

06-06798 Distributed Systems

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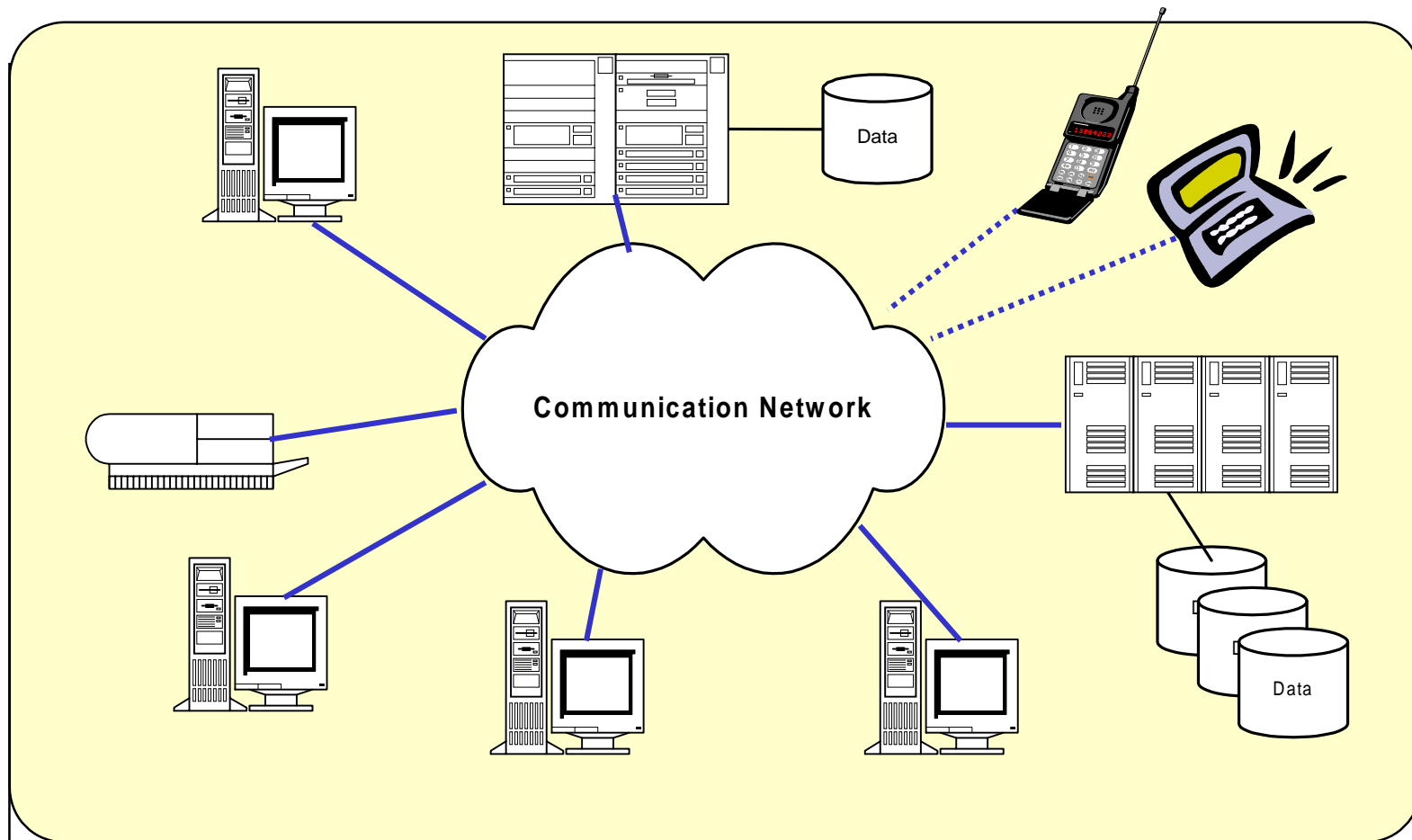
Module Organisation

