NCS 521: Data Communications

Week 1: Overview on Data Communications, Data Networks, and the Internet

By: Dr. Mahmoud Badr

Textbook: Chapter 1, Data and Computer Communications, by William Stallings

Who am I

- Mahmoud Badr, Dr. Mahmoud , Dr. Badr.
- PhD from Tennessee Technological University.
- Research focus→ Cybersecurity:
  - Security and privacy preservation
  - Machine learning in cybersecurity
  - Blockchain-based applications
- Assistant Professor, Network and Computer Security.

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Agenda

- Introduction
- A Communications Model
- Networks
- The Internet
- Summary

Introduction

- Claude Shannon said:

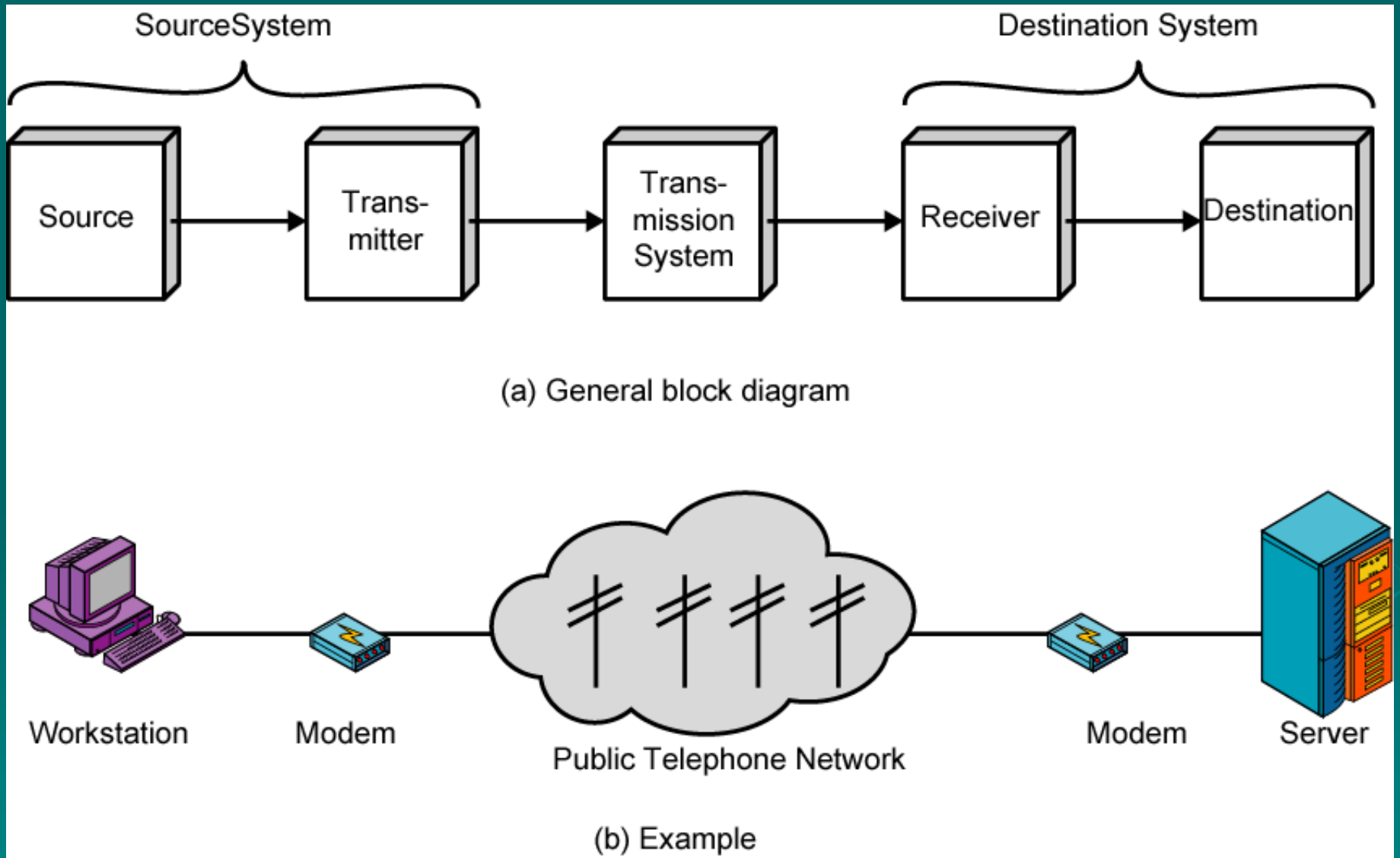
“The fundamental problem of communication is that of reproducing at one point either exactly or approximately a message selected at another point”

(The Mathematical Theory of Communication).

