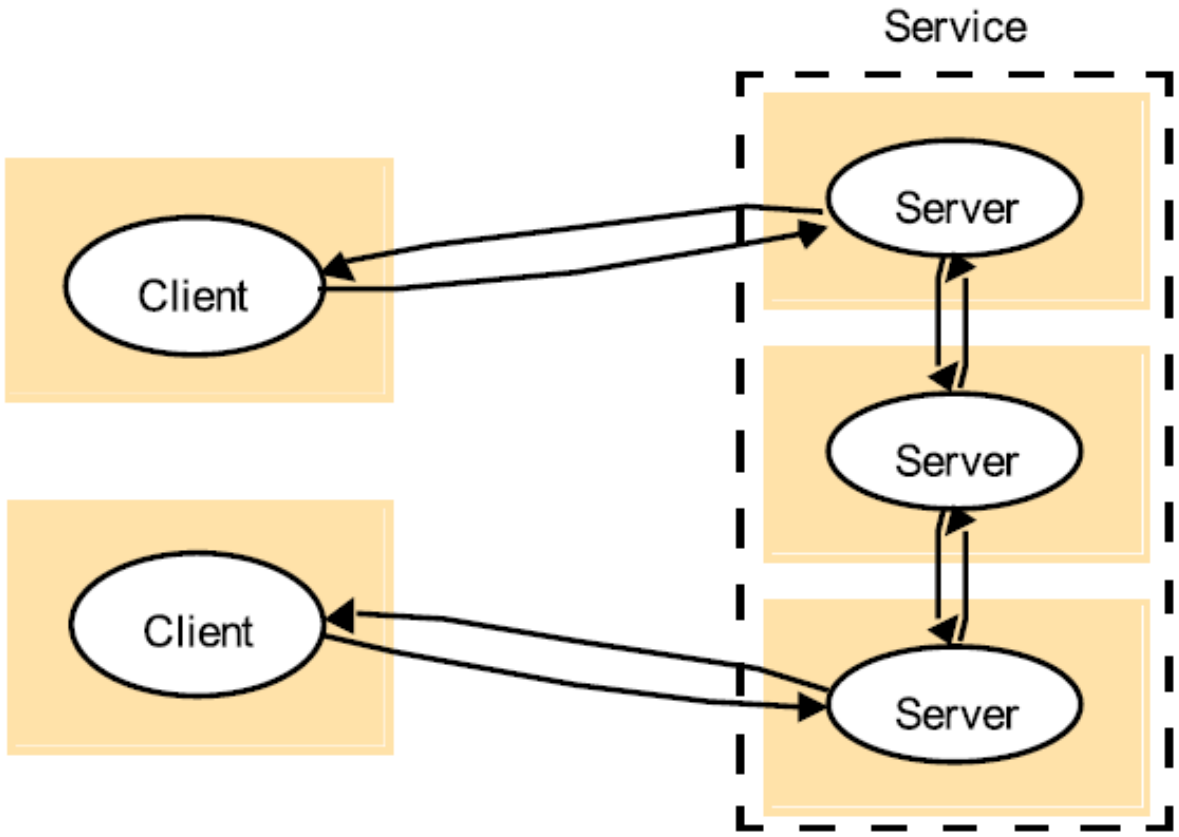
Multitiered Architectures

- There is a recent trend to move away from (d) and (e)
- Most of the processing and data storage is moving to the server
- Thin clients of (a)-(c) instead of fat clients (d), (e)
- Because:
  - Client machines are difficult to manage
- Therefore, concentrate functionalities at servers
  - *Is this distributed?*
  - Yes: Servers themselves are becoming more and more distributed; replaced by multiple servers running on different machines
- A server may sometimes need to also act as a client
  - Three-tiered architecture (and multitiered in general)

