Chapter One

Introduction to Computer Networks and Data Communications

Data Communications and Computer Networks: A Business User's Approach

Seventh Edition

After reading this chapter, you should be able to:

- *Define* the basic terminology of computer networks
- *Recognize* the individual components of the big picture of computer networks
- *Outline* the basic network layouts
- *Define* the term "convergence" and describe how it applies to computer networks
- *Cite* the reasons for using a network architecture and *explain* how they apply to current network systems

After reading this chapter, you should be able to (continued):

- *List* the layers of the TCP/IP protocol suite and describe the duties of each layer
- *List* the layers of the OSI model and describe the duties of each layer
- *Compare* the TCP/IP protocol suite and the OSI model and list their differences and similarities

Introduction

- ***Who*** today has not used a computer network?
- Mass transit, interstate highways, 24-hour bankers, grocery stores, cable television, cell phones, businesses and schools, and retail outlets support some form of computer network

The Language of Computer Networks

- Computer network – an interconnection of computers and computing equipment using either wires or radio waves over small or large geographic areas
- Local area network – networks that are small in geographic size spanning a room, floor, building, or campus
- Metropolitan area network – networks that serve an area of 1 to 30 miles, approximately the size of a typical city

The Language of Computer Networks (continued)

- Wide area network – a large network that encompasses parts of states, multiple states, countries, and the world
- Personal area network – a network of a few meters, between wireless devices such as PDAs, laptops, and similar devices
- Voice network – a network that transmits only telephone signals (almost extinct)
- Data network – a network that transmits voice and computer data (replacing voice networks)

The Language of Computer Networks (continued)

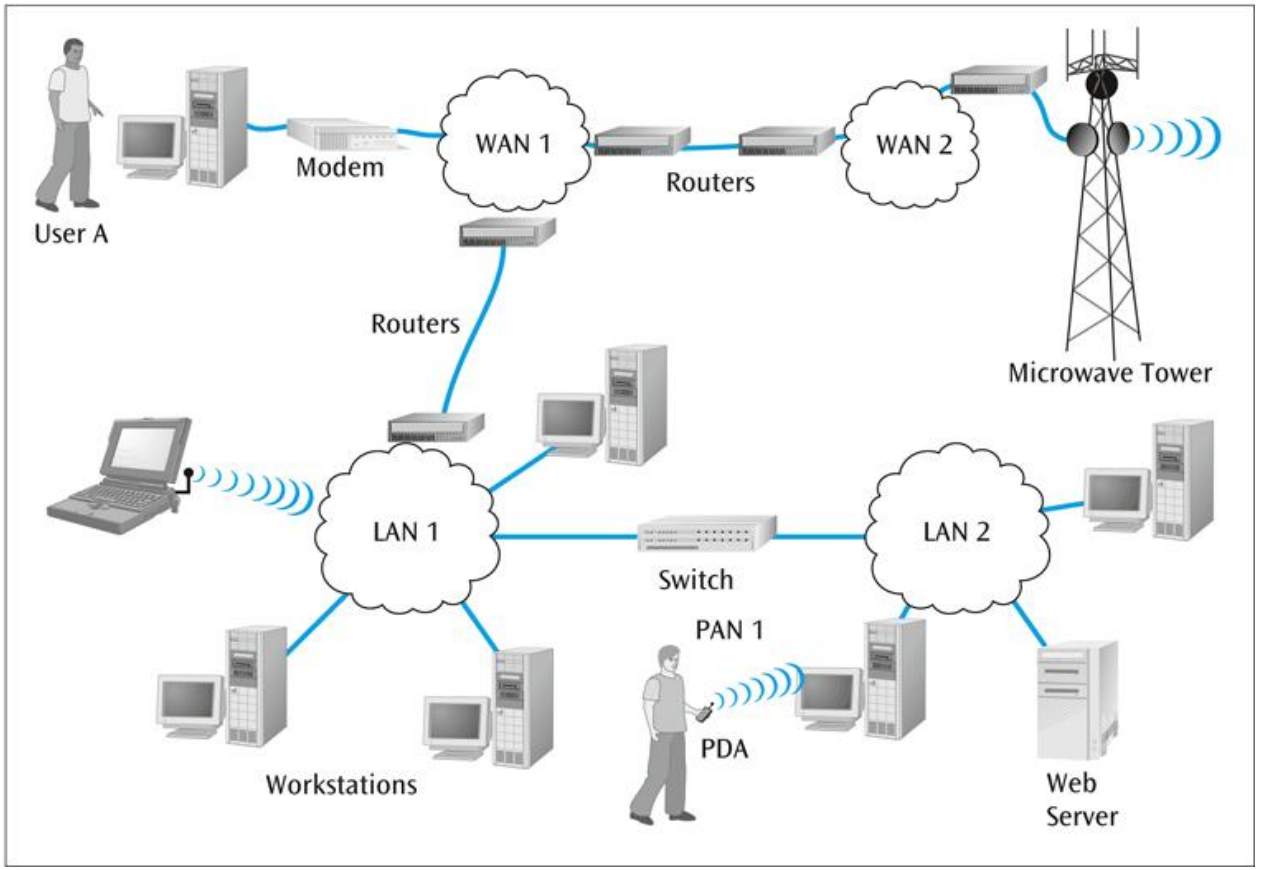
- Data communications – the transfer of digital or analog data using digital or analog signals
- Telecommunications – the study of telephones and the systems that transmit telephone signals (becoming simply data communications)
- Network management – the design, installation, and support of a network, including its hardware and software
- Network cloud – a network (local or remote) that contains software, applications, and/or data

