Data and Computer Communications

Tenth Edition

by William Stallings

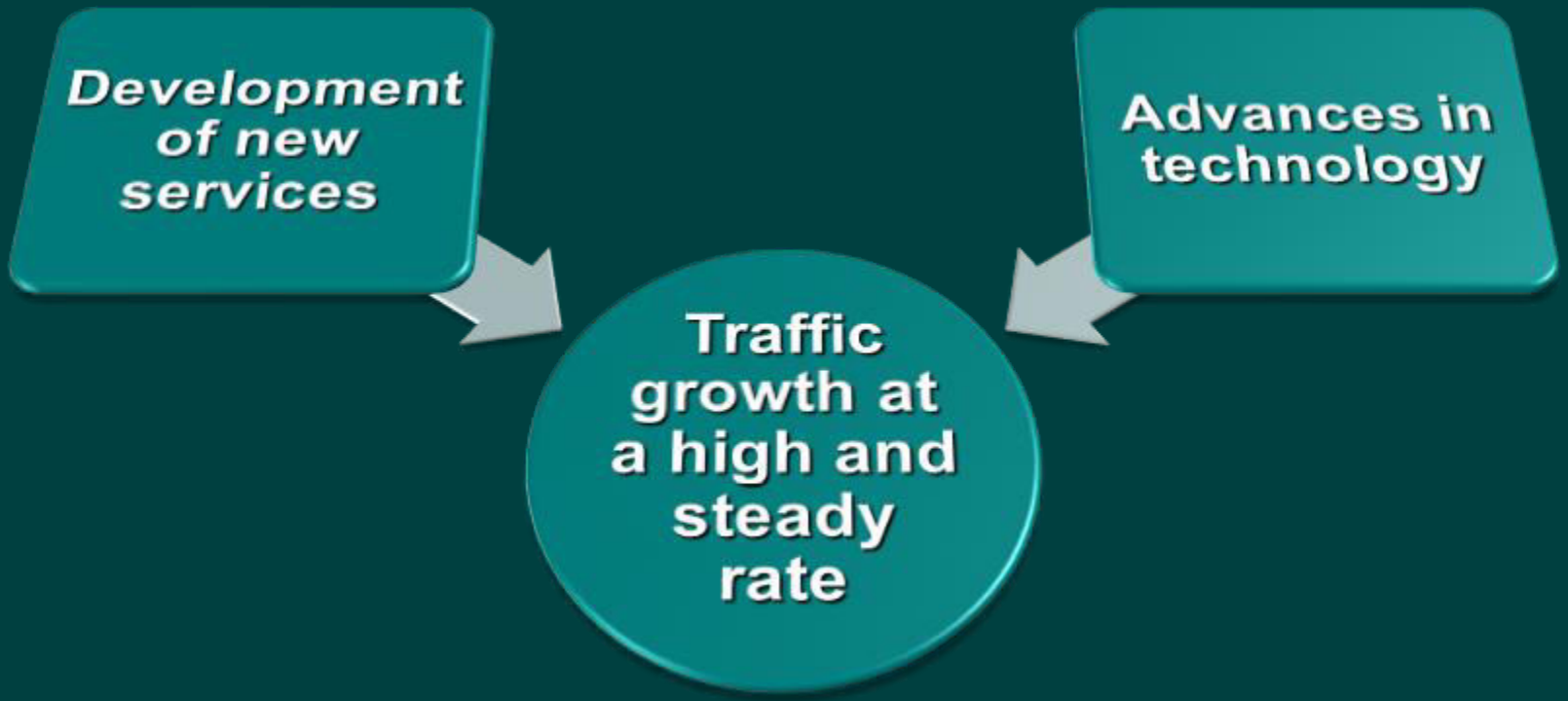
CHAPTER 1

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

Technological Advancement Driving Forces



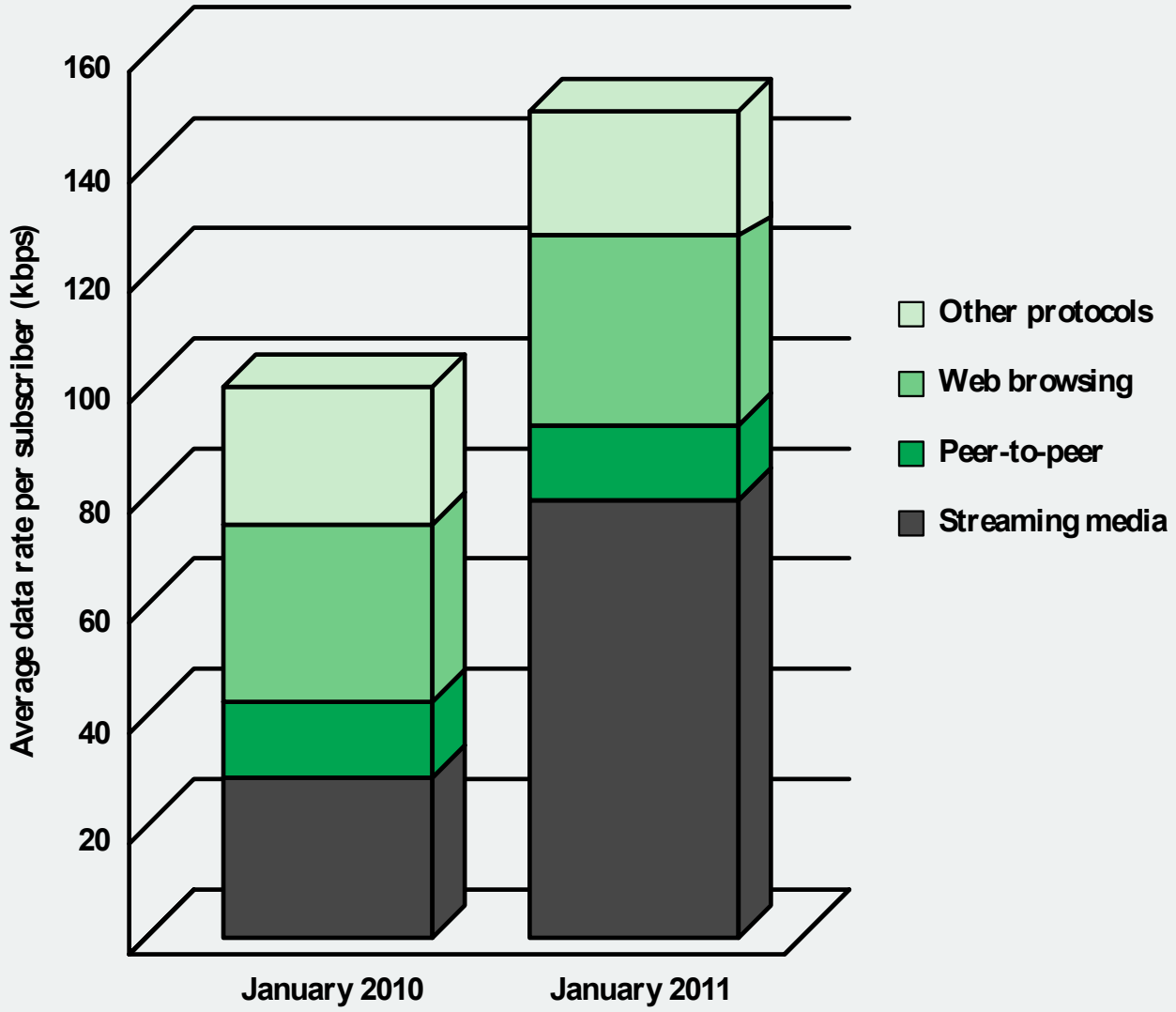


Figure 1.1 Average Downstream Traffic per Internet Subscriber

Notable Trends

Trend toward faster and cheaper, in both computing and communication

- More powerful computers supporting more demanding applications
- The increasing use of optical fiber and high-speed wireless has brought transmission prices down and greatly increased capacity

Today's networks are more "intelligent"

- Differing levels of quality of service (QoS)
- Variety of customizable services in the areas of network management and security

The Internet, the Web, and associated applications have emerged as dominant features for both business and personal network landscapes

- "Everything over IP"
- Intranets and extranets are being used to isolate proprietary information

Mobility

- iPhone, Droid, and iPad have become drivers of the evolution of business networks and their use
- Enterprise applications are now routinely delivered on mobile devices
- Cloud computing is being embraced