Multitiered Architectures

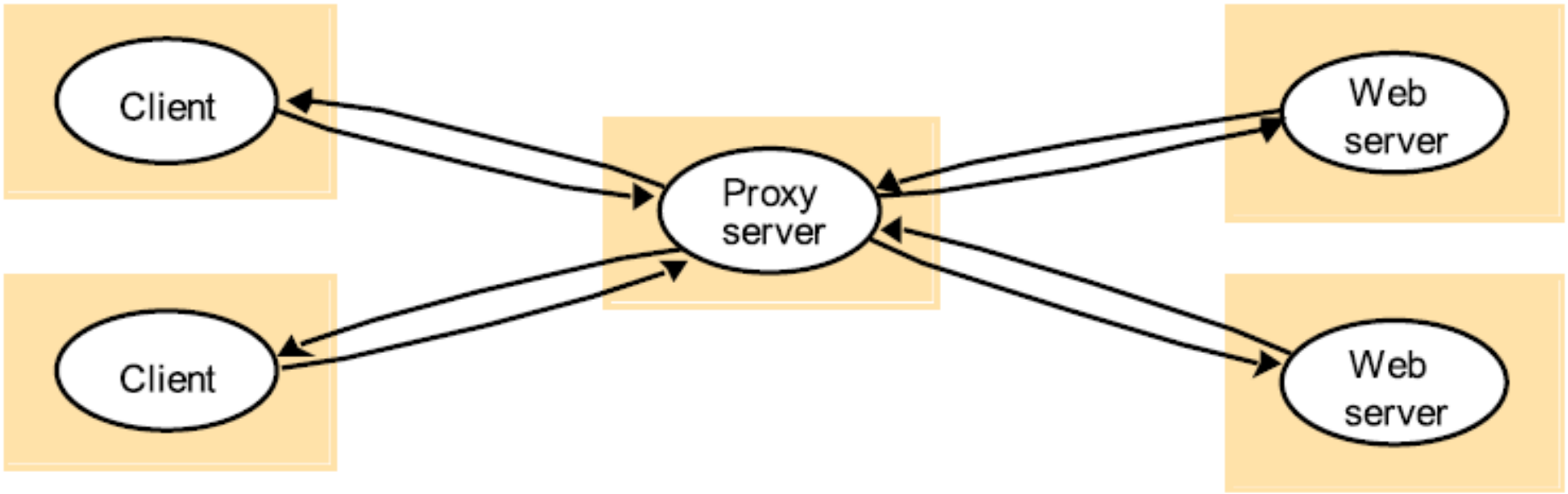


Cooperating Servers (1)



