# OCT

Principles From Chapter One of
“Distributed Systems Concepts
and Design”

# Characterization of Distributed Systems

- Components are located on networked computers and execute concurrently
- Components communicate and coordinate only by passing messages
- There is no global clock
- Components may fail independently

# Main motivation for constructing DS

Resource sharing of :

- CPU cycles
- documents
- objects
- data
- files
- printers

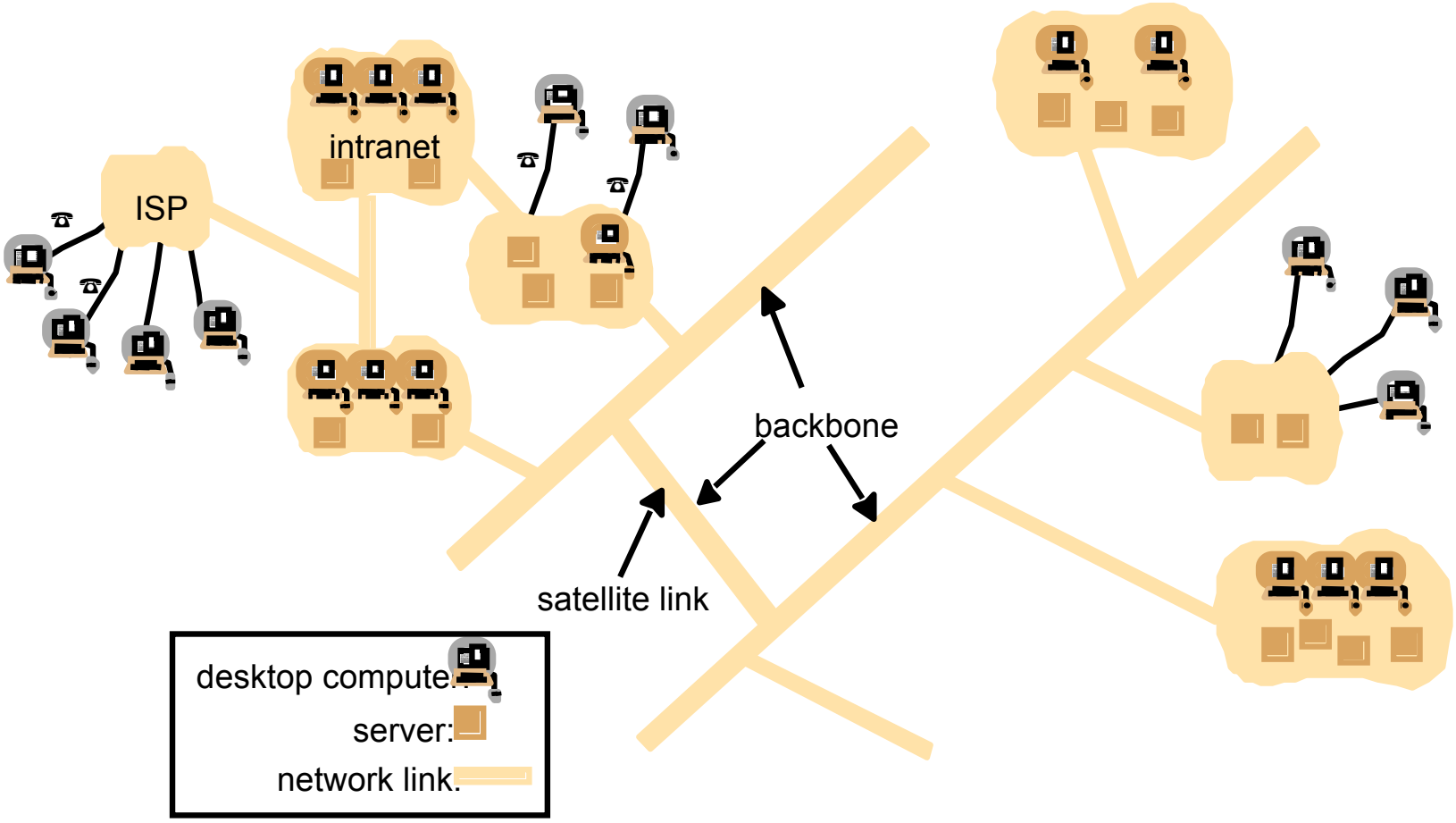
# Challenges in Constructing DS

- Heterogeneity of components
- Openness
- Security
- Scalability
- Failure handling
- Concurrency of components
- Transparency

