Communications and Networking 1

ET4254

CS4225

CS5222

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ET4254 - Communications and Networking 1

Prerequisite Modules:

- No Prerequisite Modules

Aims & Objectives:

- The aim of this module is to provide an introduction to the principles of communication systems, which will serve as a foundation for further studies in communications and computer networking.
- On completion of this module, students should understand:
  - the main building blocks of communication systems and their functions
  - the need for different ways of encoding, transmitting and multiplexing signals
  - the use of different transmission media
  - principles of digital data transmission and computer communications
  - the operation of aspects of modern communications infrastructure
  - principles and concepts in networks

Syllabus:

- Introduction to Communications and networks: definitions, standards bodies
- Communication system model and concepts; analog and digital signal concepts; frequency spectrum and bandwidth
- Overview of analog and digital signals encoding and transmission; Introduction to sampling, quantization, PAM, PCM
- Multiplexing: definition, FDM, TDM, WDM, STDM
- Transmission media: guided media, unguided media; overview of transmission impairment, performance, data rate and bandwidth; structured cabling standards
- Digital data transmission: parallel interfaces, serial transmission and synchronization
- Circuit Switching, Packet switching
- PSTN, switching concepts, routing, digital hierarchies, control signalling
- Modems; ISDN overview; DSL technologies
- Communications network architecture and protocols introduction: OSI model, networks definitions, types LAN, MAN, WAN
- Data link control: synchronous, asynchronous transmission, flow control, error control, data link protocols
- Introduction to Local Area Networks concepts

Prime Texts:

- Stallings, W., Data and Computer Communications, 2001. NJ: Prentice-Hall.
- Bateman, A., Digital Communications: Design for the Real World, 1998. Addison-Wesley
- Simmonds, A. J., Data Communications and Transmission Principles, 1997, Palgrave Macmillan

Other Relevant Texts:

- Forouzan, B. A., Data Communications and Networking, 2000. Boston:McGraw-Hill.
- Halsall, F., Data Communications, Computer Networks and Open Systems, 1998, 4th ed., AddisonWesley
- Tanenbaum, A., Computer Networks, 2002, Prentice Hall
  - M J Usher & C G Guy, Information and Communication for Engineers, 1997 MacMillan Press Ltd.

Topic 1

Aims:-

- To Introduce Communications Networks
- Definitions
- Standards Bodies

Data Communications, Data Networks, and the Internet

The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point - *The Mathematical Theory of Communication*, Claude Shannon