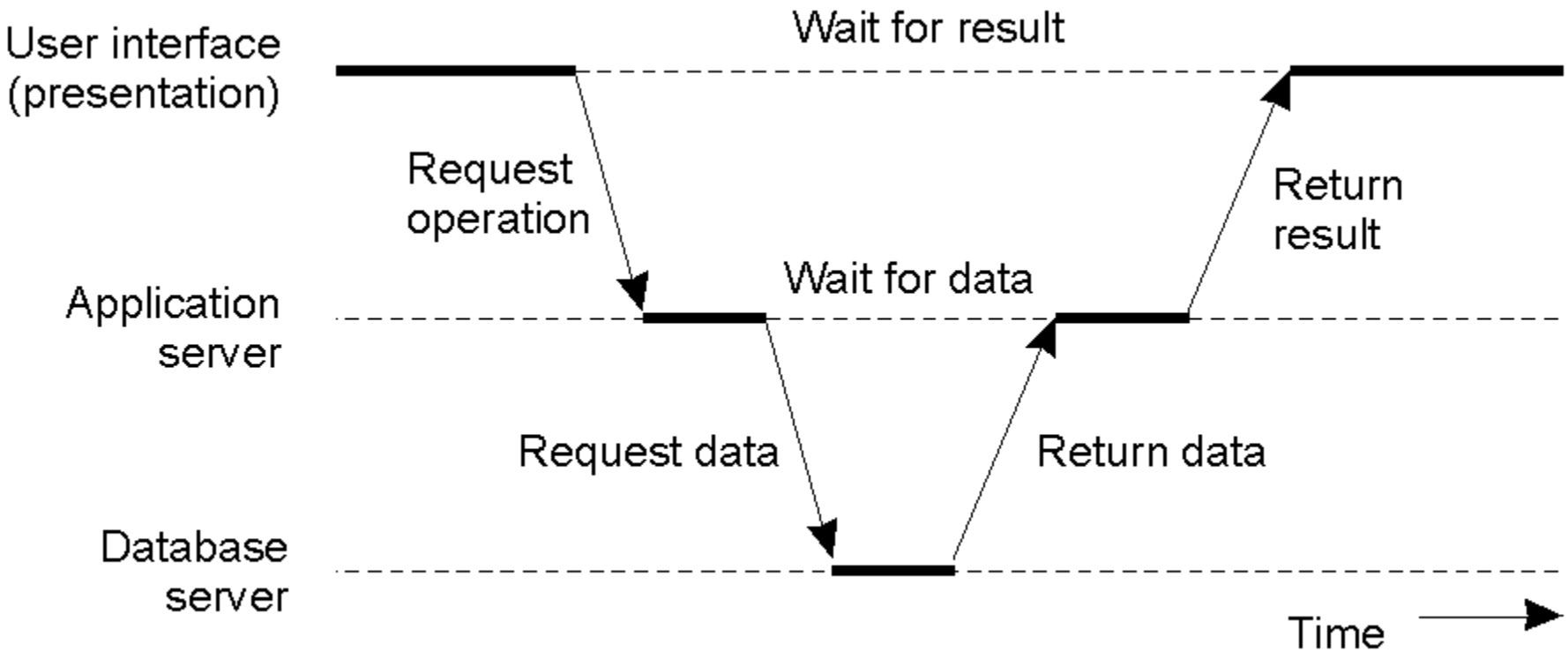
Multitiered system

Cooperating Servers (2)