Technological Advancement Driving Forces

- 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 high-speed WAN needs
  - Digital electronics

A Communications Model



Communications Tasks

Transmission system utilization	Addressing
Interfacing & Signal generation	Routing
Synchronization	Recovery
Exchange management	Message formatting
Error detection and correction	Security
Flow control	Network management

Networking

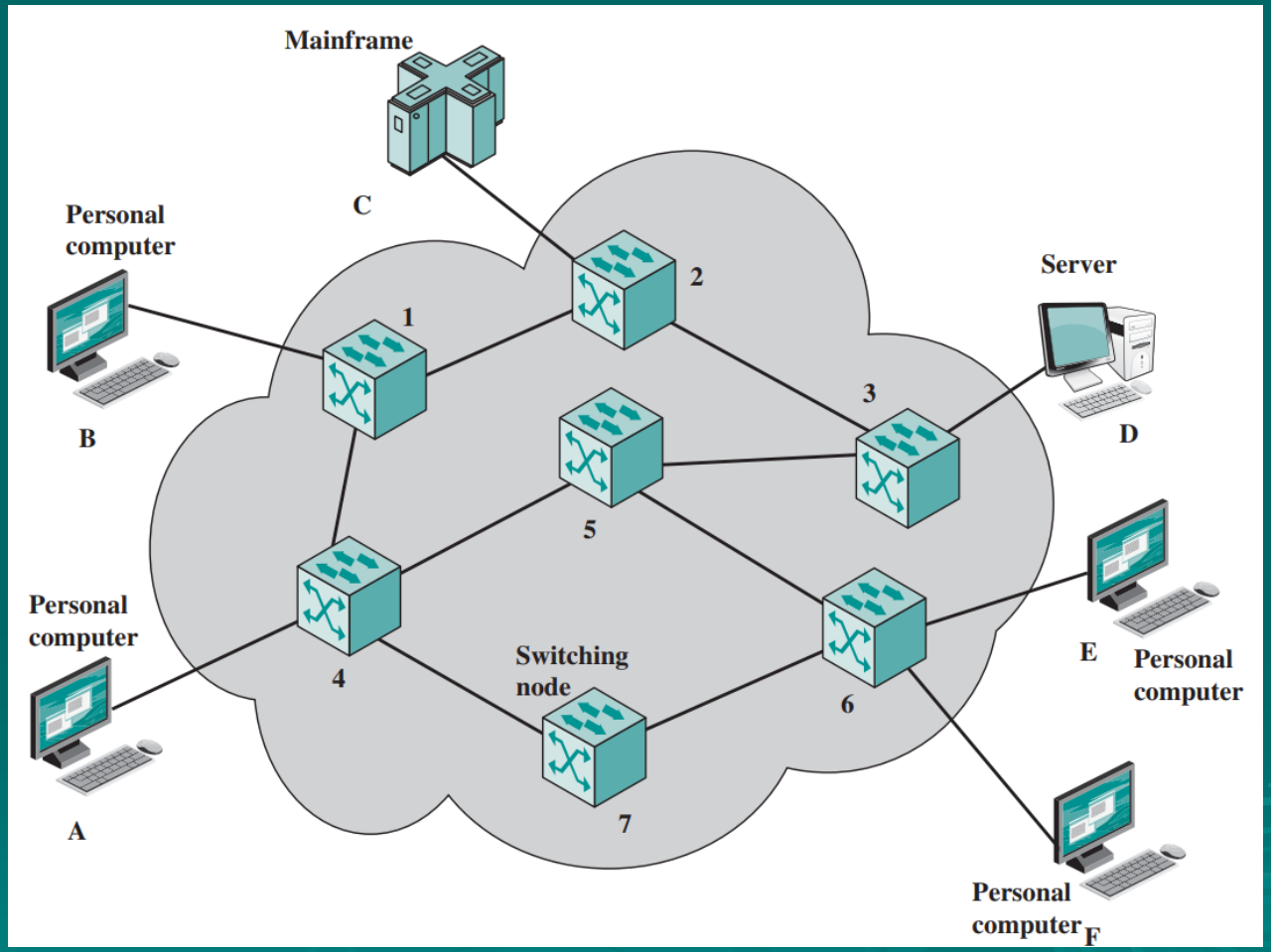
- Connecting computers, or in general communicating devices together.