- Lectures
 - Tue 12-1pm G34 Mech Eng
 - Thu 10-11am G33 Mech Eng
- Problems Classes
 - approx. 5 hrs in selected lecture slots
 - MZK + demonstrators (R Mehmood and M Zoubek)
- Assessment
 - 100% by exam

Useful Information

- Textbook (essential)
 - Coulouris *et al*, Distributed Systems: Concepts and Design, **3rd edition**, Addison-Wesley 2000
- Handouts
 - printed copies of **slides only**, copies of slides on WWW
 - see module webpage and School library
- Module webpage
 - www.cs.bham.ac.uk/~mzk/courses/DistSys/
 - links to book website, URLs, glossary, animations, etc
 - comments/suggestions welcome!

Distributed Systems



Why Distributed Systems?

- Main features
 - geographical **distribution** of **autonomous** computers
 - **communication** through cable/fibre/wireless/... connections
- Advantages:
 - **interaction**, **co-operation** and **sharing** of resources
- Benefits
 - **reduced** costs, improved **availability** and **performance**

Module Aims

- Introduce the **principles** and **concepts** involved in design of distributed systems
- Familiarise with **mechanisms** and **protocols** for inter-process communication
- Give overview of fundamental **problems** and **techniques** for their solution

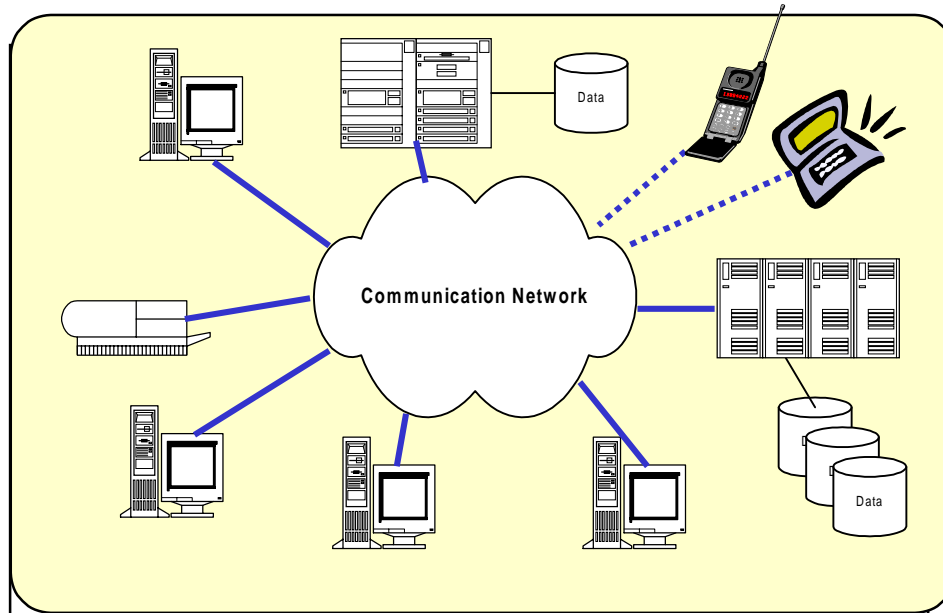
Topics Covered

- Architectures and models
- Inter-process communication
- Distributed file storage
- Timing issues, co-ordination, concurrency control and transactions
- Security and fault-tolerance
- Distributed multimedia

This lecture: Introduction

- Definition of Distributed Systems
- Examples
 - Internet
 - intranets
 - mobile and ubiquitous computing
 - The World-Wide Web
- Characteristics
- Challenges

Definition



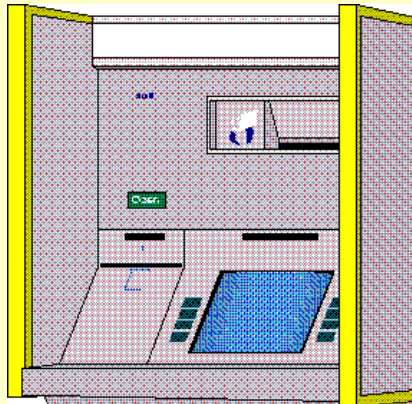
A **distributed system** is a collection of **autonomous computers** interconnected by a **computer network** and equipped with distributed **system software** to form an **integrated** computing facility.