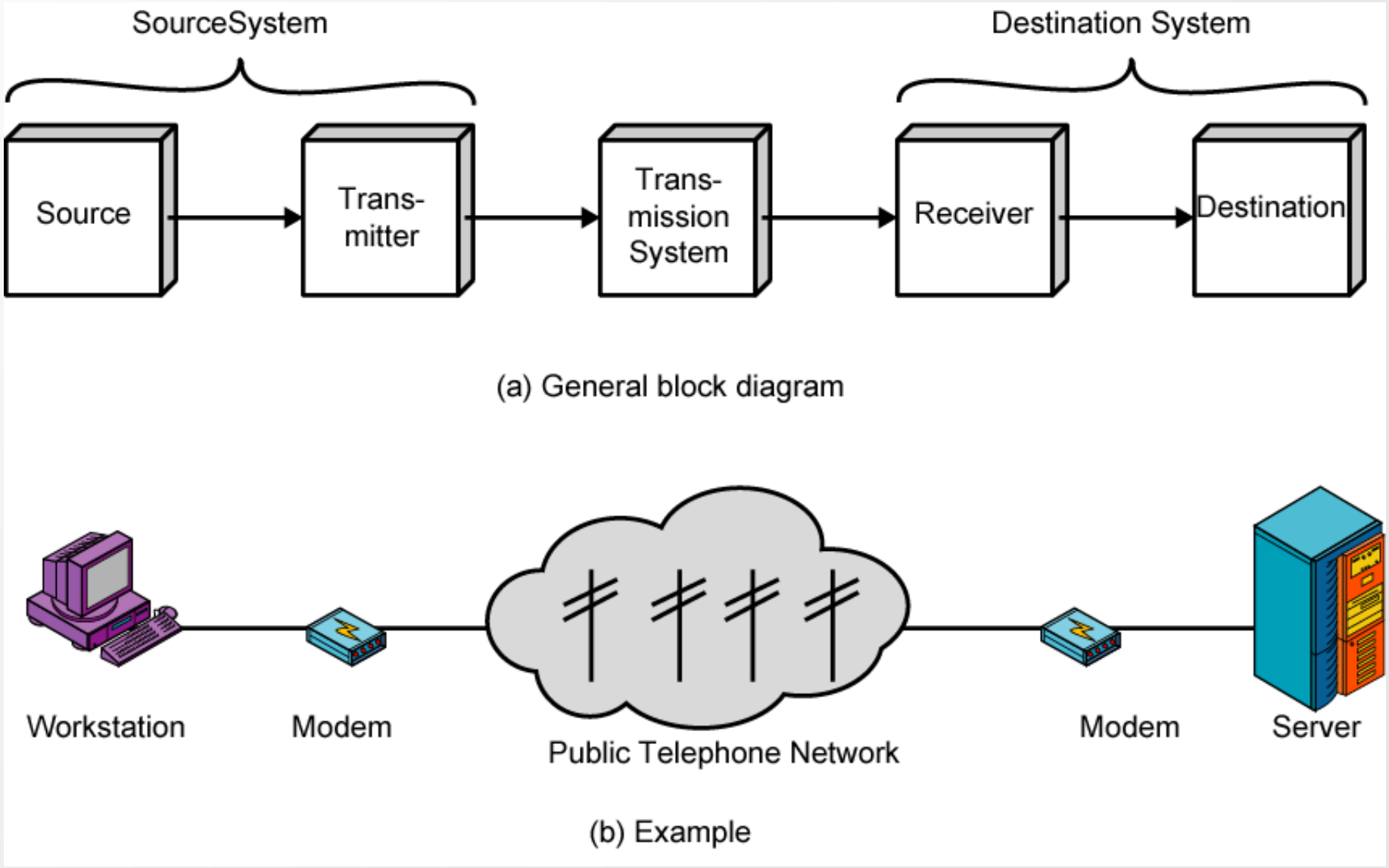
Contemporary Data Communications

- Trends
- traffic growth at a high & steady rate
- development of new services
- advances in technology
- Significant change in requirements
- emergence of high-speed LANs
- corporate WAN needs
- digital electronics

A Communications Model

- Source:
  - Generates data to be transmitted
- Transmitter:
  - Converts data into transmittable signals
- Transmission System:
  - Carries data
- Receiver:
  - Converts received signal into data
- Destination:
  - Takes incoming data