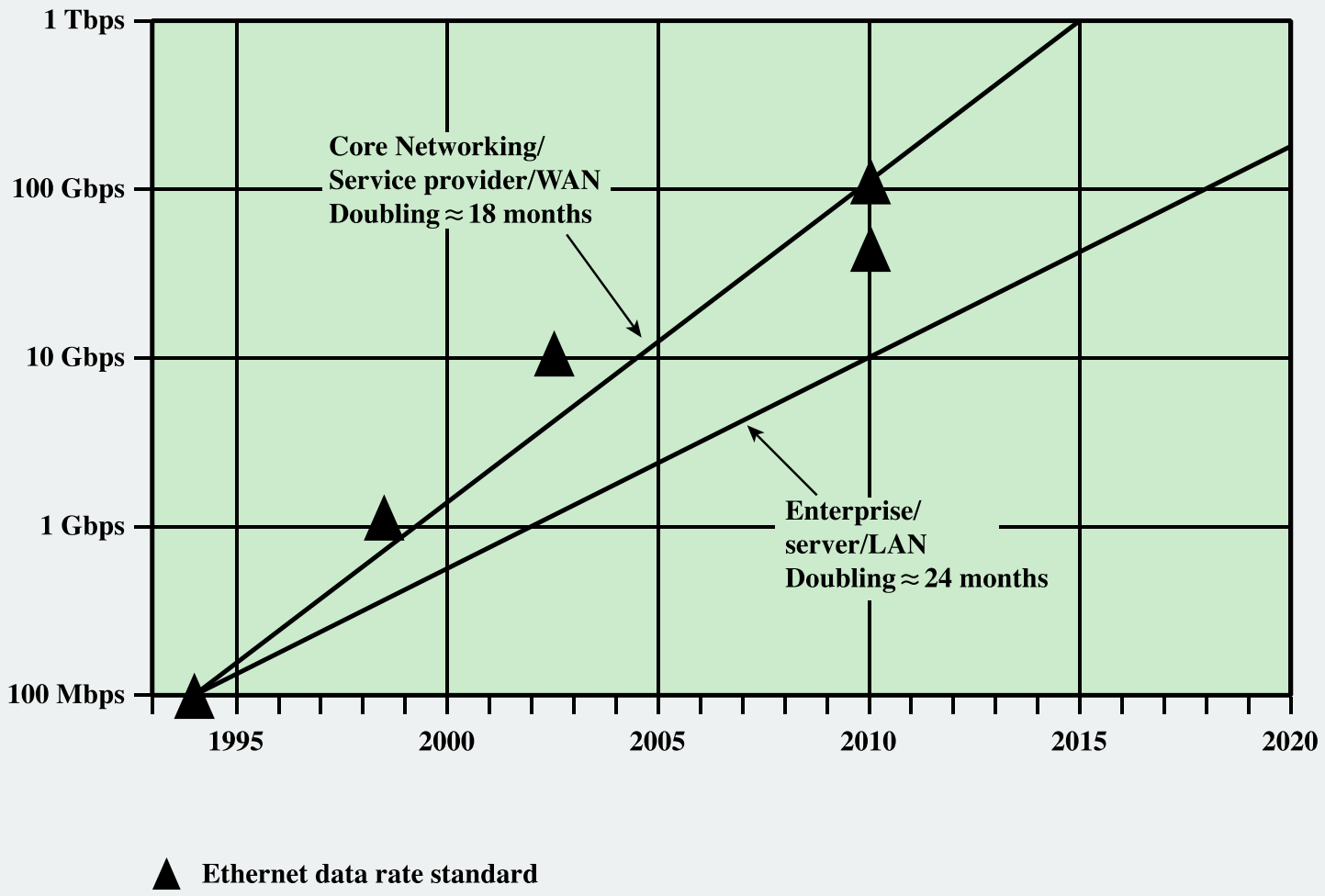


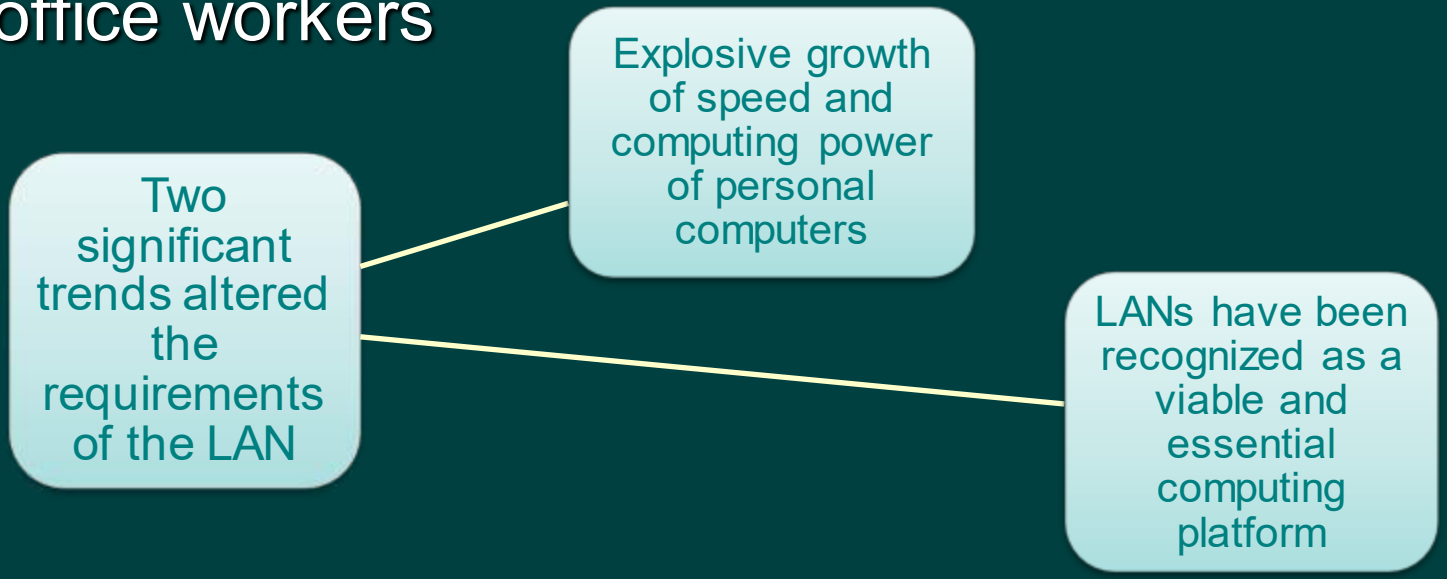
Figure 1.2 Past and Projected Growth in Ethernet Data Rate Demand Compared to Existing Ethernet Data Rates

Changes in Networking Technology

* Emergence of high-speed LANs
* Corporate WAN needs
* Digital electronics

Emergence of High-Speed LANs

- Personal computers and microcomputer workstations have become an essential tool for office workers



- Examples of requirements that call for higher-speed LANs:
  - Centralized server farms
  - Power workgroups
  - High-speed local backbone

Corporate Wide Area Networking Needs

Changes in corporate data traffic patterns are driving the creation of high-speed WANs

- Growing use of telecommuting
- Nature of the application structure has changed
- Intranet computing
- More reliance on personal computers, workstations, and servers
- More data-intensive applications
- Most organizations require access to the Internet
- Traffic patterns have become more unpredictable
- Average traffic load has risen