Processes

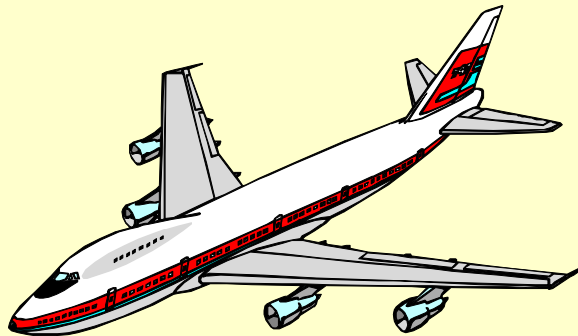
- execute **concurrently**
- **interact** in order to co-operate to achieve a common goal
- co-ordinate their activities and exchange information by means of **messages** transferred over a communication network

Importance of Distributed Computing

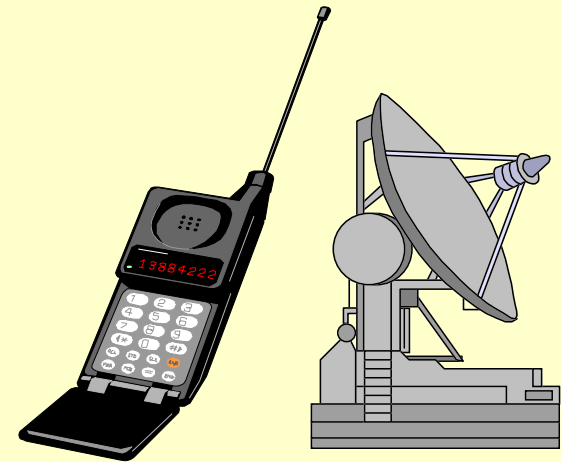
Distributed computer systems are **critical** for functioning of many organisations