The Big Picture of Networks

- Networks are composed of many devices, including:
  - Workstations (computers, tablets, wireless phones, etc)
  - Servers
  - Network hubs and switches
  - Routers (LAN to WAN and WAN to WAN)
  - Telephone switching gear

The Big Picture of Networks (continued)

Figure 1-1
An overall view of the interconnection between different types of networks



Communications Networks – Basic Layouts

- Microcomputer-to-local area network
- Microcomputer-to-Internet
- Local area network-to-local area network
- Personal area network-to-workstation
- Local area network-to-metropolitan area network

Communications Networks – Basic Layouts (continued)

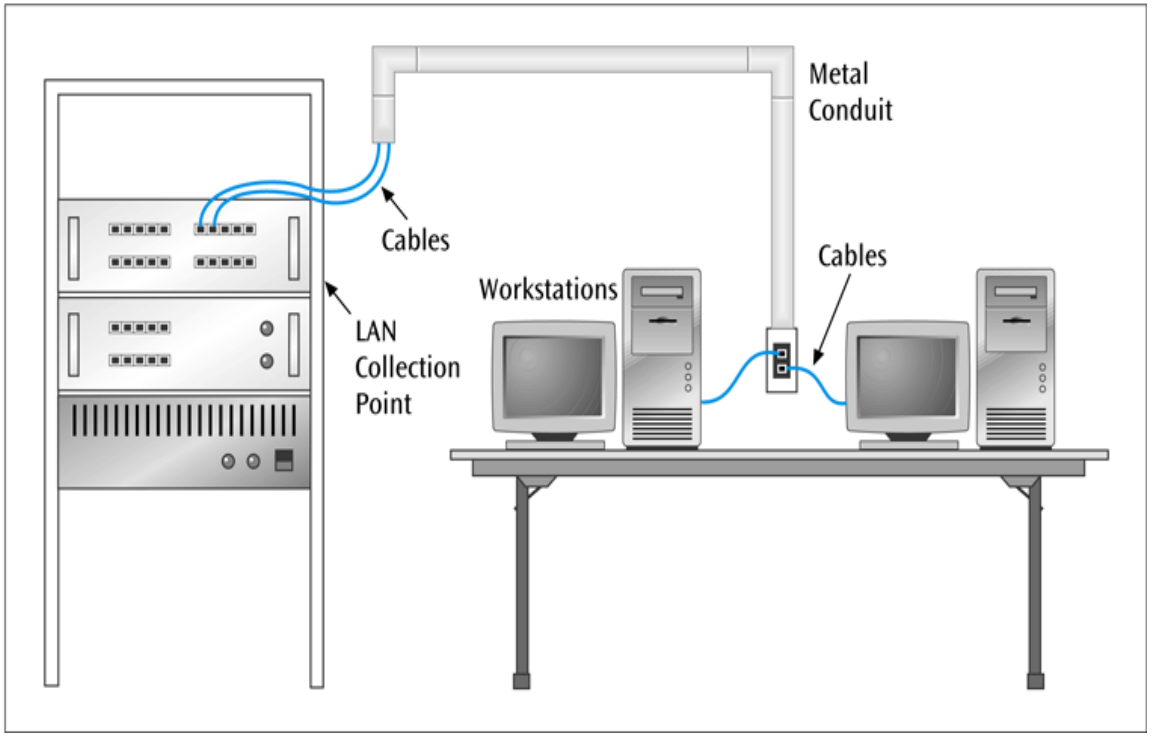
- Local area network-to-wide area network
- Wide area network-to-wide area network
- Sensor-to-local area network
- Satellite and microwave
- Cell phones
- Computer terminal / microcomputer-to-mainframe