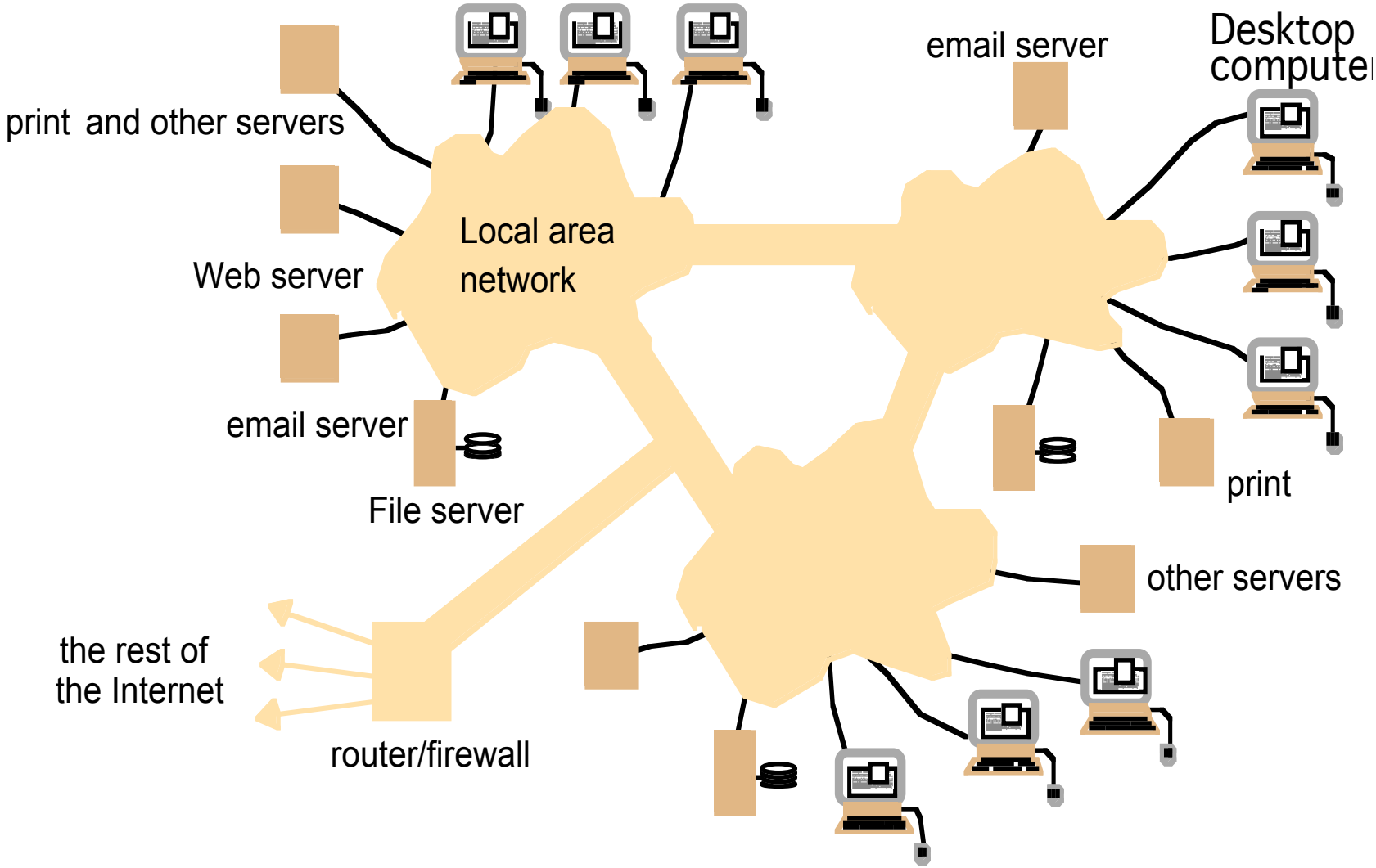
# Examples

- The internet
  - A collection of diverse networks
  - A very large distributed system
  - Providing services such as email,
    - file transfer, telnet, and recently,
    - WWW, Web Services, and multimedia
- Intranets (a portion of the internet separately administrated) and connected to the internet via a router
- Mobile and ubiquitous computing