- More data is transported off premises and into the wide area

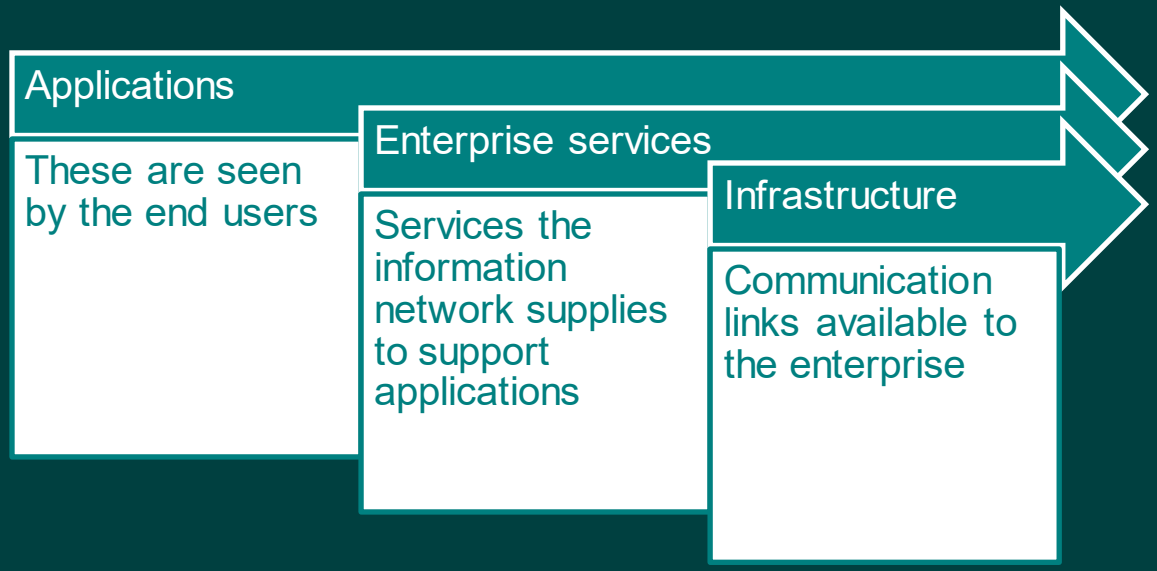
Digital Electronics

- The rapid conversion of consumer electronics to digital technology is having an impact on both the Internet and corporate intranets
  - Image and video traffic carried by networks is dramatically increasing
    - Because of their huge storage capacity digital versatile disks (DVDs) are being incorporated into Web sites
    - Digital camcorders have made it easier to make digital video files to be placed on corporate and Internet Web sites

Convergence

- The merger of previously distinct telephony and information technologies and markets
  - Involves:
    - Moving voice into a data infrastructure
    - Integrating all the voice and data networks inside a user organization into a single data network infrastructure
    - Then extending that into the wireless arena
  - Foundation is packet-based transmission using the Internet Protocol (IP)
  - Increases the function and scope of both the infrastructure and the application base

Layers:



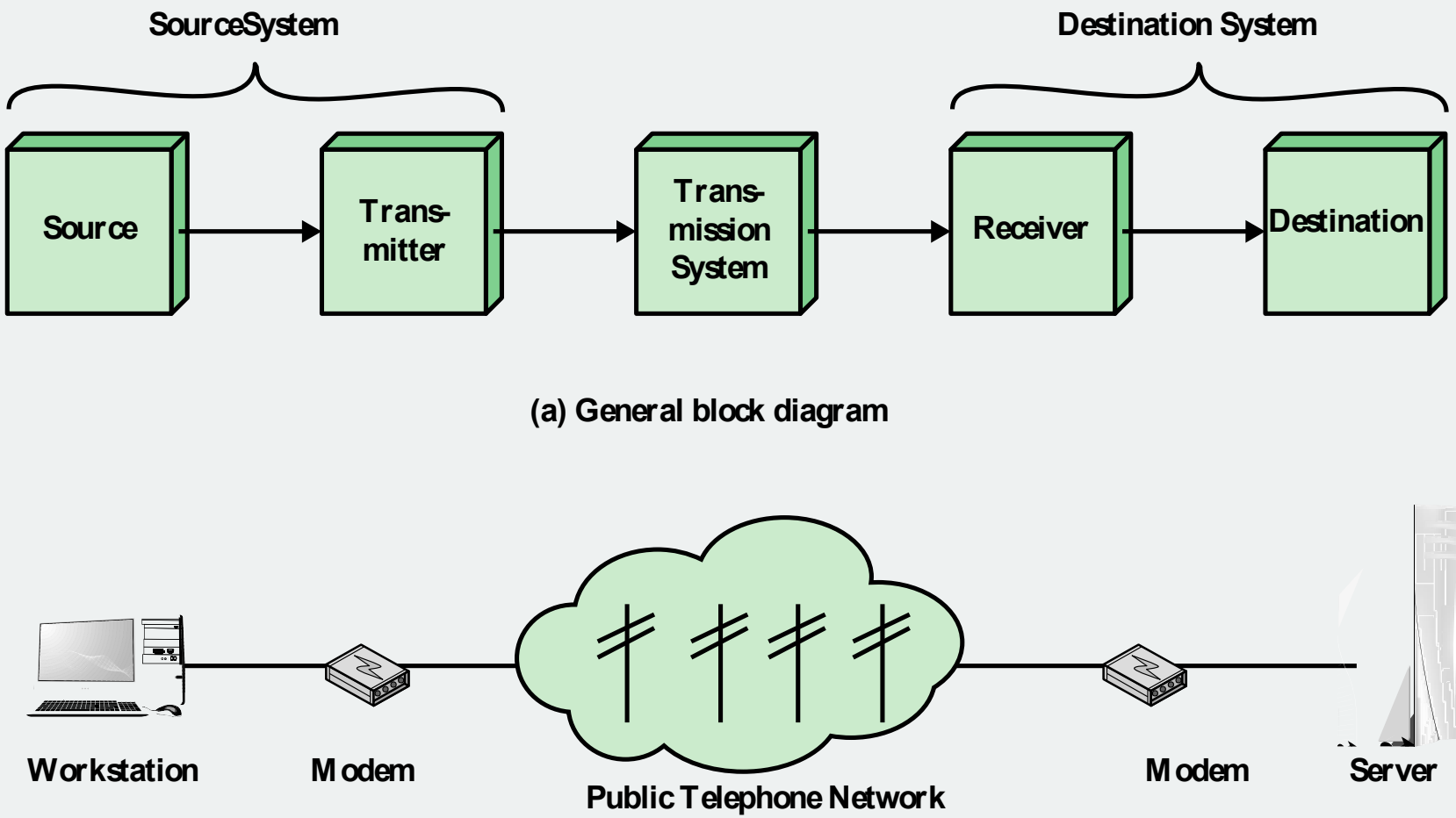


Figure 1.3 Simplified Communications Model

Table 1.1
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	

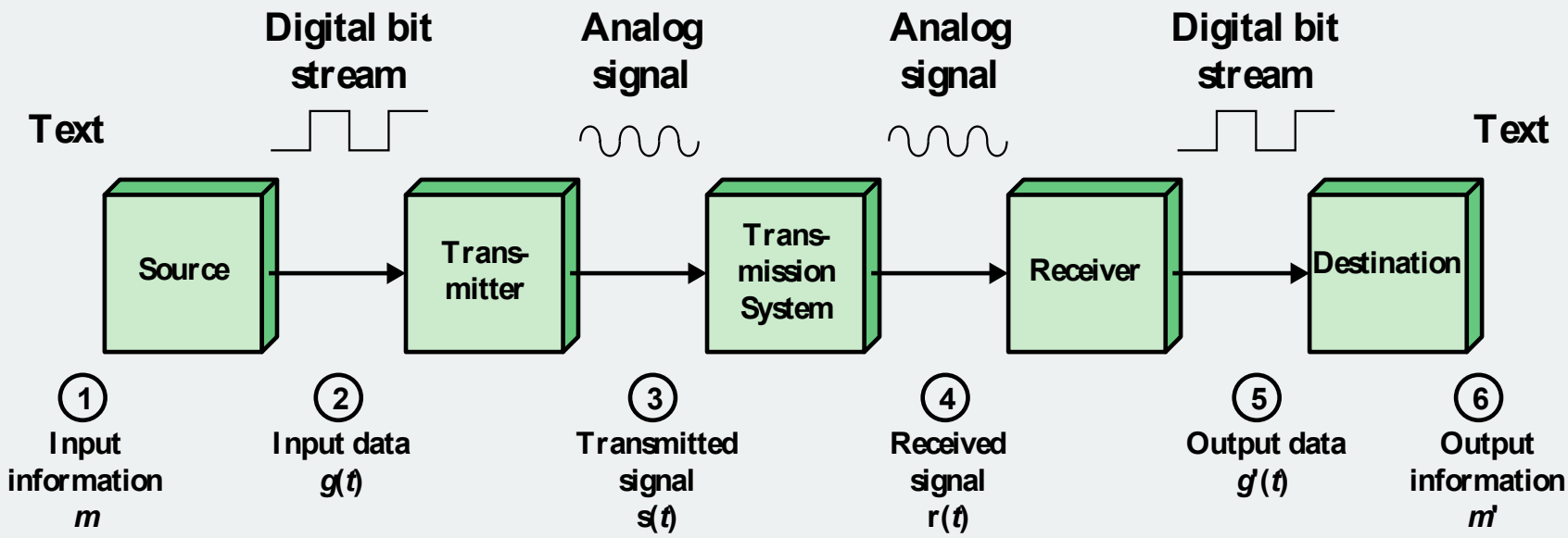


Figure 1.4 Simplified Data Communications Model

Transmission Lines

The basic building block of any communications facility is the transmission line

The business manager is concerned with a facility providing the required capacity, with acceptable reliability, at minimum cost

