CSF661 – Distributed Systems

分散式系統

Chapter 1
Characterization of Distributed Systems

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Chapter 1 Characterization of Distributed Systems

1.1 Introduction

- Motivation:

  Networks of computers are everywhere!

  – Mobile phone networks
  – Corporate networks
  – Factory networks
  – Campus networks
  – Home networks
  – In-car networks
  – Planetary networks

  Why networked?

  Desire to share resources

- Influence:

  Networked computers impact system designers and implementers

Defining Distributed Systems

- *"A system in which hardware or software components located at networked computers communicate and coordinate their actions only by message passing."* [Coulouris]
  - Networked computers could be far apart or in the same room
    - relying on computer networking
    - i.e. cluster and grid

- *"A distributed system is a collection of independent computers that appear to the users of the system as a single computer."* [Tanenbaum]

Consequences of Distributed Systems

- Concurrency
  - Autonomous: Computers carry out tasks independently
  - Cooperative: Computers coordinate actions
- No global clock
  - Hard to synchronize their clocks precisely
  - Coordinate by exchanges messages
- Independent failures
  - Part of network or node faults does stop the running of the whole system

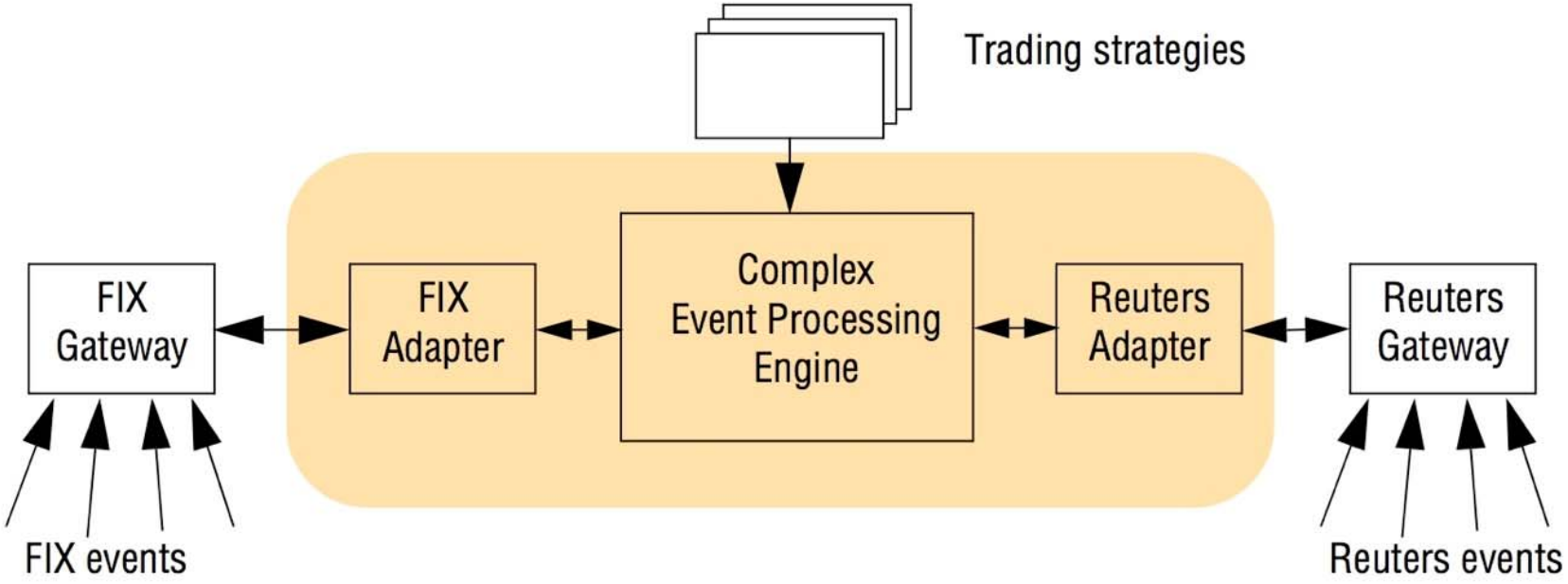
1.2 Examples of Distributed Systems

- Examples
  - 1.2.1 Web search (Google)
  - 1.2.2 Massively multiplayer online games (MMOGs)
  - 1.2.3 Financial trading