- Two broad categories of networks:
  - Local Area Network (LAN)
  - Wide Area Network (WAN)

Wide Area Networks

- Cover a large geographical area, require the crossing of public right-of-ways, and rely at least in part on circuits provided by one or more common carriers.
- Typically, a WAN consists of a number of interconnected switching nodes.
- WANs can be implemented using one of the following alternative technologies:
  - Circuit switching
  - Packet switching
  - Frame relay
  - Asynchronous Transfer Mode (ATM)

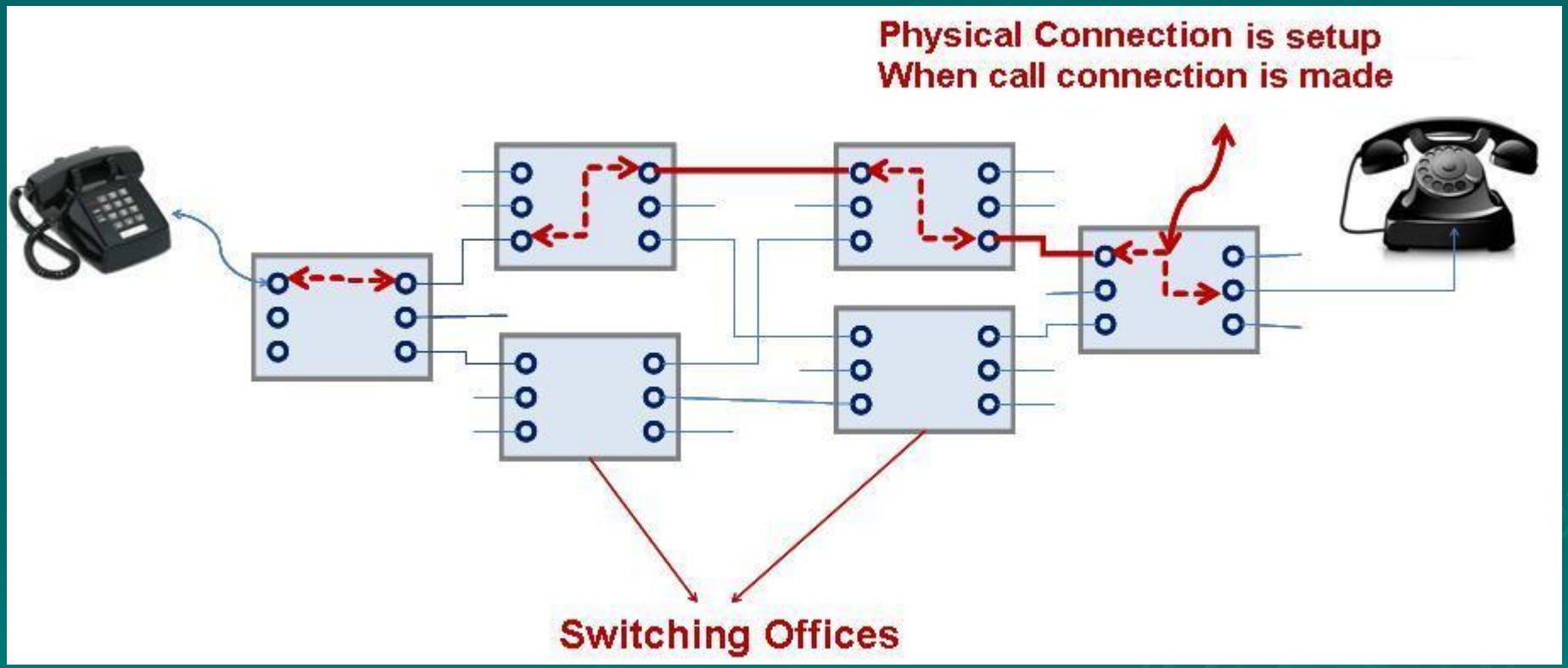
Wide Area Networks



Circuit Switching

- A dedicated communications path is established between the two communicating devices through the switching nodes for the duration of conversation.
- The path is a connected sequence of physical links between the nodes.
- Data generated by the source station are transmitted along the dedicated path as rapidly as possible.
- The most common example of circuit switching is the telephone network