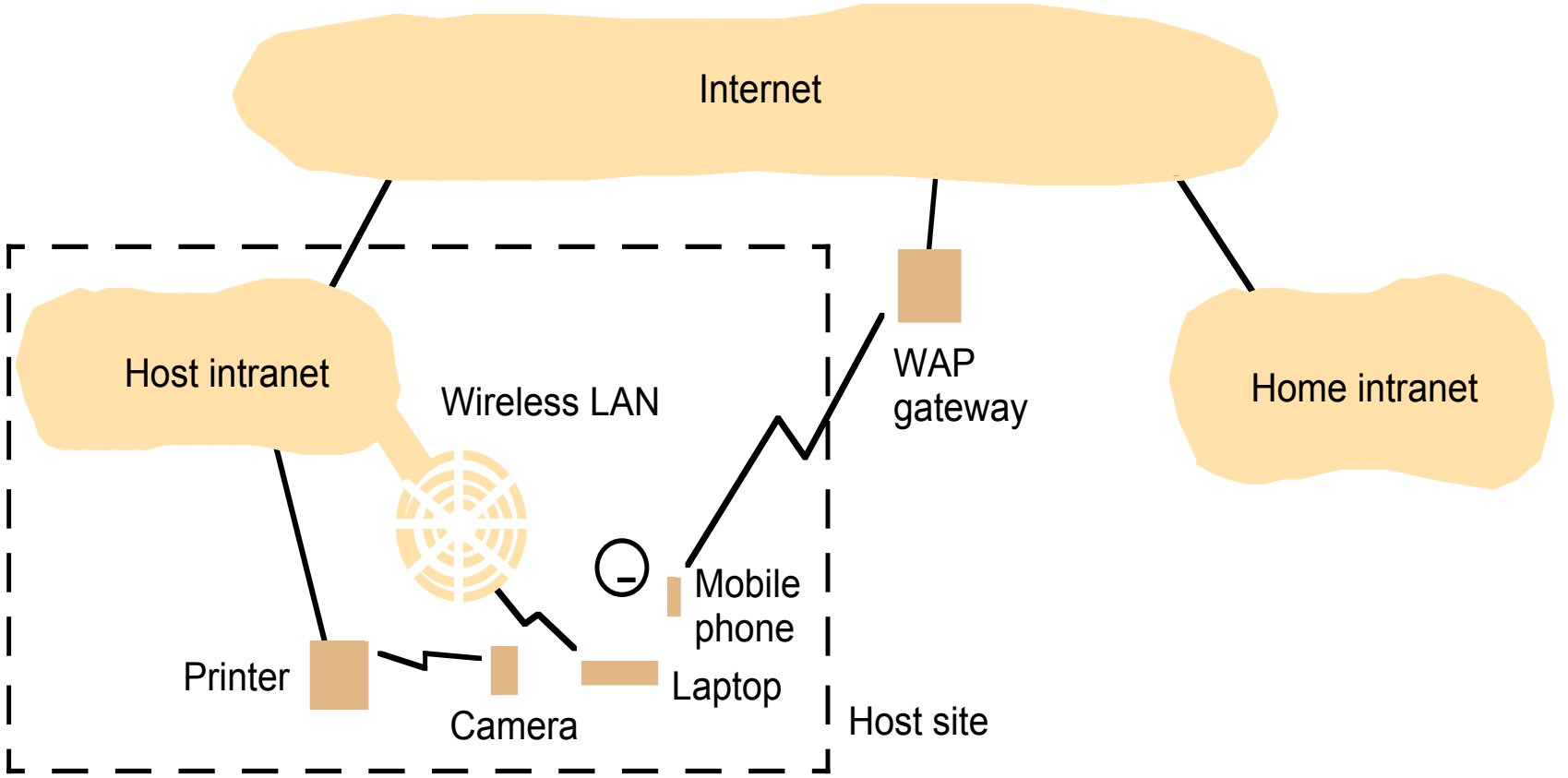
# A typical portion of the Internet



# A typical intranet



# Portable and handheld devices in a distributed system



# Resource Sharing and the Web

- A *server* is a running program on a networked computer that accepts requests from programs running on other computers to perform a service and respond appropriately
- The requesting processes are referred to as *clients*
- WWW, Web Services, networked printers and email fit this model