Figure 1.1 Selected application domains and associated networked applications

Finance and commerce	eCommerce e.g. Amazon and eBay, PayPal, online banking and trading
The information society	Web information and search engines, ebooks, Wikipedia; social networking: Facebook and MySpace.
Creative industries and entertainment	online gaming, music and film in the home, user-generated content, e.g. YouTube, Flickr
Healthcare	health informatics, on online patient records, monitoring patients
Education	e-learning, virtual learning environments; distance learning
Transport and logistics	GPS in route finding systems, map services: Google Maps, Google Earth
Science	The Grid as an enabling technology for collaboration between scientists
Environmental management	sensor technology to monitor earthquakes, floods or tsunamis

Figure 1.2
An example financial trading system



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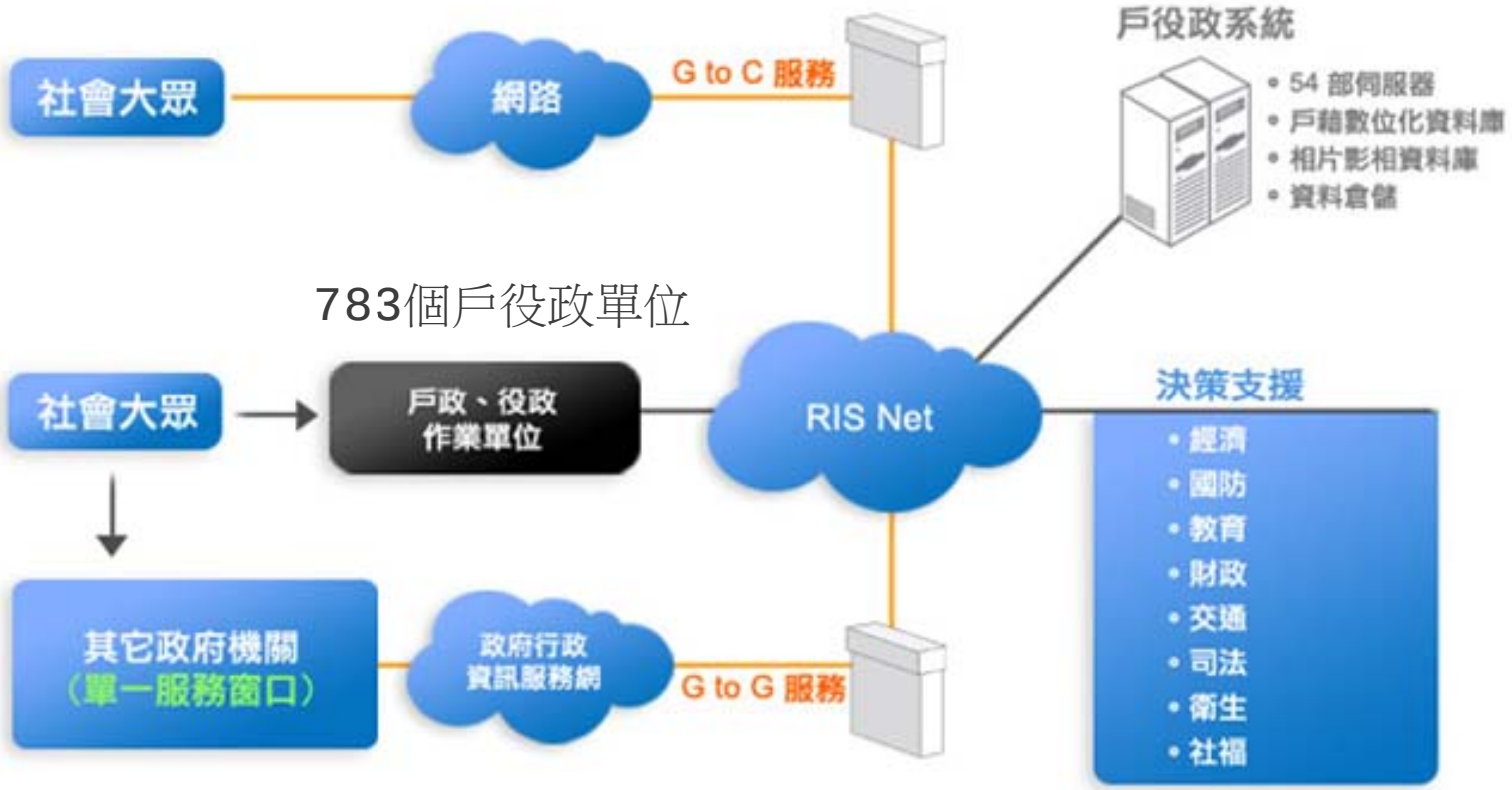