Banks



Transport

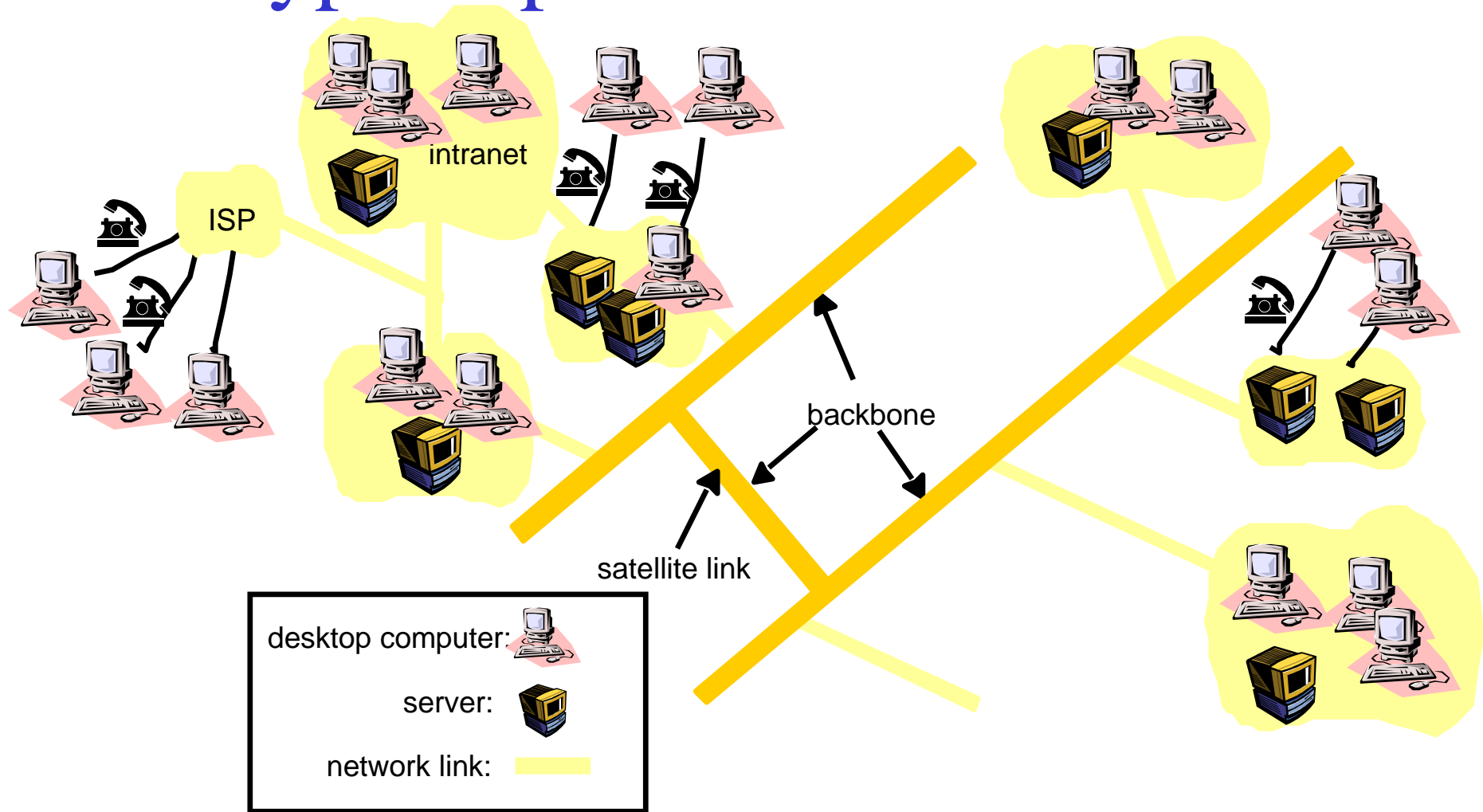


Telecommunications

Typical examples

- **Internet**
 - global network of interconnected computers which communicate through IP protocols
- **Intranet**
 - a separately administered network with a boundary that allows to enforce local security policies
- **Mobile and ubiquitous (pervasive) computing**
 - laptops, PDAs, mobile phones, printers, home devices, ...
- **The World-Wide Web**
 - system for publishing and accessing resources and services across the Internet