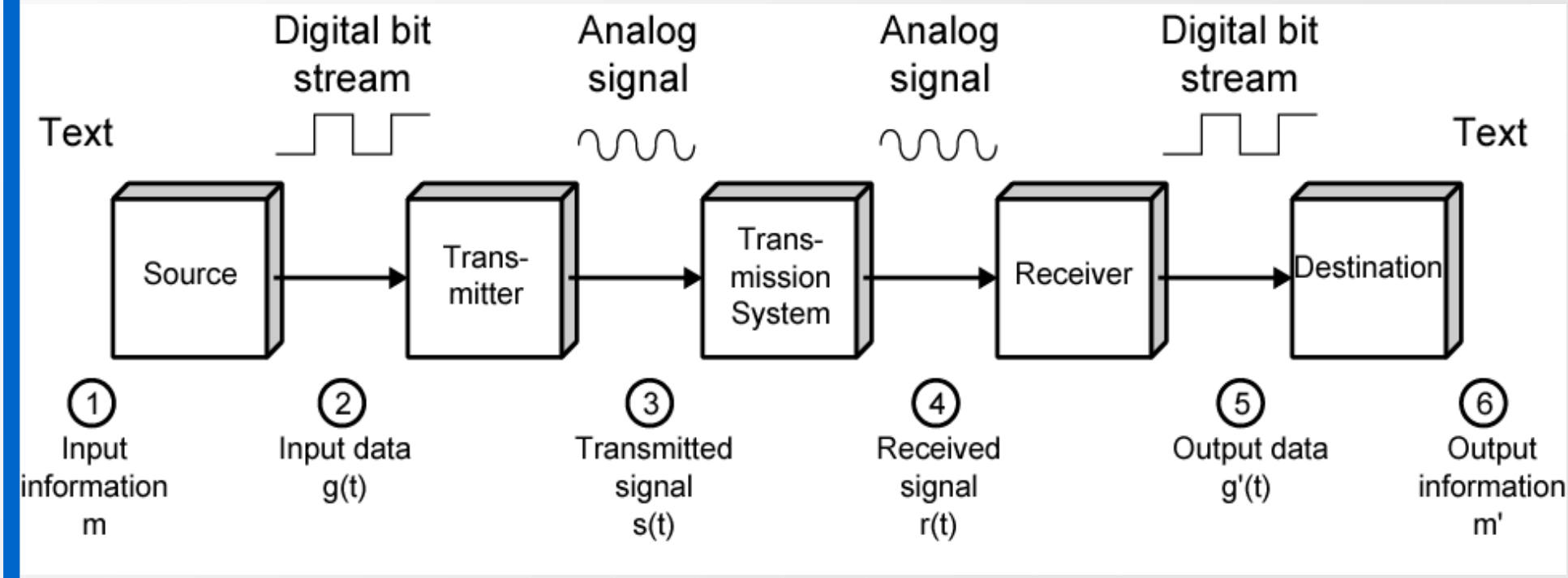
A Communications Model



Communications Tasks

Transmission System Utilization	Addressing
Interfacing	Routing
Signal Generation	Recovery
Synchronization	Message Formatting
Exchange Management	Security
Error detection and correction	Network Management
Flow Control	

Data Communications Model



Transmission Medium

- Selection is a basic choice
  - *internal use entirely up to business*
  - *long-distance links made by carrier*
- Rapid technology advances change mix
  - *fiber optic*
  - *wireless*
- Transmission costs still high
- Hence interest in efficiency improvements

Networking

- Point to point communication not usually practical
  - *Devices are too far apart*
  - *Large set of devices would need impractical number of connections*
- Growth of number & power of computers is driving need for interconnection
- Also seeing rapid integration of voice, data, image & video technologies
- Solution is a communications network
- Two broad categories of communications networks:
  - *Local Area Network (LAN)*
  - *Wide Area Network (WAN)*

Wide Area Networks

- Span a large geographical area
- Cross public rights of way
- Rely in part on common carrier circuits
- Alternative technologies used include:
  - *Circuit switching*
  - *Packet switching*
  - *Frame relay*
  - *Asynchronous Transfer Mode (ATM)*

Circuit Switching

- Uses a dedicated communications path established for duration of conversation
- Comprising a sequence of physical links
- With a dedicated logical channel
- Example:- telephone network

Packet Switching

- Data sent out of sequence
- Small chunks (packets) of data at a time
- Packets passed from node to node between source and destination
- Used for terminal to computer and computer to computer communications

Frame Relay

- Packet switching systems have large overheads to compensate for errors
- Modern systems are more reliable
- Errors can be caught in end system
- Frame Relay provides higher speeds
- With most error control overhead removed

Asynchronous Transfer Mode

- ATM
- Evolution of frame relay
- Fixed packet (called cell) length
- With little overhead for error control
- Anything from 10Mbps to Gbps
- Constant data rate using packet switching technique with multiple virtual circuits

Integrated Services Digital Network

- ISDN
- Designed to replace public telecom system
- Wide variety of services
- Entirely digital domain

Local Area Networks

- Smaller scope
  - Building or small campus
- Usually owned by same organization as attached devices
- Data rates much higher
- Switched LANs, eg Ethernet
- Wireless LANs