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http://www.iisigroup.com/tw/cases/gov-ris.html

1.3 Trends in distributed systems

- Influential trends
  - Emergence of pervasive networking technology
  - Emergence of ubiquitous computing coupled with the desire to support mobility
  - Increasing demand of multimedia services
  - View of distributed systems as a utility
- Sections

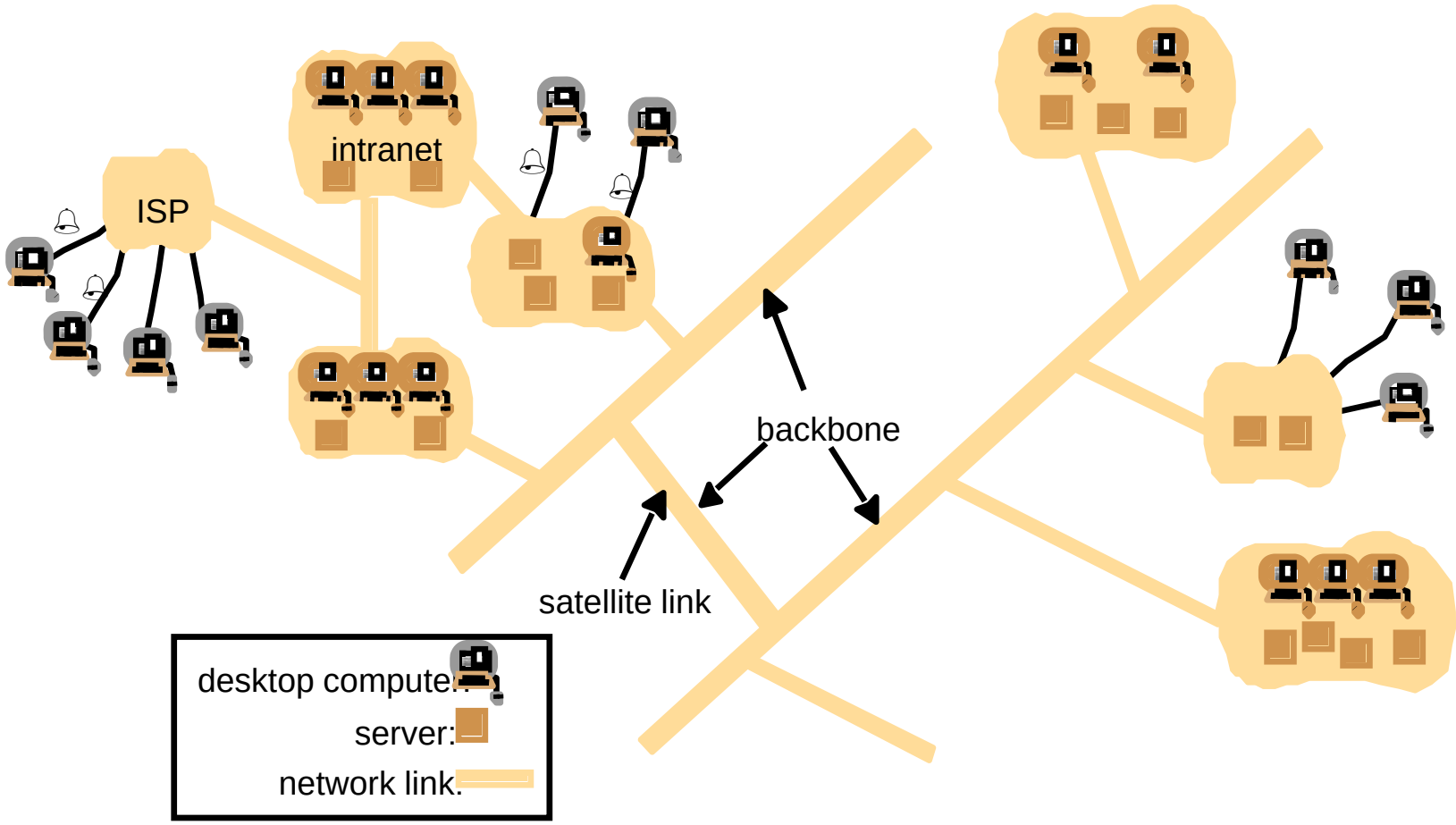
  1.3.1 Pervasive networking and the modern Internet