Transmission Mediums

Two mediums currently driving the evolution of data communications transmission are:

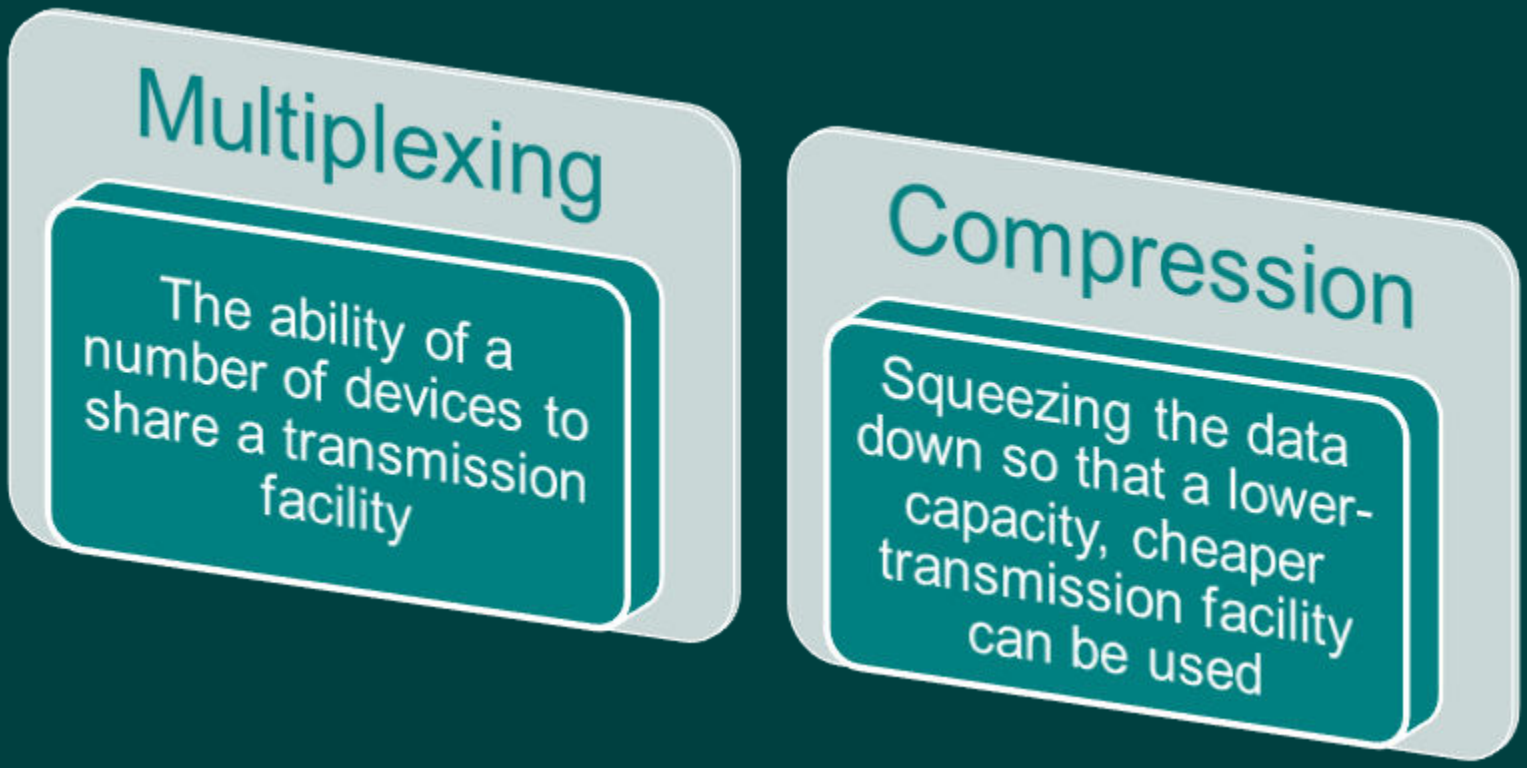
Fiber optic transmissions

and

Wireless transmissions

Transmission Services

- Remain the most costly component of a communications budget
- Two major approaches to greater efficiency:

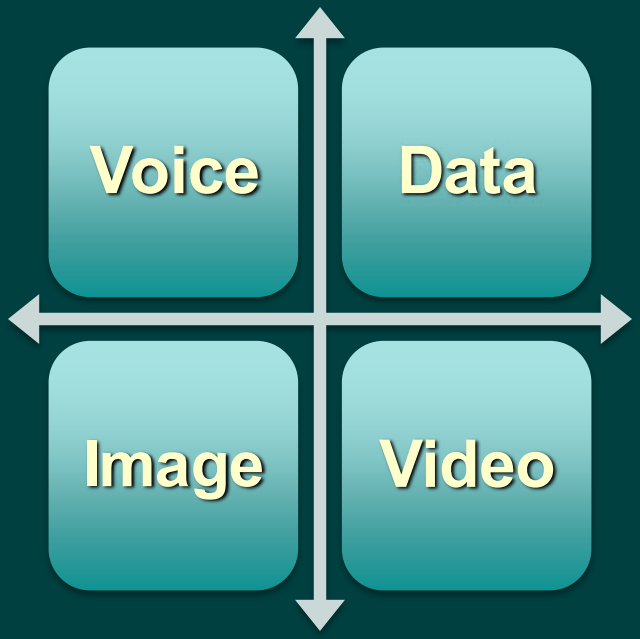


Networks

- It is estimated that by 2016 there will be over 20 billion fixed and mobile networked devices
  - This affects traffic volume in a number of ways:
    - It enables a user to be continuously consuming network capacity
    - Capacity can be consumed on multiple devices simultaneously
    - Different broadband devices enable different applications which may have greater traffic generation capability