Proxy server

Multitiered Architectures

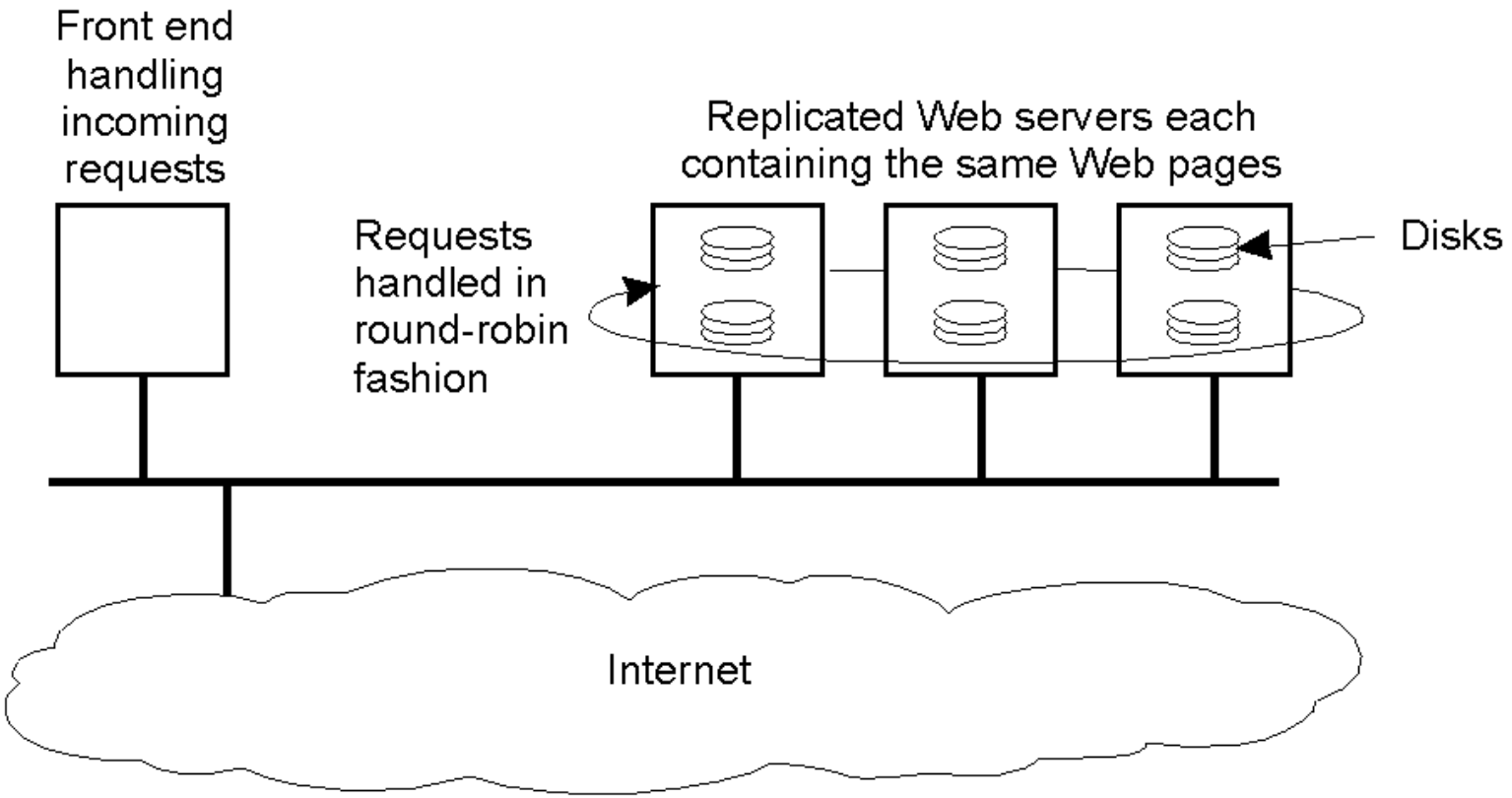


- An example of a server acting as a client
  - This is a very common vertical distribution model for distributed systems.
- An application: Web sites
  - Web server (entry point to site) ↔ Application Server (actual processing) ↔ Database server (raw data)

Vertical vs Horizontal Splitting