  1.3.2 Mobile and ubiquitous computing

  1.3.3 Distributed multimedia systems

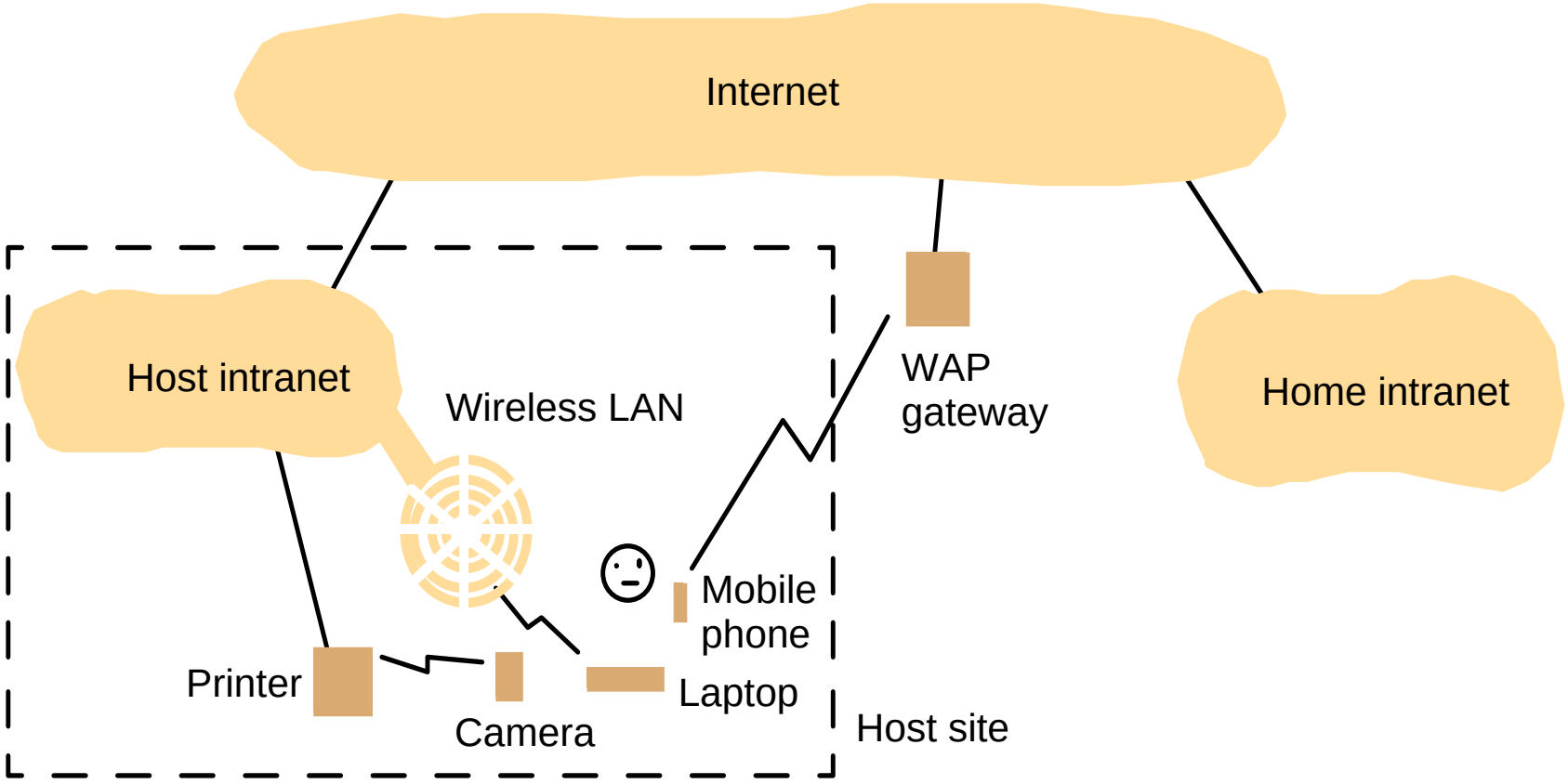
  1.3.4 Distributed computing as a utility (cloud)