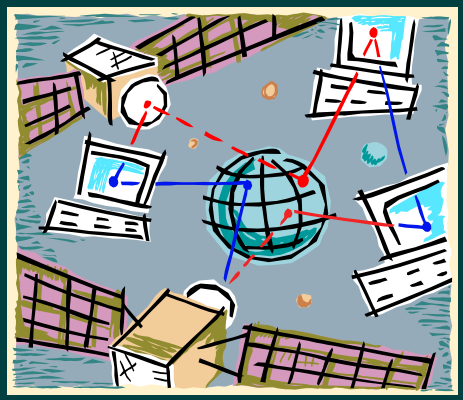
Networking

Advances in technology have led to greatly increased capacity and the concept of integration, allowing equipment and networks to work simultaneously



Wide Area Networks (WANs)

- Span a large geographical area
- Require the crossing of public right-of-ways
- Rely in part on common carrier circuits
- Typically consist of a number of interconnected switching nodes



Wide Area Networks

Alternative technologies used include:

- Circuit switching
- Packet switching
- Frame relay
- Asynchronous Transfer Mode (ATM)

Circuit Switching

- Uses a dedicated communications path
- Connected sequence of physical links between nodes
- Logical channel dedicated on each link
- Rapid transmission
- The most common example of circuit switching is the telephone network

Packet Switching

- Data are sent out in a sequence of small chunks called packets
- Packets are passed from node to node along a path leading from source to destination
- Packet-switching networks are commonly used for terminal-to-terminal computer and computer-to-computer communications

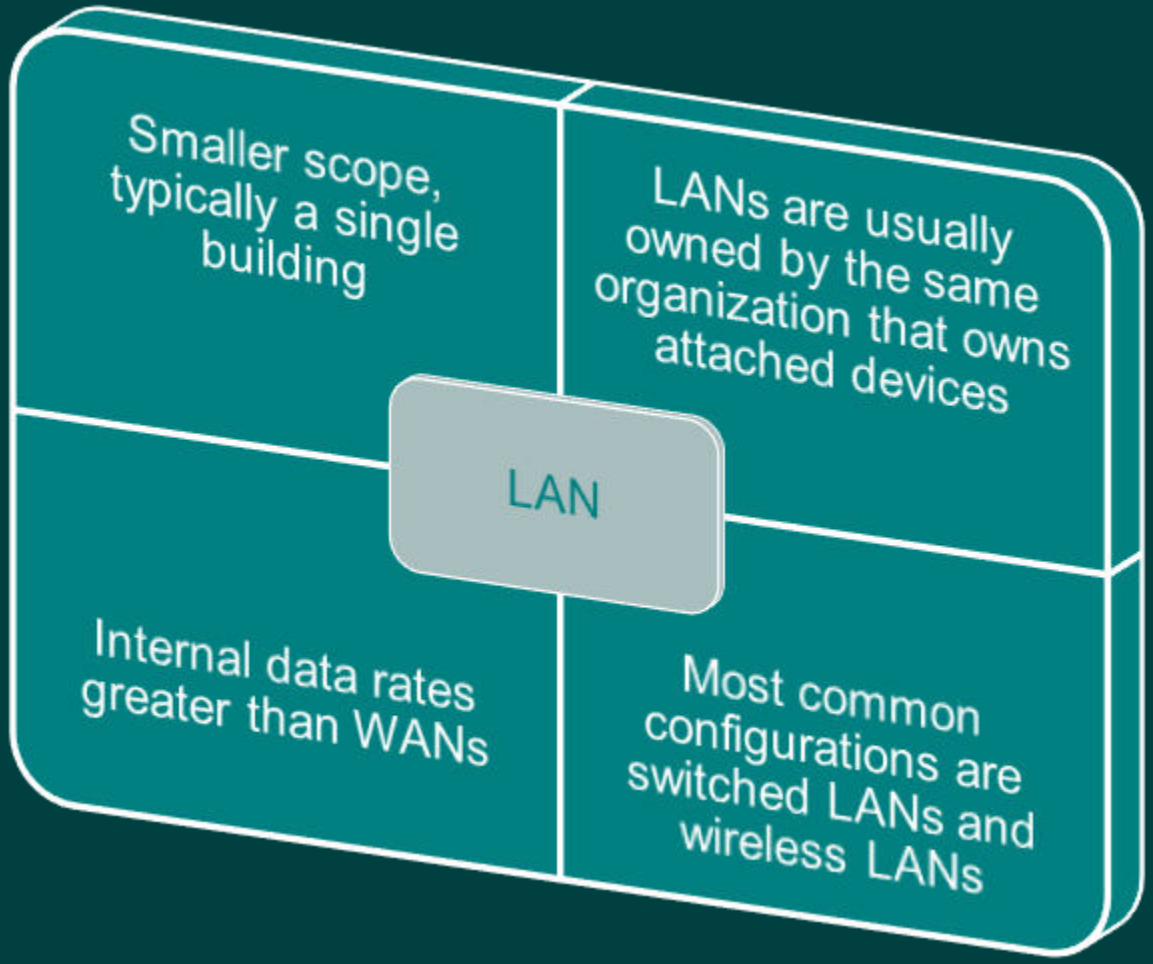
Frame Relay

- Developed to take advantage of high data rates and low error rates
- Operates at data rates of up to 2 Mbps
- Key to achieving high data rates is to strip out most of the overhead involved with error control

Asynchronous Transfer Mode (ATM)

- Referred to as cell relay
- Culmination of developments in circuit switching and packet switching
- Uses fixed-length packets called cells
- Works in range of 10s and 100s of Mbps and in the Gbps range
- Allows multiple channels with the data rate on each channel dynamically set on demand

Local Area Networks (LAN)



The Internet

- Internet evolved from ARPANET
- Developed to solve the dilemma of communicating across arbitrary, multiple, packet-switched networks
- Foundation is the TCP/IP protocol suite