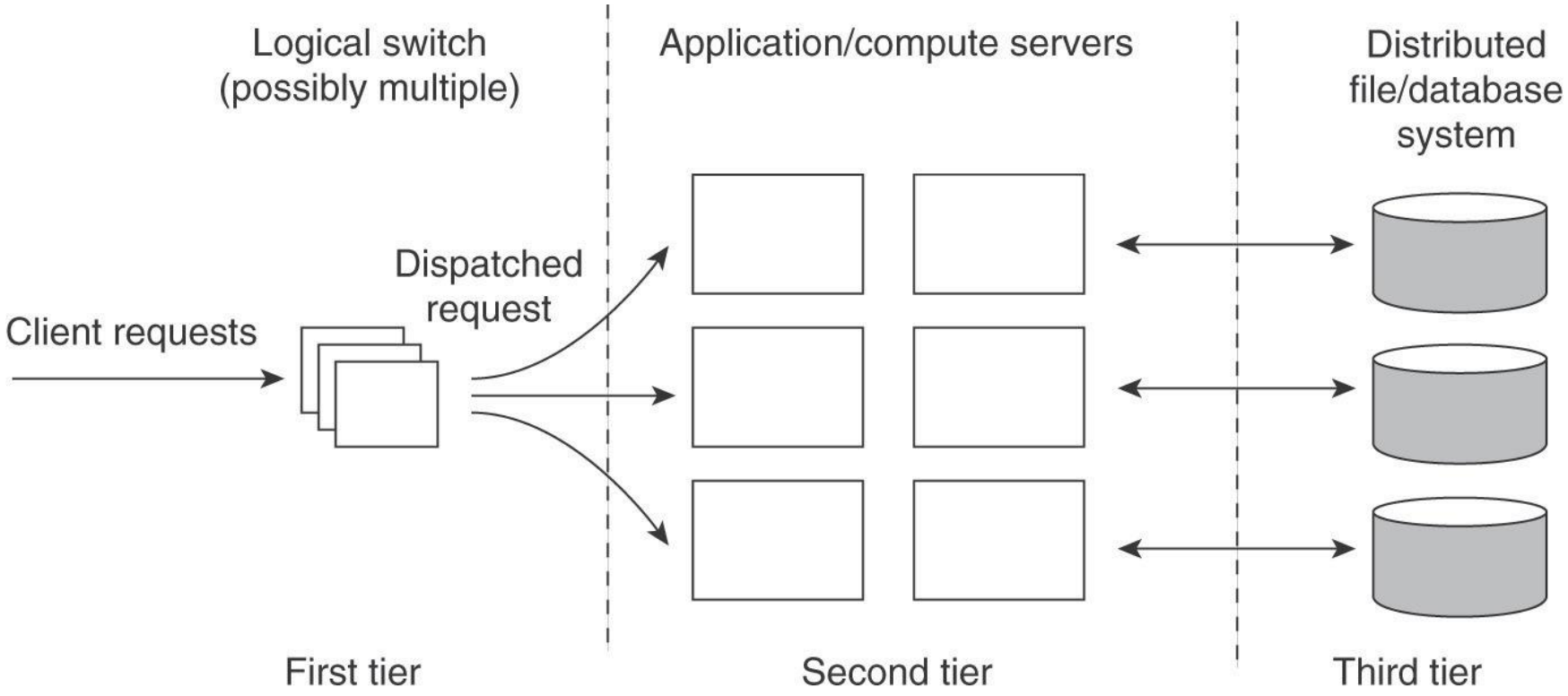
- Vertical distribution: placing logically different components on different machines
- Horizontal distribution: a client or server may be physically split up into logically equivalent parts, each operating on its own share of the complete data
  - Examples: server farms/clusters, peer-to-peer systems