Figure 1.3 Typical Portion of the Internet



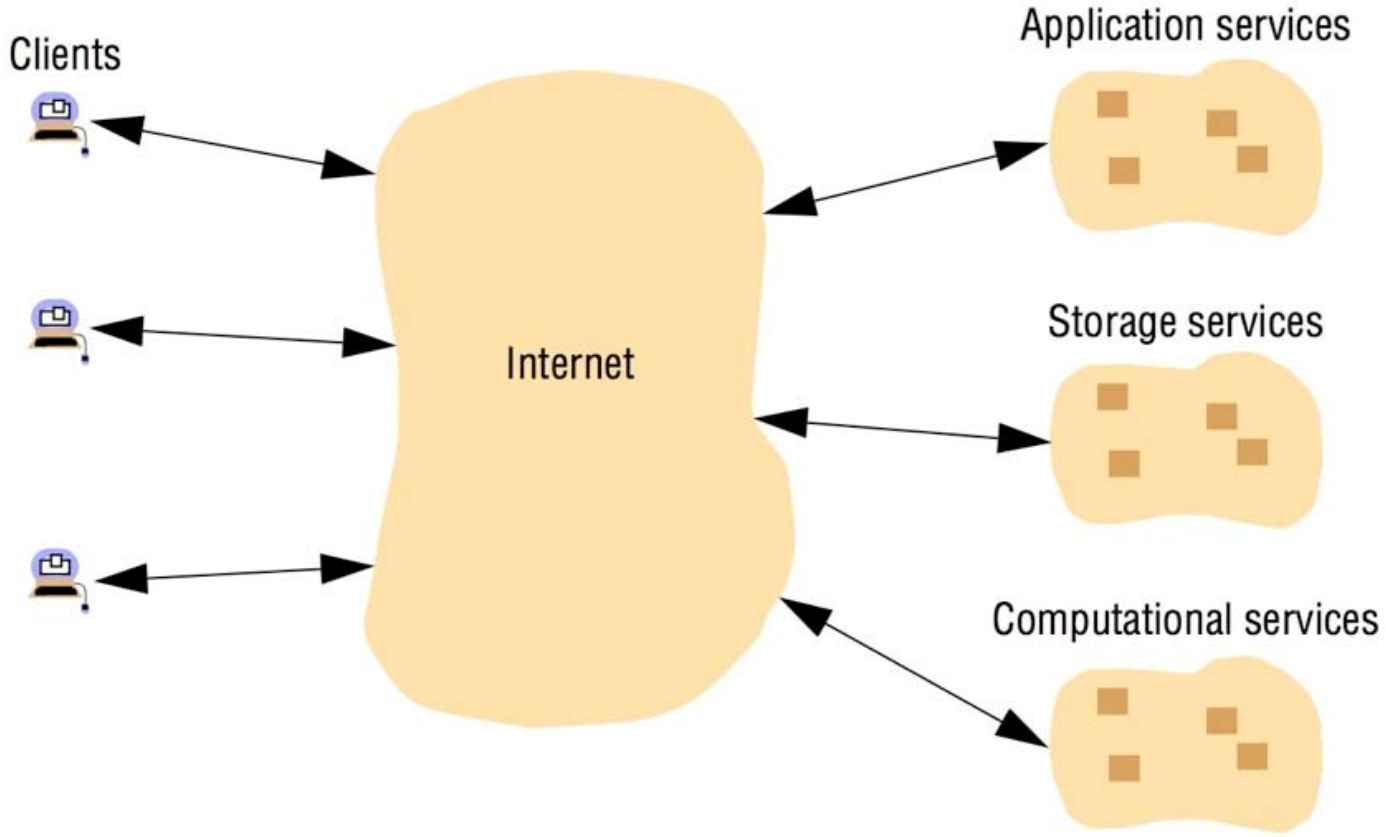
The Internet is a vast collection of computer networks of many different types and hosts supporting various types of services