# The World Wide Web

- Created by Tim Berners-Lee at European centre for nuclear research (CERN) in Switzerland in 1989 (Knighted 2003)
- Provides a hypertext structure allowing documents to contain links to other documents
- Is an open system (can be extended and implemented in new ways, standards are public and widely implemented)

# The World Wide Web (2)

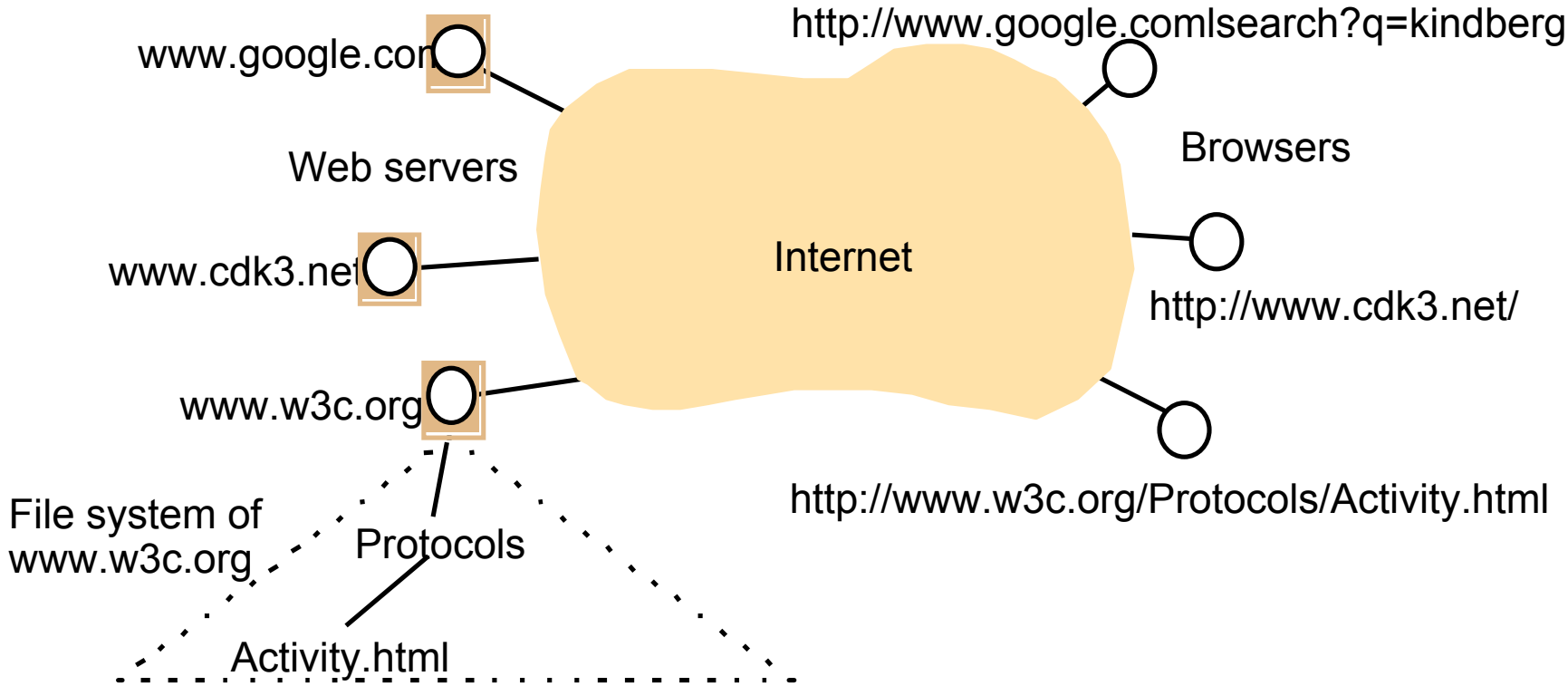
- The web is based on three main standard technological components