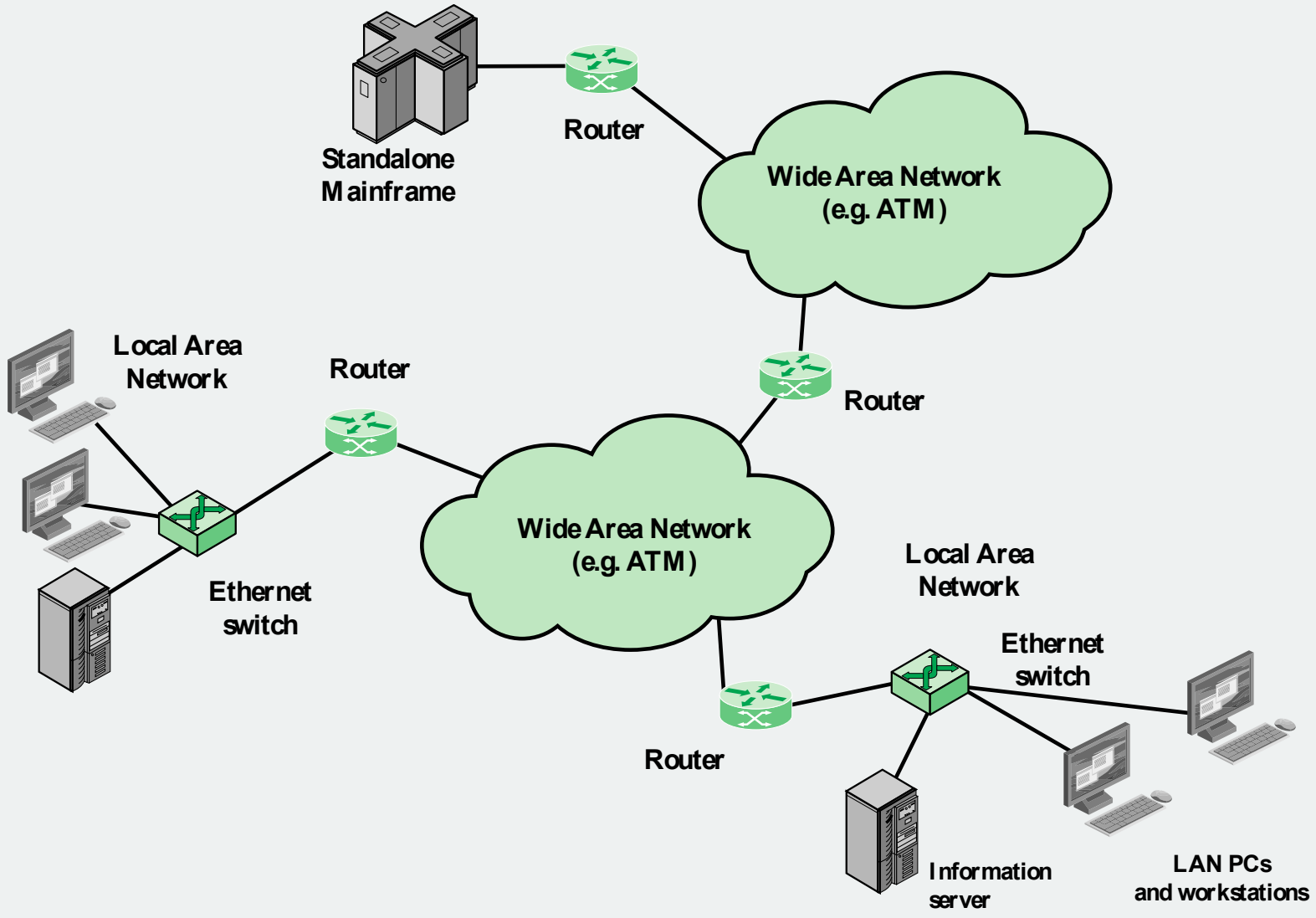


Figure 1.5 Key Elements of the Internet

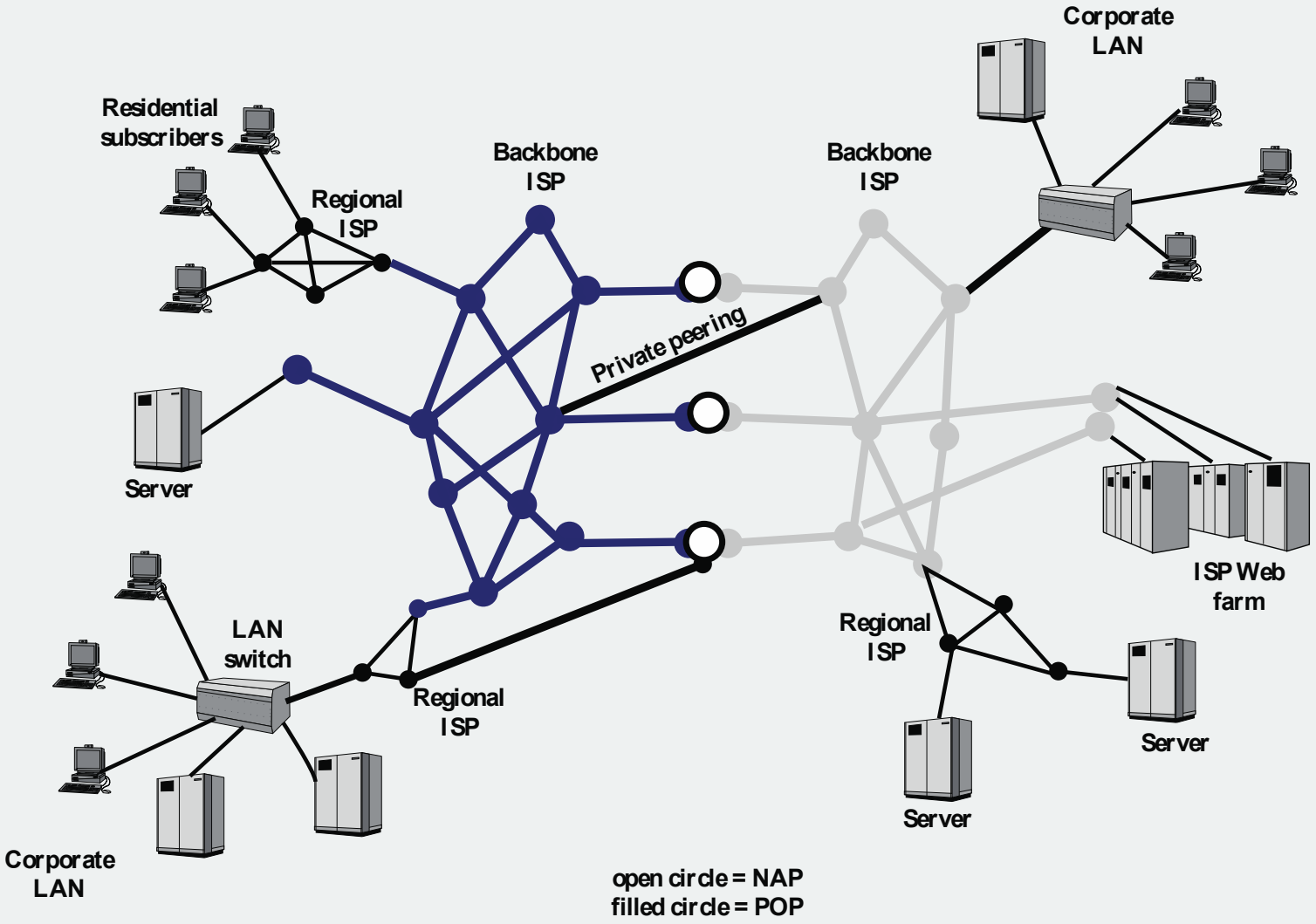


Figure 1.6 Simplified View of Portion of Internet

Table 1.2
Internet Terminology

- Central Office (CO)
  - The place where telephone companies terminate customer lines and locate switching equipment to interconnect those lines with other networks
- Customer Premises Equipment (CPE)
  - Telecommunications equipment that is located on the customer's premises
- Internet Service Provider (ISP)
  - A company that provides other companies or individuals with access to, or presence on, the Internet
- Network Access Point (NAP)
  - One of several major Internet interconnection points that serve to tie all the ISPs together
- Network Service Provider (NSP)