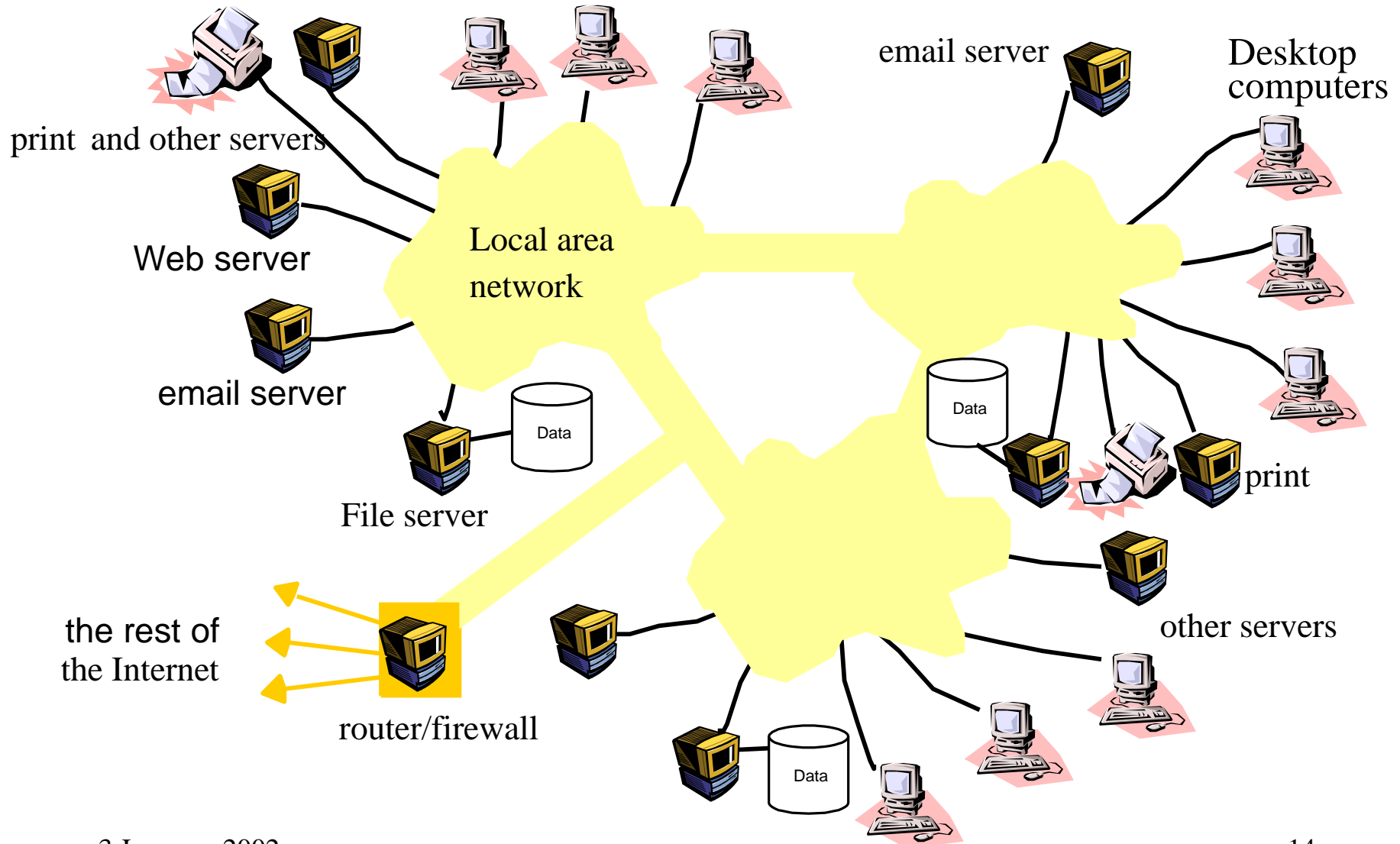
A typical portion of the Internet



Characteristics of Internet

- very **large** and **heterogeneous**
- enables email, file transfer, multimedia communications, WWW,...
- **open-ended**
- connects **intranets** (via backbones) with **home users** (via modems, ISPs)