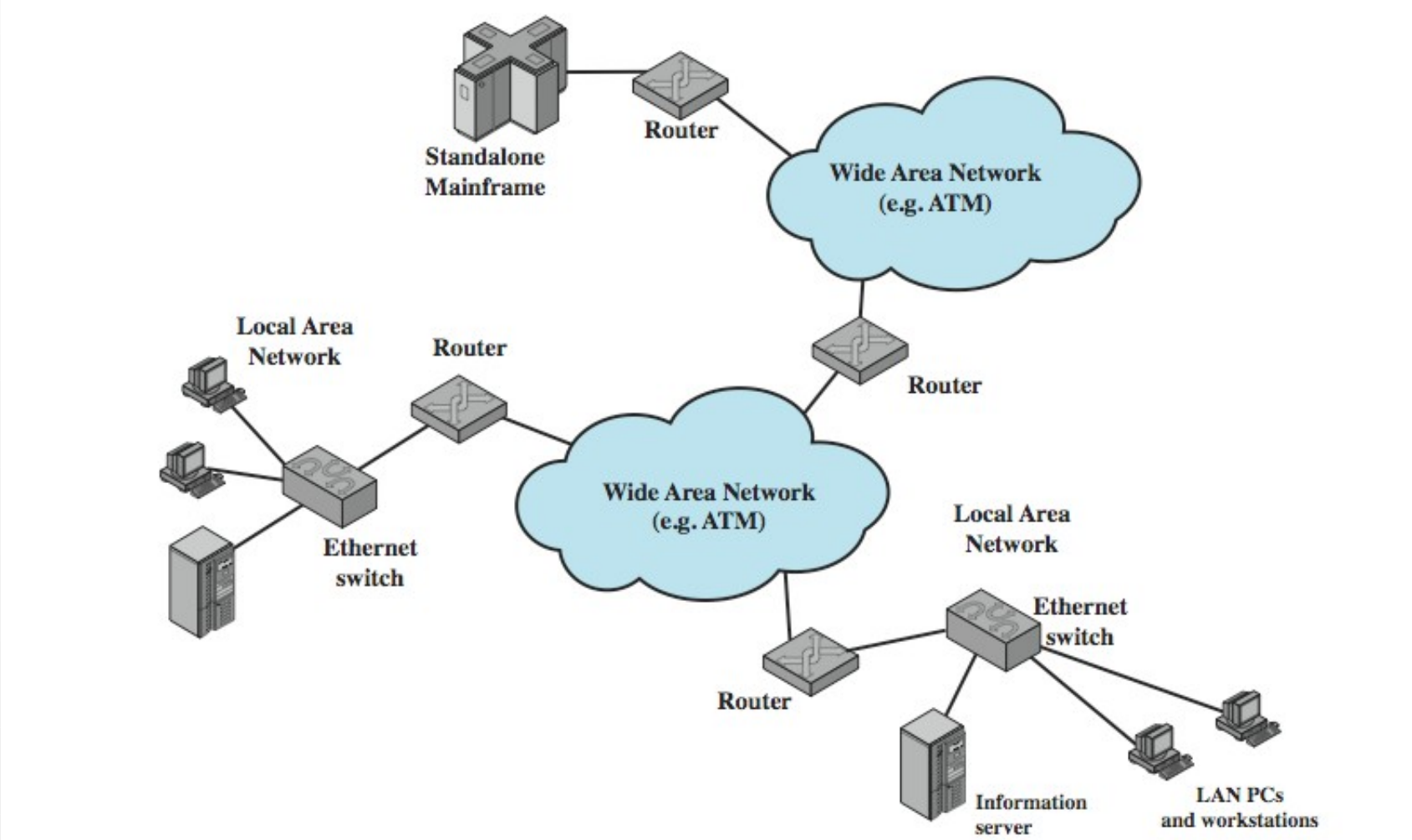
Metropolitan Area Networks

- MAN
- Middle ground between LAN and WAN
- Private or public network
- High speed
- Large area