Figure 1.4 Portable and handheld devices



Support continued access to Home intranet resources via wireless and provision to utilize resources (e.g., printers) that are conveniently located (location-aware computing)

Figure 1.5 Cloud Computing



A ***cloud*** is a set of Internet-based application, storage and computing services sufficient to support most users' needs, thus enabling them to largely or totally dispense with local data storage and application software

1.4 Focus on Resource Sharing

- Users are accustomed to the benefits of resource sharing
  - Share hardware resources such as printers
  - Share data such as files
  - Share specific functionality such as search engines

- Service-oriented: client-server computing
  - remote invocation of an operation to an object

1.5 Challenges

- 1.5.1 Heterogeneity
  - networks, hardware, os, languages...
  - solutions: middleware (i.e. corba), mobile code, virtual machines
- 1.5.2 Openness
  - extended and re-implemented in various ways
  - standard published interfaces, RFC (request for comments)
- 1.5.3 Security
  - confidentiality, integrity, availability
- 1.5.4 Scalability
  - effective with significant increase in resources
  - cost and performance
- 1.5.5 Failure handling
  - detecting
  - masking: hide, less severe (retransmit)
  - tolerating: ignore, timeout
  - recovery: logs, rollback
  - redundancy
- 1.5.6 Concurrency
  - several clients access a shared resource at the same time

Challenges (Cont.)