Circuit Switching



Packet Switching

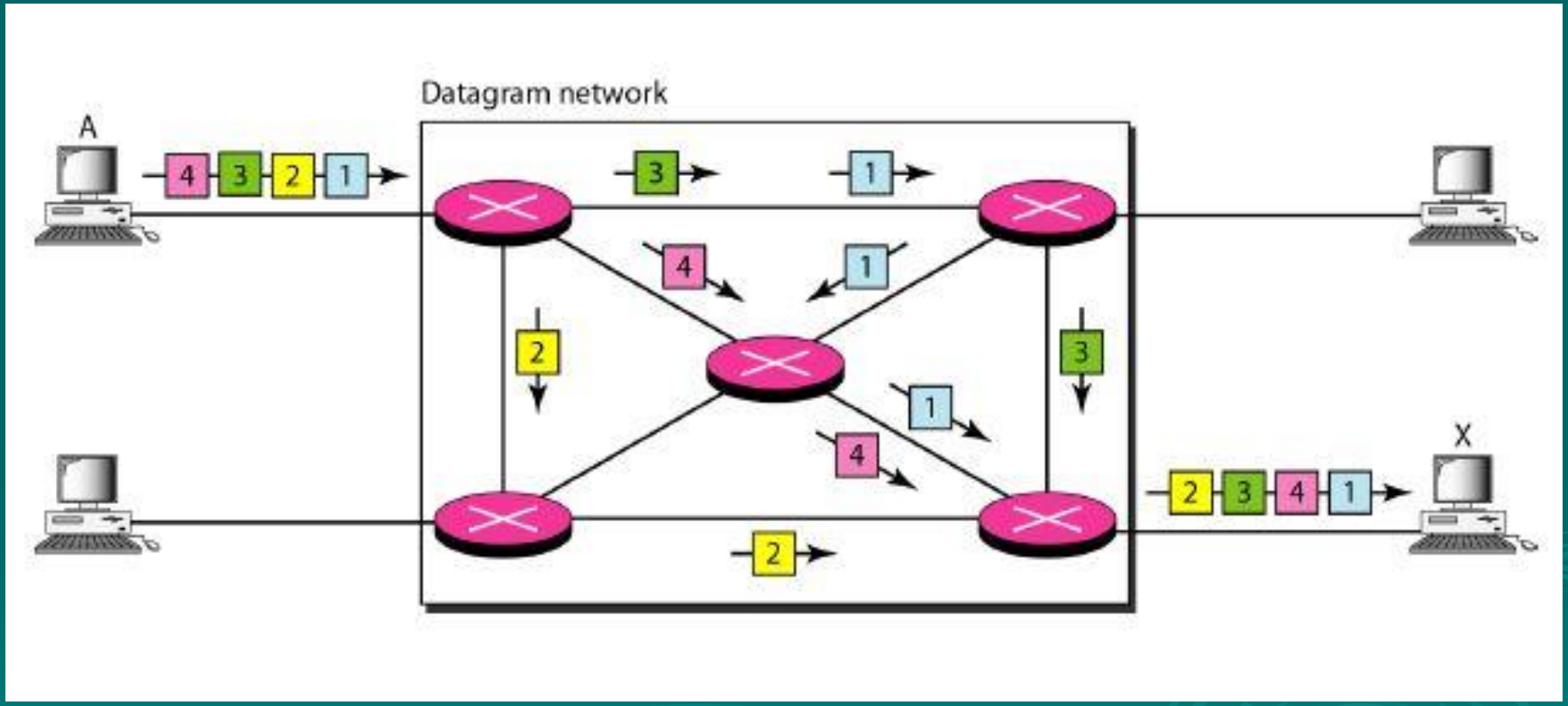
- It is not necessary to dedicate a certain transmission path for the communication process.

- Data is divided into small chunks (packets) and sent in a sequence.
- Each packet is passed through the network from node to node along some path leading from source to destination (different packets may take different paths).

- At each node, the entire packet is received, stored briefly, and then transmitted to the next node.

- Commonly used for computer-to-computer communications.

Packet Switching



Frame Relay

- Original packet-switching networks have large overheads to compensate for transmission errors.
- They add redundant bits to the packets to allow for error detection and correction.