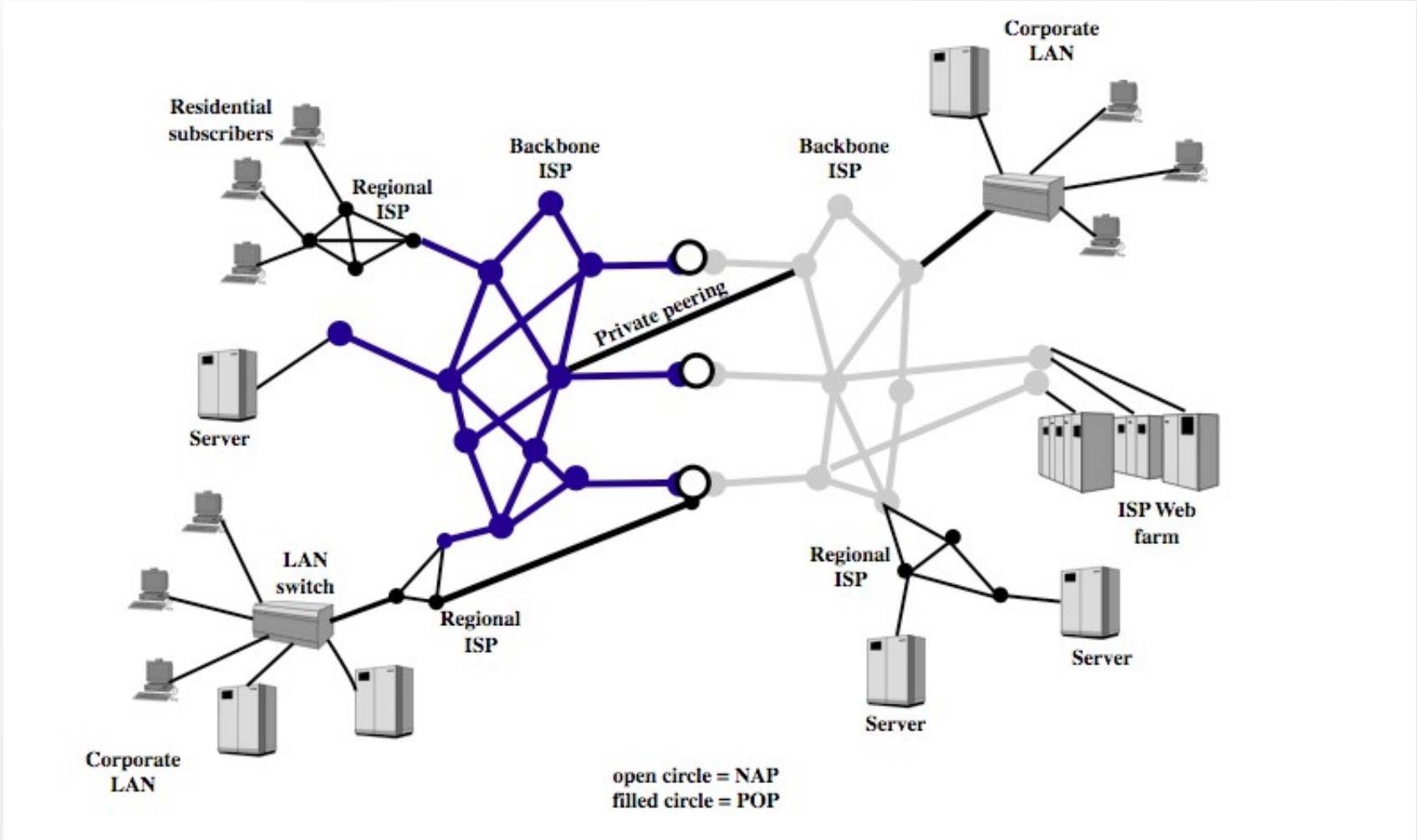
The Internet

- Internet evolved from ARPANET
  - First operational packet network
  - Applied to tactical radio & satellite nets also
  - Had a need for interoperability
  - Led to standardized TCP/IP protocols