  - A company that provides backbone services to an Internet service provider (ISP)
- Point of Presence (POP)
  - A site that has a collection of telecommunications equipment, usually refers to ISP or telephone company sites

(Table can be found on page 51 in textbook)

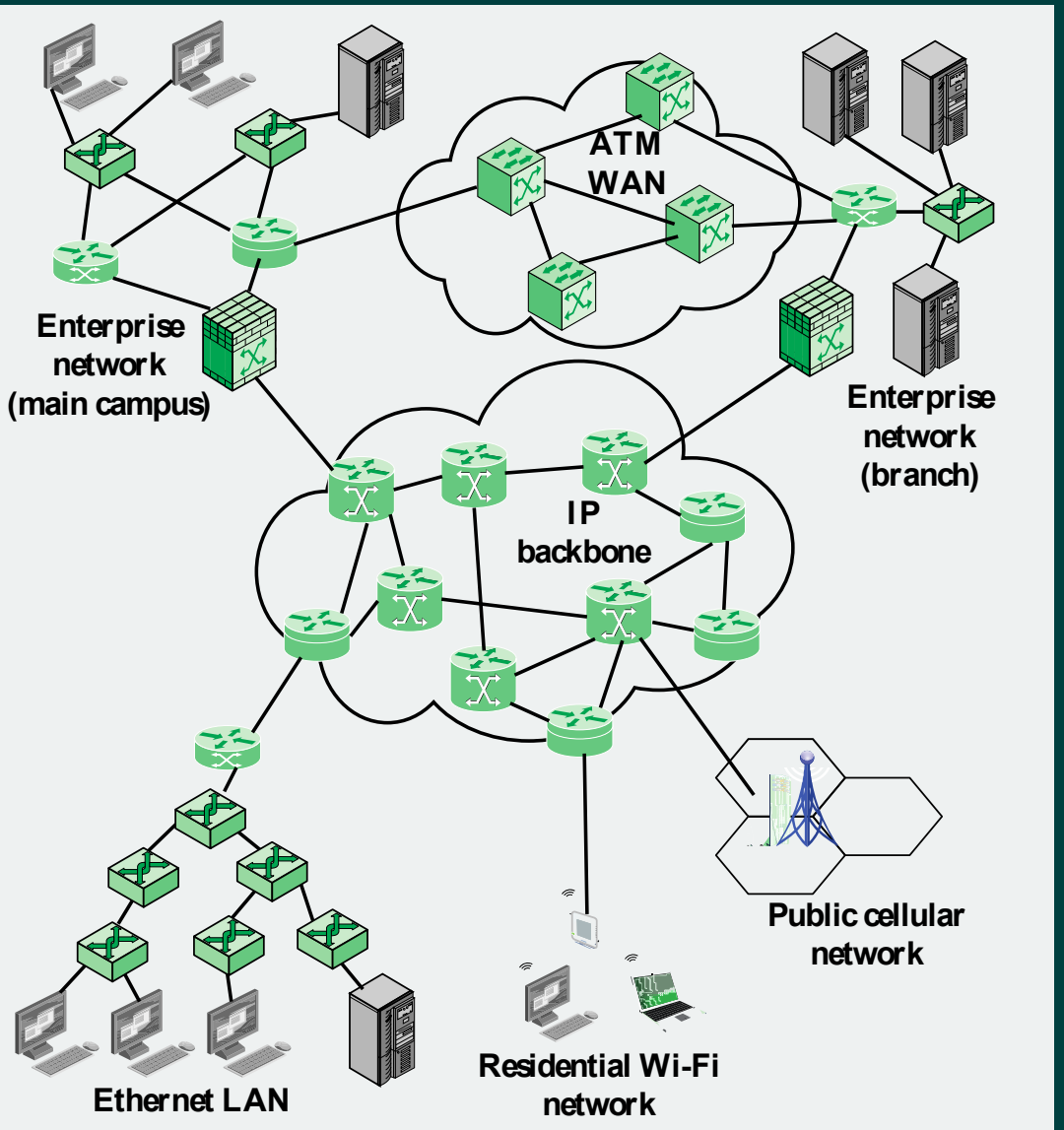


Figure 1.7 A Networking Configuration

Summary

- Transmission mediums
  - Fiber optic
  - Wireless
- Network categories:
  - Wide Area Networks
  - Local Area Networks
  - Wireless Networks
- Internet
  - Origin
  - Key elements
  - Internet architecture
- Trends challenging data communications:
  - Traffic growth
  - Development of new services
  - Advances in technology
- Data Transmission and Network Capacity Requirements
- Convergence