- Frame relay was developed to take advantage that modern communication systems are more reliable (low error rates) by stripping out most of the overhead involved with error control.

- Frame Relay provides higher data rates of up to 2 Mbps comparing to the original data rate of 64 kbps

Asynchronous Transfer Mode

- ATM is an evolution from frame relay.
- Like frame relay, ATM provides little overhead for error control.

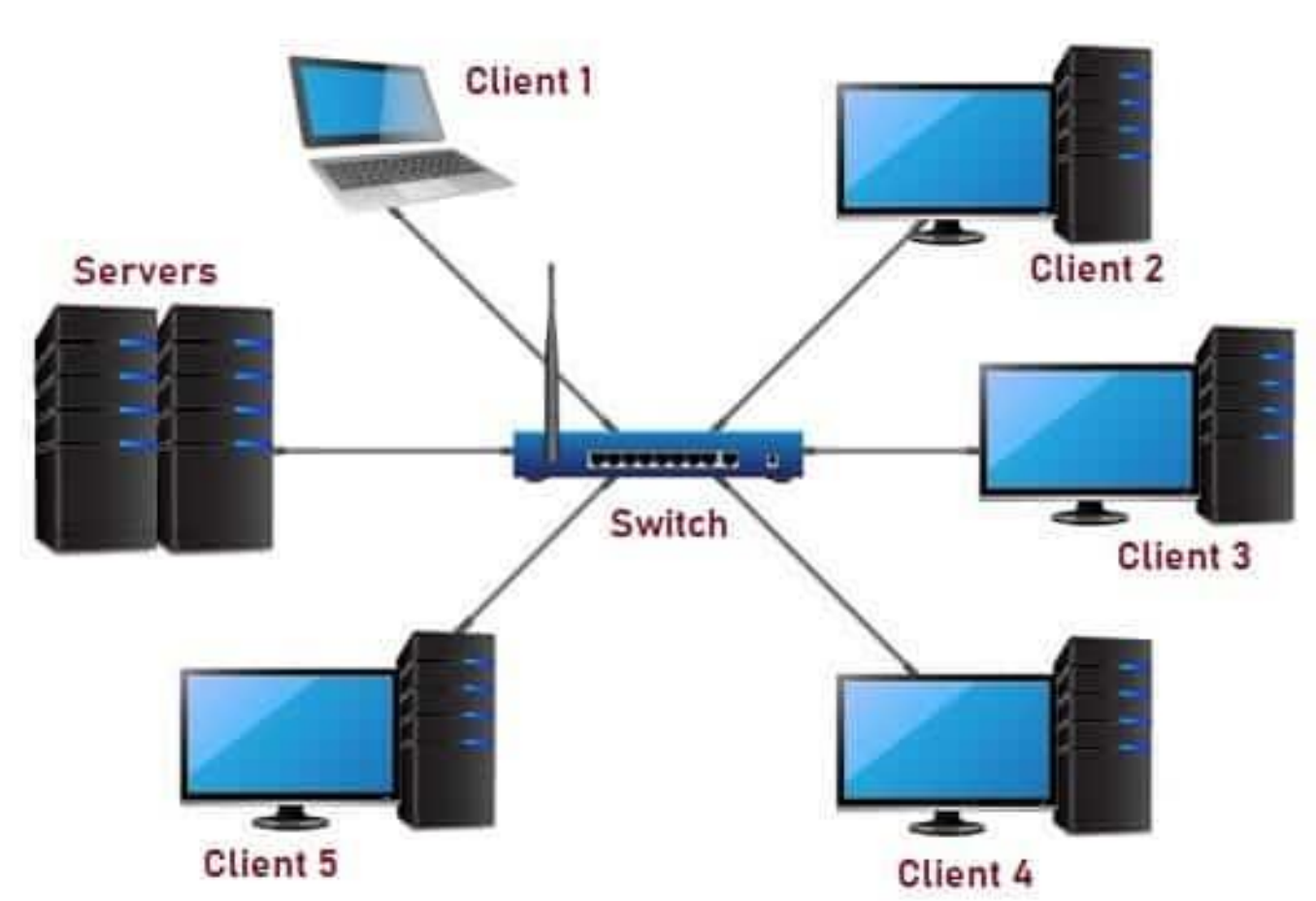
- Unlike frame relay that uses variable-length packets, called frames, ATM uses fixed-length packets, called cells.
- By using a fixed packet length, the processing overhead is reduced even further for ATM compared to frame relay.