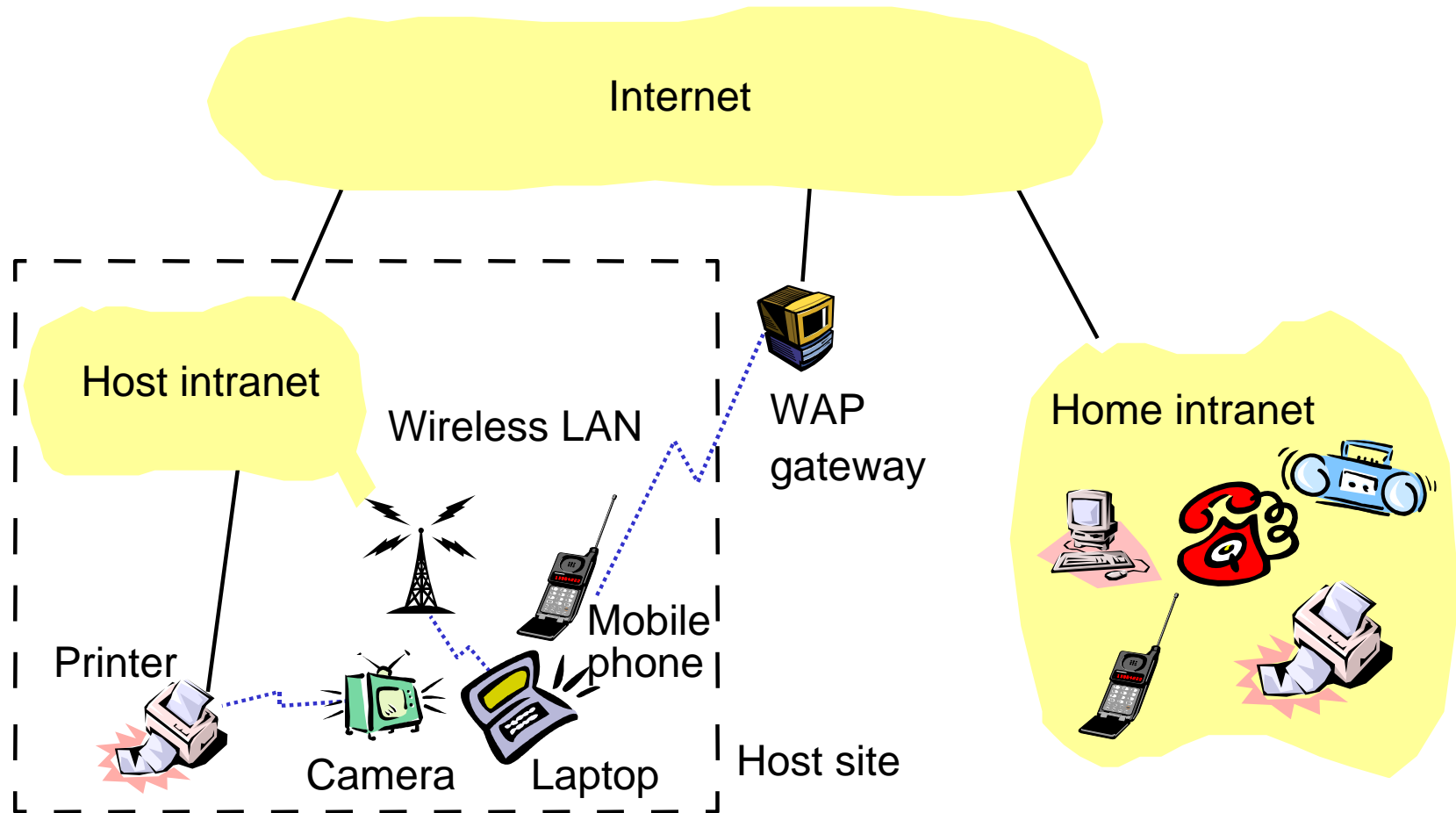
A typical Intranet



Characteristics of intranets

- several **LANs** linked by backbones
- enables info. flow **within** organisation
 - electronic data, documents, ...
- provides **services**
 - email, file, print servers,...
- often **connected to** Internet via router
- in/out communications protected by **firewall**