  (1) HTML (User presentation of content and Links)

  (2) URL's (Used to point to a resource and specify a protocol)

  (3) HTTP (A request-reply protocol)

# Web servers and web browsers



# A Request May Cause

- A simple file transfer
- A process to be run on the server and content sent to the browser (CGI programs, servlets, JSP pages, etc.)
- Program code to be downloaded and executed in the browser (JavaScript, Applets, Java Web Start, etc.)

# Challenges to DS Design(1)

- Heterogeneity applies to
  - Networks (Ethernet, Wireless,..)
  - Computer Hardware (PC's, PDA's,..)
  - Operating Systems (Linux, Windows,..)
  - Programming Languages (Java, C++, C#,..)
  - Different developers
- *Middleware* provides a programming abstraction that addresses these issues

# Challenges to DS Design(2)

- Open
  -- The system can be extended and re-implemented in a variety of ways
  -- The key specifications are published
  -- The system is independent of a particular vendor

# Challenges to DS Design(3)

- Security
  - Many resources have a very high value
  - Confidentiality (only those authorized)
  - Integrity (no alteration or corruption)
  - Availability (interference not permitted)
- Encryption will help with much of this
- Denial of Service and Mobile Code are not yet easy to handle

# Challenges to DS Design(4)

- Scalability

  A system is described as scalable if it will remain effective when there is a significant increase in the number of resources and the number of users

  For a system with n users to be scalable the quantity of physical resources required to support them should be O(n)

# Challenges to DS Design(5)

- Scalability

  For system to be scalable, the loss in performance attributed to additional users or resources should be O(Log n)

  Bottleneck avoidance

  - distributed algorithms (Domain Name System)
  - caching
  - replication

# Computers in the Internet

| *Date* | *Computers* | *Web servers* |
|---|---|---|
| 1979, Dec. | 188 | 0 |
| 1989, July | 130,000 | 0 |
| 1999, July | 56,218,000 | 5,560,866 |

The internet has been scalable and extensible.
However, the 32 bit IP address was too small.
Moving to IPv6, 128 bits.

# Computers vs. Web servers in the Internet

| *Date* | *Computers* | *Web servers* | *Percentage* |
|---|---|---|---|
| 1993, July | 1,776,000 | 130 | 0.008 |
| 1995, July | 6,642,000 | 23,500 | 0.4 |
| 1997, July | 19,540,000 | 1,203,096 | 6 |
| 1999, July | 56,218,000 | 6,598,697 | 12 |

# Challenges to DS Design(6)

- Failure Handling

Particularly difficult in DS
Failures are often partial
Issues include:
- Detecting failures
- Masking failures
- Tolerating Failures
- Recovery from failures

# Challenges to DS Design(7)

- Concurrency

  Multiple client requests are often allowed to take place concurrently

  Standard techniques such as semaphores

  may be used to ensure that the data in shared objects remain consistent

# Challenges to DS Design(8)

- Transparency

***Access transparency***: enables local and remote resources to be accessed using identical operations.
***Location transparency***: enables resources to be accessed without knowledge of their location.
***Concurrency transparency***: enables several processes to operate concurrently using shared resources without interference between them.
***Replication transparency***: enables multiple instances of resources to be used to increase reliability and performance without knowledge of the replicas by users or application programmers.

# Challenges to DS Design(9)

***Failure transparency***: enables the concealment of faults,allowing users and application programs to complete their
tasks despite the failure of hardware or software components.
***Mobility transparency***: allows the movement of resources and clients within a system without affecting the operation of users or programs.
***Performance transparency***: allows the system to be reconfigured to improve performance as loads vary.
***Scaling transparency***: allows the system and applications to expand in scale without change to the system structure or the application algorithms.