An Example of a Modern Architecture



- An example of horizontal distribution of a Web service
  - Often also referred to as clustering

More Like This



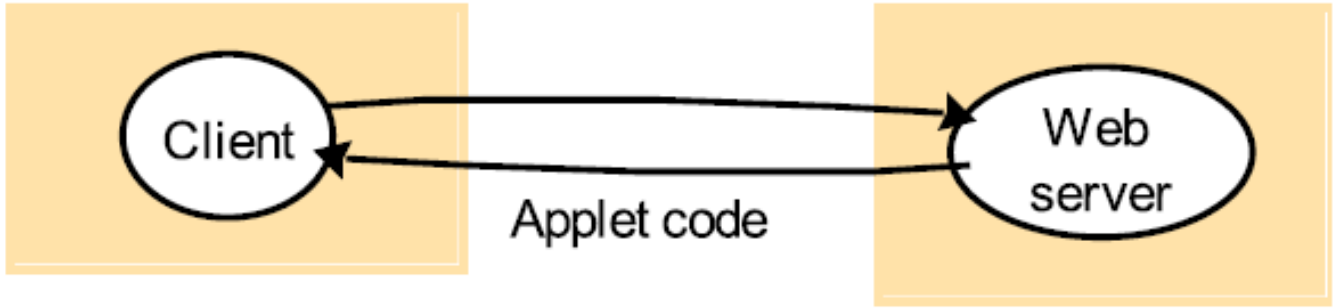
Other Architectures

Alternative Architectures

- Cooperating clients
  - Teleconferencing
- Web applets
- Peer-to-peer networks

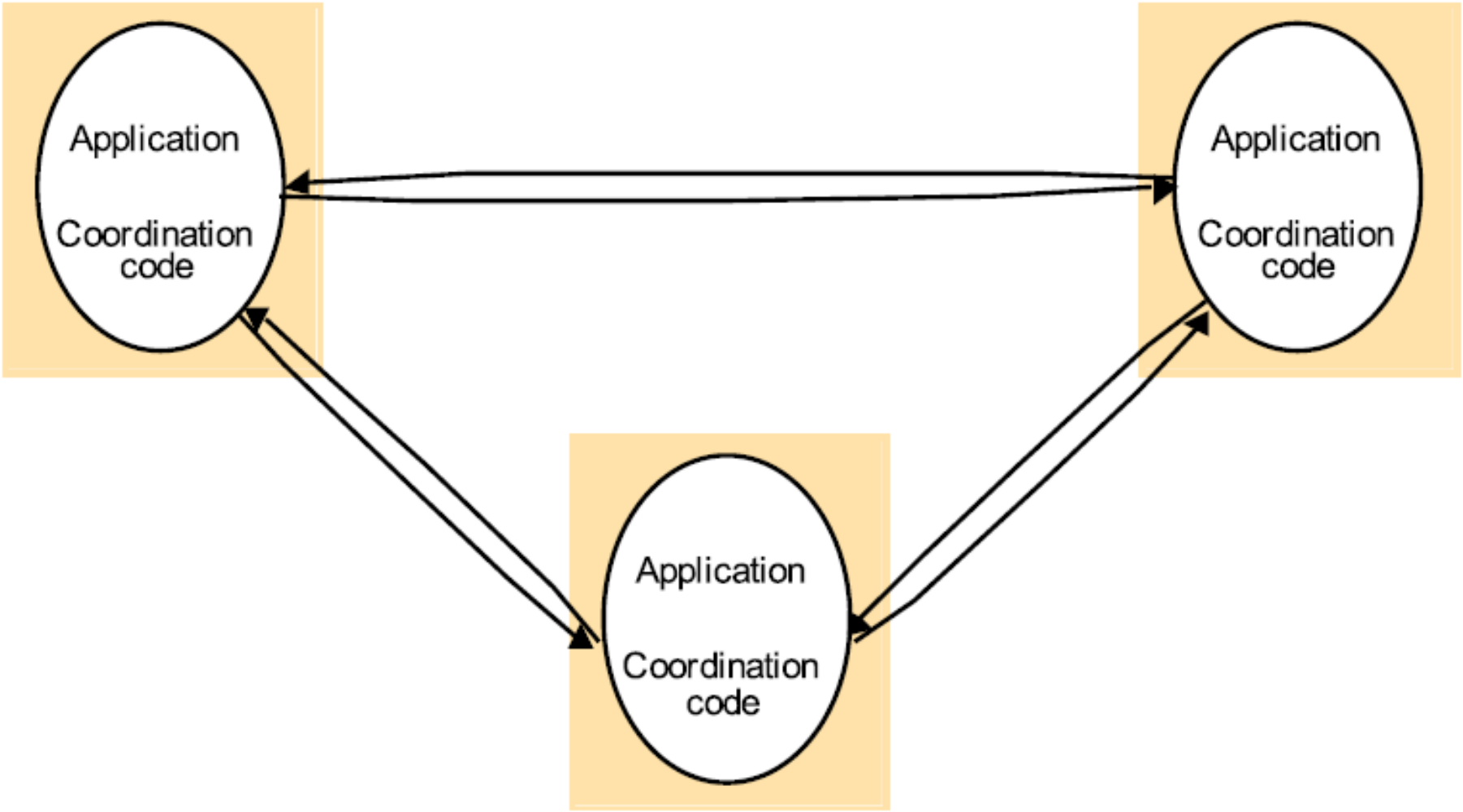
Web Applets

a) client request results in the downloading of applet code

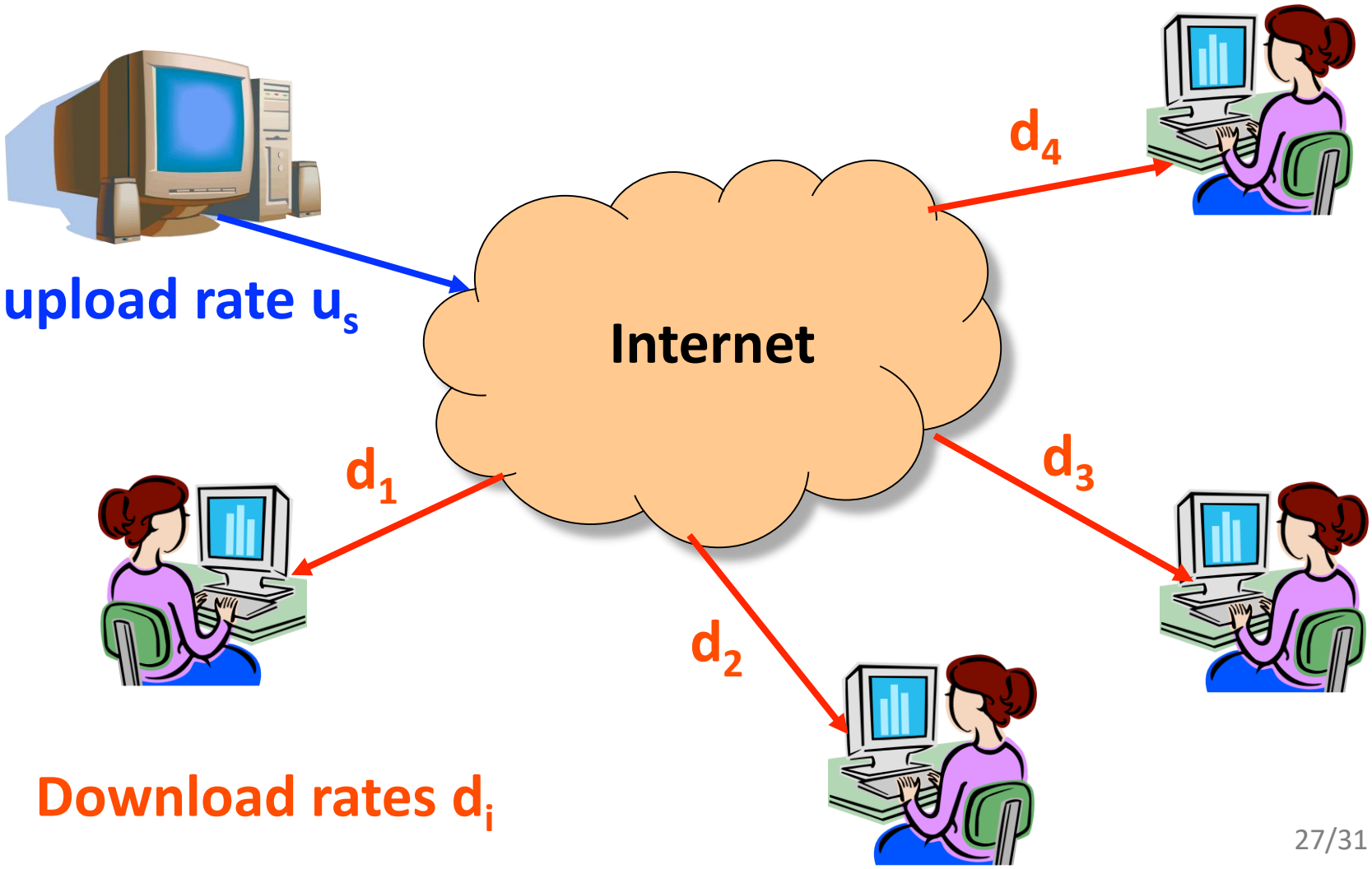


b) client interacts with the applet