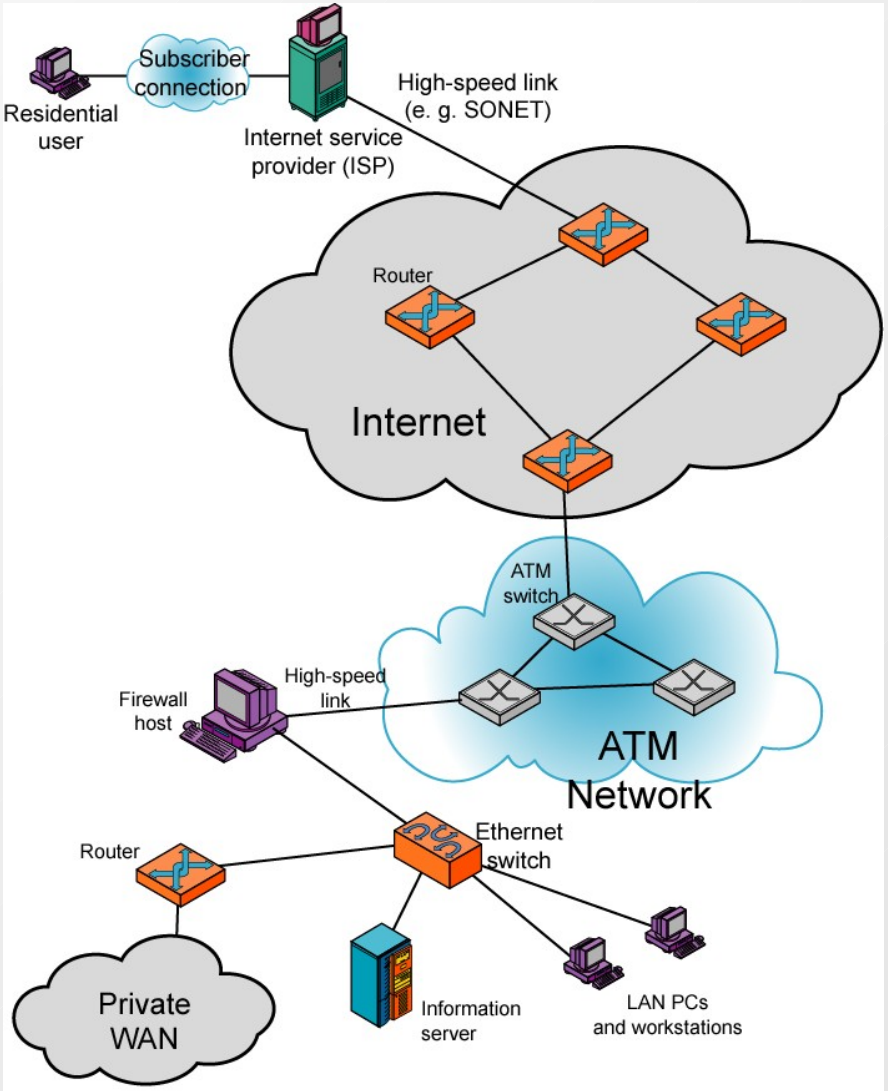
Internet Elements



Internet Architecture



Example Configuration



Standards

- Required to allow for interoperability between equipment
- Advantages
  - Ensures a large market for equipment and software
  - Allows products from different vendors to communicate
- Disadvantages
  - Freeze technology
  - May be multiple standards for the same thing

Standard Organisations

- Internet Society
  - Internet Architecture Board (IAB)
  - Internet Engineering Task Force (IETF)
  - Internet Engineering Steering Group (IESG)
- International Organization for Standardization (ISO)
- International Telecommunications Union (ITU-T) (formally CCITT)
- ATM forum
- IEEE 802

Internet Society

The Internet Society is the coordinating committee for Internet design, engineering, and management. Areas covered include the operation of the Internet itself and the standardization of protocols used by end systems on the Internet for interoperability. Three organizations under the Internet Society are responsible for the actual work of standards development and publication:

- Internet Architecture Board (IAB): Responsible for defining the overall architecture of the Internet, providing guidance and broad direction to the IETF
- Internet Engineering Task Force (IETF): The protocol engineering and development arm of the Internet
- Internet Engineering Steering Group (IESG): Responsible for technical management of IETF activities and the Internet standards process