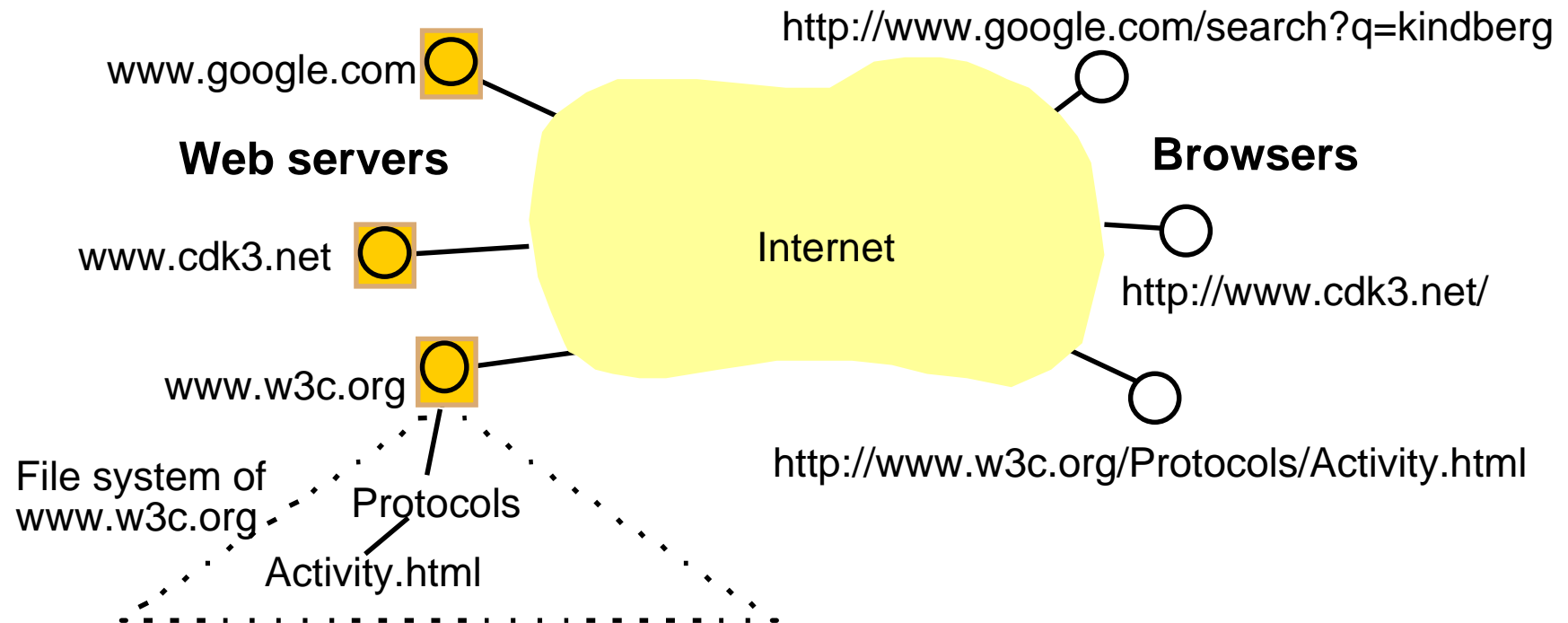
Portable and handheld devices



Mobile & ubiquitous computing

- **Wireless LANs (WLANs)**
 - connectivity for portable devices (laptops, PDAs, mobile phones, video/dig. cameras, ...)
 - WAP (Wireless Applications Protocol)
- **Home intranet**
 - devices embedded in home appliances (hi-fi, washing machines, ...)
 - universal ‘remote control’ + communication

Web servers and web browsers



WWW

- world-wide **resource sharing** over Internet
- based on **technologies**:
 - HTML (HyperText Markup Language)
 - URL (Uniform Resource Locator)
 - client-server architecture
- **open system**
 - can be extended, re-implemented, ...

Challenges posed by DSs

Due to:

- complexity
- size
- changing technologies
- society's dependence

Heterogeneity

- varying software and hardware
 - need for **standards** (protocols, middleware)
- mobile code support
 - **virtual machine** (cf Java)

Openness

- independence of vendors
- publishable key interfaces
 - CORBA
- publishable communication mechanisms
 - Java RMI

Security

- **confidentiality** (protect against disclosure)
 - cf medical records
- **integrity** (protect against alteration and interference)
 - cf financial data

Need **encryption** and knowledge of **identity**.

Scalability

- will it remain effective with growth?
- need to control cost of resources, performance, ...
 - e.g. escalating growth of computers/web server ratio

<i>Date</i>	<i>Computers</i>	<i>Web servers</i>	<i>Percentage</i>
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

Failure handling

Ability to continue computation in the presence of failures.

- **detect/mask/tolerate** failures
- **recovery** from failures
- **redundancy**

Concurrency

Processes execute **simultaneously** and share **resources**.

- **synchronisation**
- inter-process **communication**

Transparency

Concealment of the **separated** nature of system from user/programmer.

- network **transparency**
 - cf log on, email on SoCS network

Summary

Distributed Systems

- pervasive in society
- use a variety of technologies
- understanding underlying concepts and issues important in their management, implementation, programming