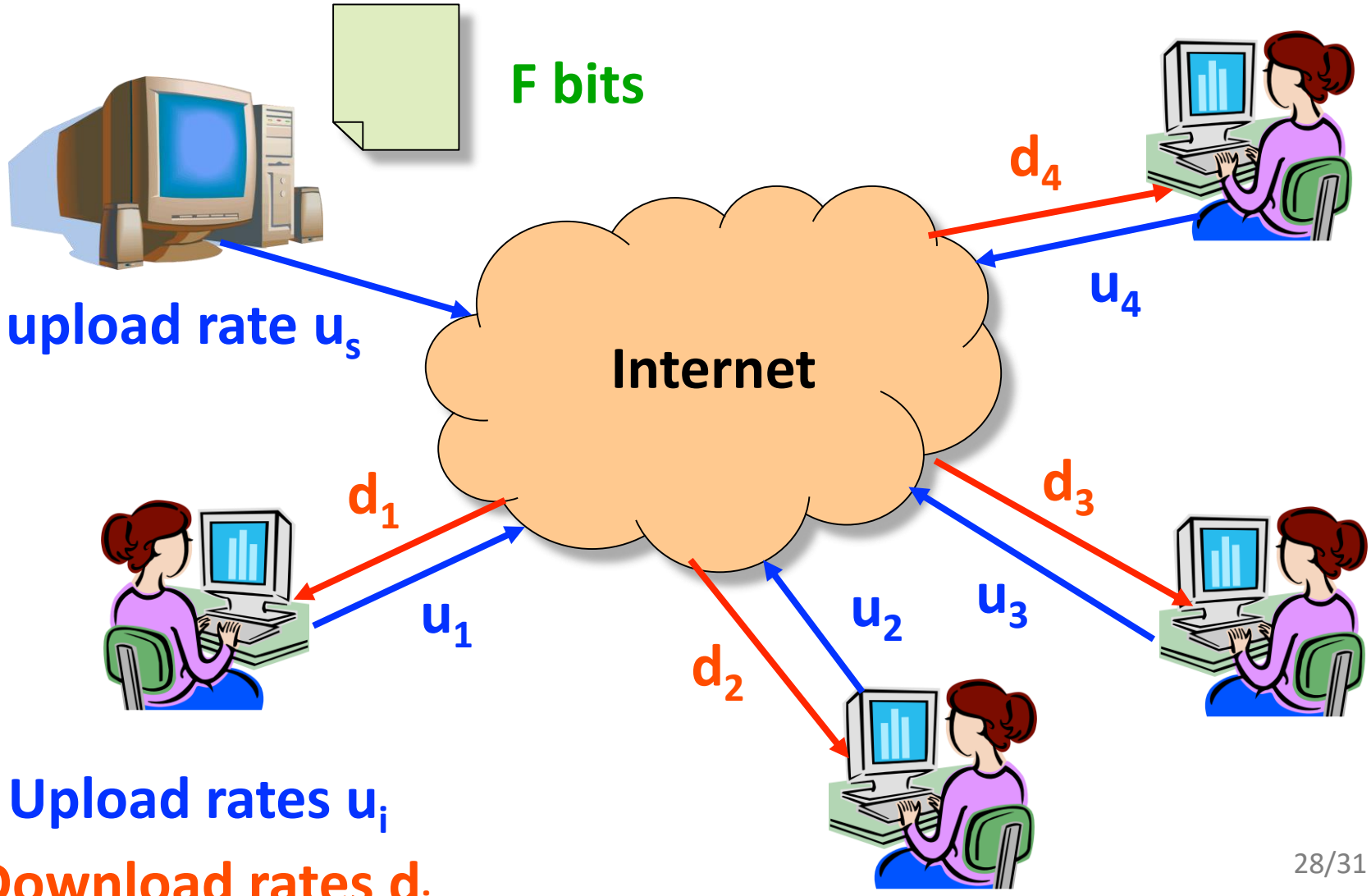
Peer-to-peer Networks



Server Distributing a Large File



Peers Help Distributing a Large File



Brief History of P2P

- 1999: Napster
  - Centralised inventory of available files
  - Restricted to music files
  - Out of business by mid 2000
- Many followed (with novel characteristics):
  - Truly decentralised P2P networks
  - Decentralised catalogue
  - Search by asking neighbours
  - No control over distributed content

Bit Torrent

- Developed in 2002 to speed up distribution of large files
- Control over what is being distributed – “trackers”
- Free software distributions
- Blizzard Downloader for WoW, Starcraft II
- Facebook, Twitter to update servers
- A file is split in small pieces
- Rarest pieces are distributed first (+random pieces)
- Faster uploaders get priority
- 30-50% of all traffic

Conclusions

- Architecture of modern distributed systems can be rather involved
- Tiered servers
- Cooperating servers / clients
- Peer-to-peer

- Client-server communication is still the most popular form of communication