ISO

- ISO is not an acronym (in which case it would be IOS), but a word, derived from the Greek *isos*, meaning "equal."
- The International Organization for Standardization, or ISO, is an international agency for the development of standards on a wide range of subjects.
- It is a voluntary, nontreaty organization whose members are designated standards bodies of participating nations, plus nonvoting observer organizations.
- Although ISO is not a governmental body, more than 70 percent of ISO member bodies are governmental standards institutions or organizations incorporated by public law.
- Most of the remainder have close links with the public administrations in their own countries.
- The United States member body is the American National Standards Institute.
- ISO was founded in 1946 and has issued more than 12,000 standards in a broad range of areas.
- Its purpose is to promote the development of standardization and related activities to facilitate international exchange of goods and services and to develop cooperation in the sphere of intellectual, scientific, technological, and economic activity.
- Standards have been issued to cover everything from screw threads to solar energy.
- One important area of standardization deals with the Open Systems Interconnection (OSI) communications architecture and the standards at each layer of the OSI architecture.
- In the areas of data communications and networking, ISO standards are actually developed in a joint effort with another standards body, the International Electrotechnical Commission (IEC).
- IEC is primarily concerned with electrical and electronic engineering standards.
- In the area of information technology, the interests of the two groups overlap, with IEC emphasizing hardware and ISO focusing on software.
- In 1987, the two groups formed the Joint Technical Committee 1 (JTC 1). This committee has the responsibility of developing the documents that ultimately become ISO (and IEC) standards in the area of information technology.

ITU-T

- The International Telecommunication Union (ITU) is a United Nations specialized agency.
- Hence the members of ITU-T are governments.
- The U.S. representation is housed in the Department of State.
- The charter of the ITU is that it

"is responsible for studying technical, operating, and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis."

- Its primary objective is to standardize, to the extent necessary, techniques and operations in telecommunications to achieve end-to-end compatibility of international telecommunication connections, regardless of the countries of origin and destination.

ATM forum

- The ITU-T is responsible, among other areas, for the development of standards for Broadband ISDN (B-ISDN), which is based on ATM technology.
- The ATM Forum also plays a crucial role in the development of ATM standards.
- In the ITU-T and the constituent member bodies from the participating countries, the process of developing standards is characterized by wide participation by government, users, and industry representatives, and by consensus decision making.
- This process can be quite time consuming.
- While ITU-T has streamlined its efforts, the delays involved in developing standards are particularly significant in the area of B-ISDN, which is dominated by the rapidly evolving asynchronous transfer mode (ATM) technology.
- Because of the strong level of interest in ATM technology, the ATM Forum was created with the goal of accelerating the development of ATM standards.
- The ATM Forum is an international nonprofit organization, funded by over 600 member companies.
- End users are also represented within the Forum.
- The ATM Forum has seen more active participation from computing vendors than has been the case in ITU-T.
- Because the forum works on the basis of majority rule rather than consensus, it has been able to move rapidly to define some of the needed details for the implementation of ATM.
- This effort, in turn, has fed into the ITU-T standardization effort.

IEEE 802

- The key to the development of the LAN market is the availability of a low-cost interface.
- The cost to connect equipment to a LAN must be much less than the cost of the equipment alone.
- This requirement, plus the complexity of the LAN logic, dictates a solution based on the use of chips and very-large-scale integration (VLSI).
- However, chip manufacturers will be reluctant to commit the necessary resources unless there is a high-volume market.
- A widely accepted LAN standard assures that volume and also enables equipment from a variety of manufacturers to intercommunicate. This is the rationale of the IEEE 802 committee.
- The committee issued a set of standards, which were adopted in 1985 by the American National Standards Institute (ANSI) as American National Standards.
- The standards were subsequently revised and reissued as international standards by the International Organization for Standardization (ISO) in 1987, with the designation ISO 8802.
- Since then, the IEEE 802 committee has continued to revise and extend the standards, which are ultimately then adopted by ISO.

Summary

- Introduced data communications needs
- Communications model
- Defined data communications
- Overview of networks
- Introduce Internet
- Standards Bodies