- ATM provides higher data rates in the range from 10Mbps to Gbps.

Local Area Networks

- Smaller geographic scope
  - Building or small campus
- Usually owned by same organization that owns the attached devices. This is not the case in WANs.
- The internal data rates of LANs are typically much greater than those of WANs.
- Two common configurations for LANs:
  - Switched LANs, Ex: Ethernet.
  - Wireless LANs, Ex: Wi-Fi.

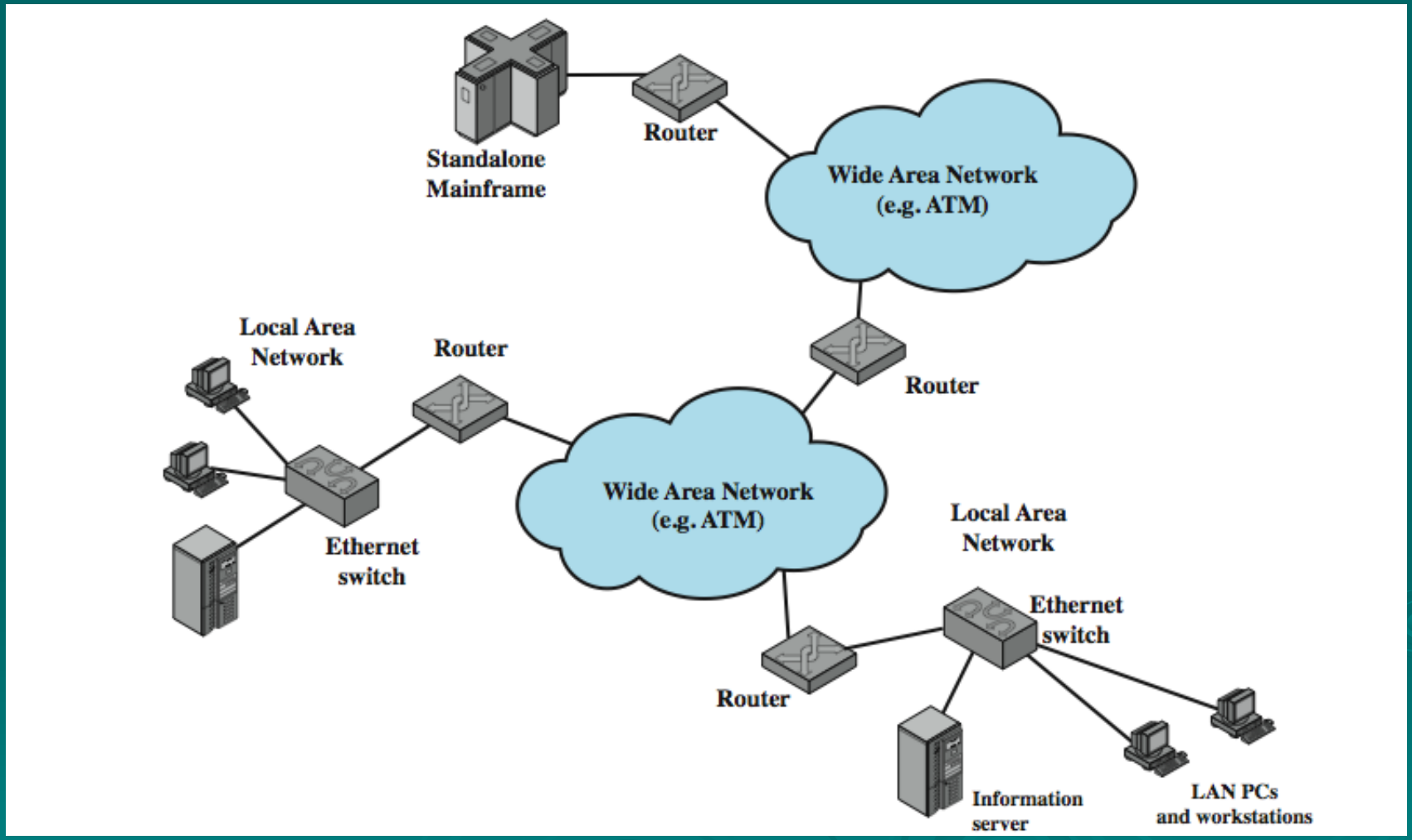
Local Area Networks



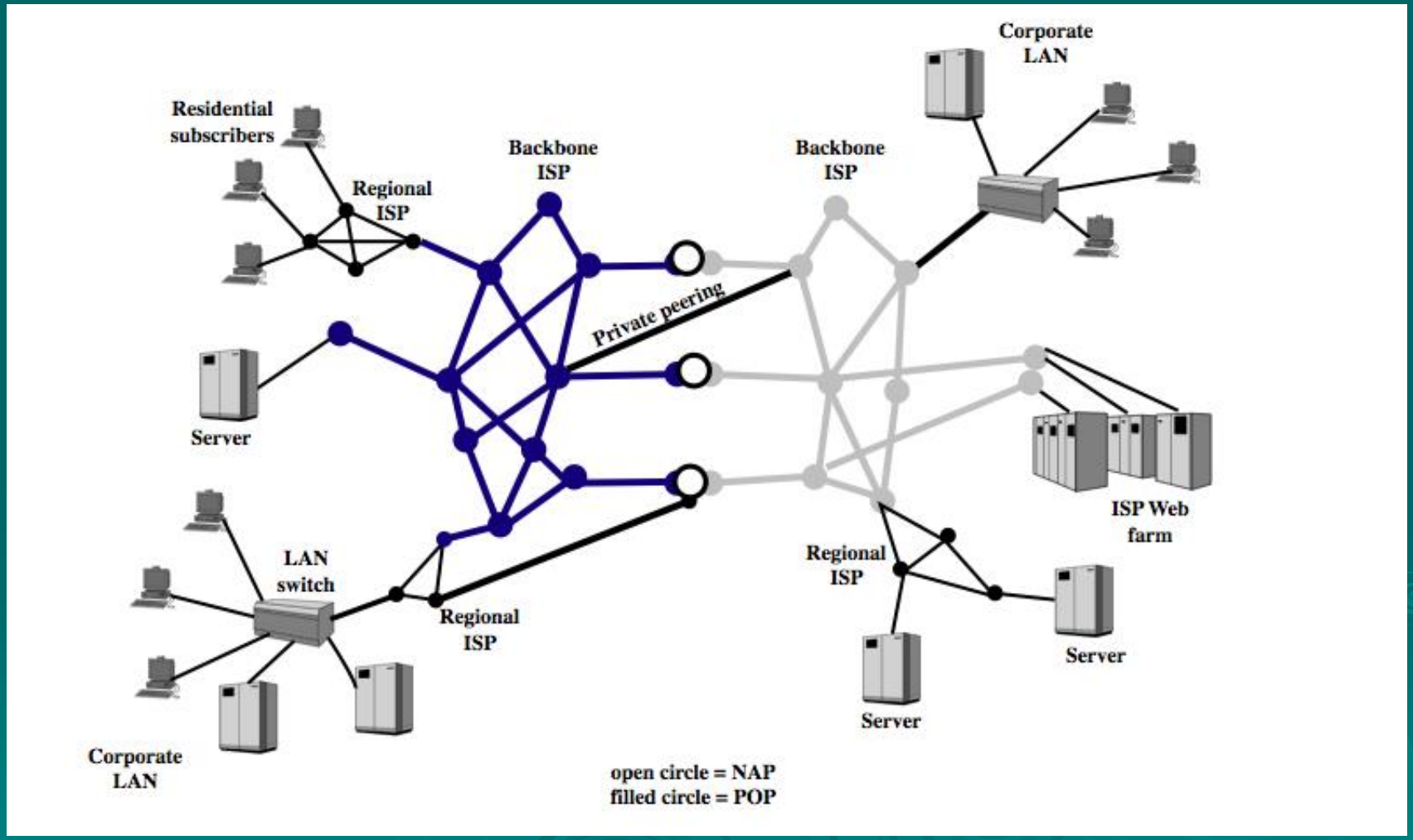
Origins of the Internet

- The Internet evolved from the ARPANET, developed in 1969 by the Advanced Research Projects Agency (ARPA) of the U.S. Department of Defense.
- ARPANET:
  - First operational packet-switching network.
  - Applied to tactical radio & satellite communication networks.
- The need for interworking between these different networks (interoperability)
  - led to the development of standardized TCP/IP protocols suite.

Key Elements of the Internet



Internet Architecture



Summary

- introduced data communications needs
- communications model
- defined data communications
- overview of networks
- introduce Internet