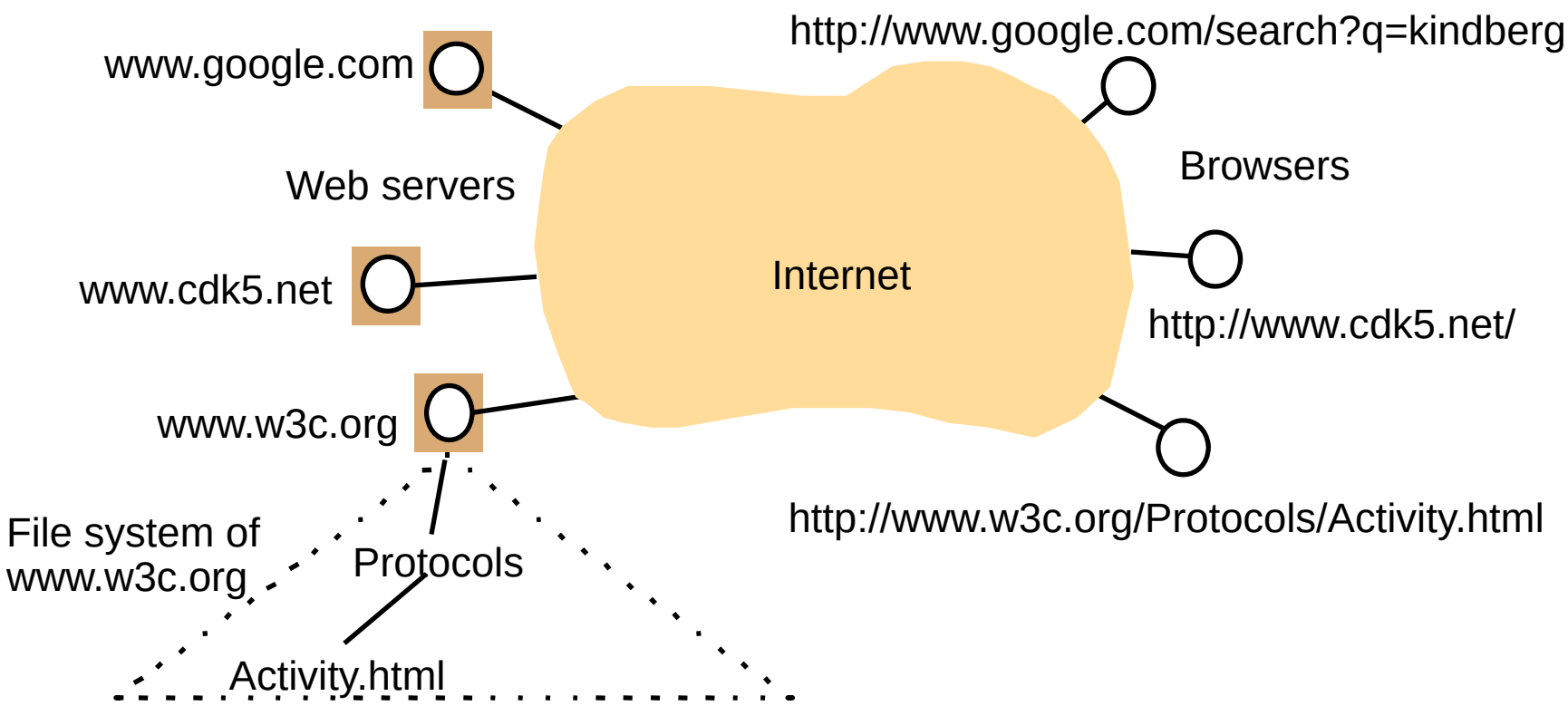
- 1.5.7 Transparency
  - *Access transparency*: enables local and remote resources to be accessed using identical operations
  - *Location transparency*: enables resources to be accessed without knowledge of their physical or network location (for example, which building or IP address)
  - *Concurrency 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
  - *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 application algorithms
- 1.5.8 Quality of Service

1.6 Case Study: The World Wide Web

Three major parts

- HTML, Hyper Text Markup Language
- URL, Uniform Resource Locator
  - http://servername[:port] [/pathname] [?arguments]
- HTTP, HyperText Transfer Protocol
  - request-reply protocol (client-server)
  - content types--MIME types, multipurpose internet mail extensions
  - one resource per request
  - simple access control (mostly public)

Figure 1.7 Web Servers and Web Browsers



Other Web Technologies

- web forms
- CGI programs, common gateway interface, run on the server
- applets, run on the client
- RDF, resource description framework, vocabulary for meta-data
- XML, extensible markup language, allow meta-data information to be included

1.7 Summary

- Computer networks and distributed systems are everywhere
- Resource sharing is the main motivating factor for constructing distributed systems
- Challenges: heterogeneity, openness, security, scalability, failure handling, concurrency, transparency