Microcomputer-to-Local Area Network Layout

- Highly common throughout business and academic environments, and now homes
- Typically a medium- to high-speed connection
- Computer (device) requires a NIC (network interface card)
- NIC connects to a hub-like device (switch)

Microcomputer-to-Local Area Network Layout (continued)

Figure 1-2
A microcomputer lab, showing the cabling that exits from the back of a workstation and runs to a LAN collection point



Microcomputer-to-Internet Layout

- Popular with home users and small businesses
- For some, a dial-up modem is used to connect user's microcomputer to an Internet service provider
- Technologies such as DSL and cable modems are quickly replacing dial-up modems

Microcomputer-to-Internet Layout (continued)

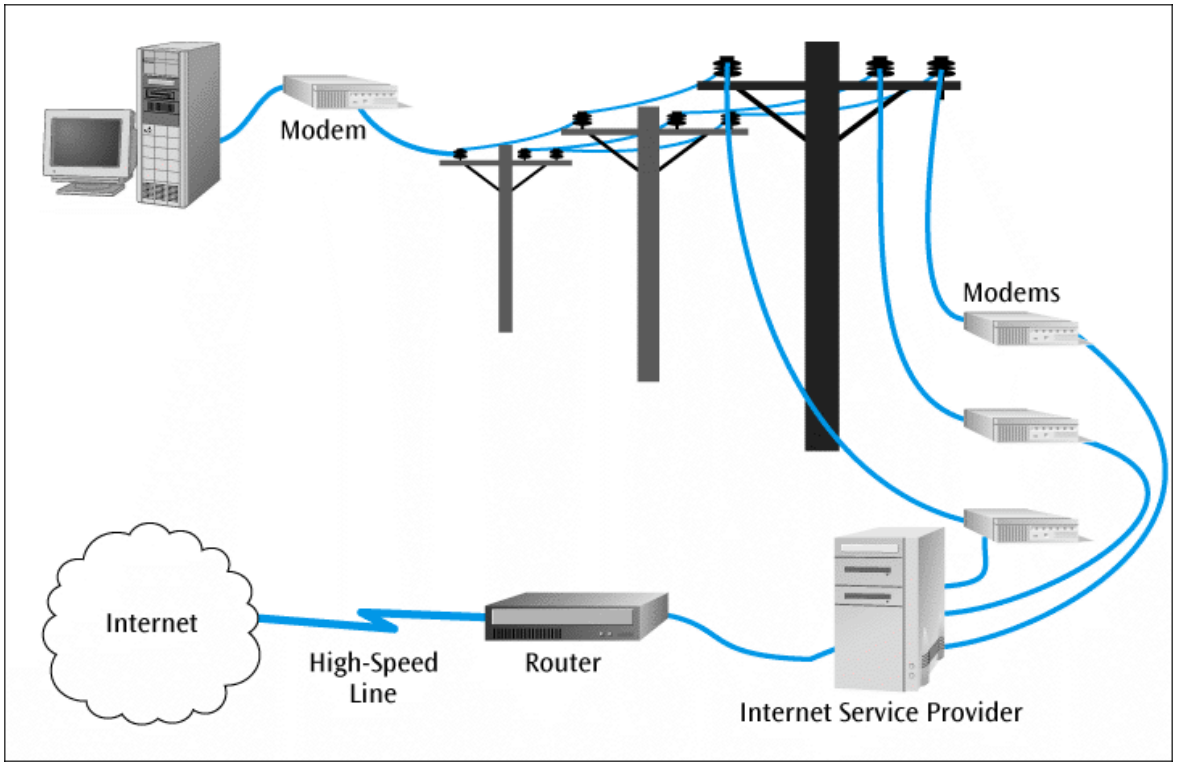


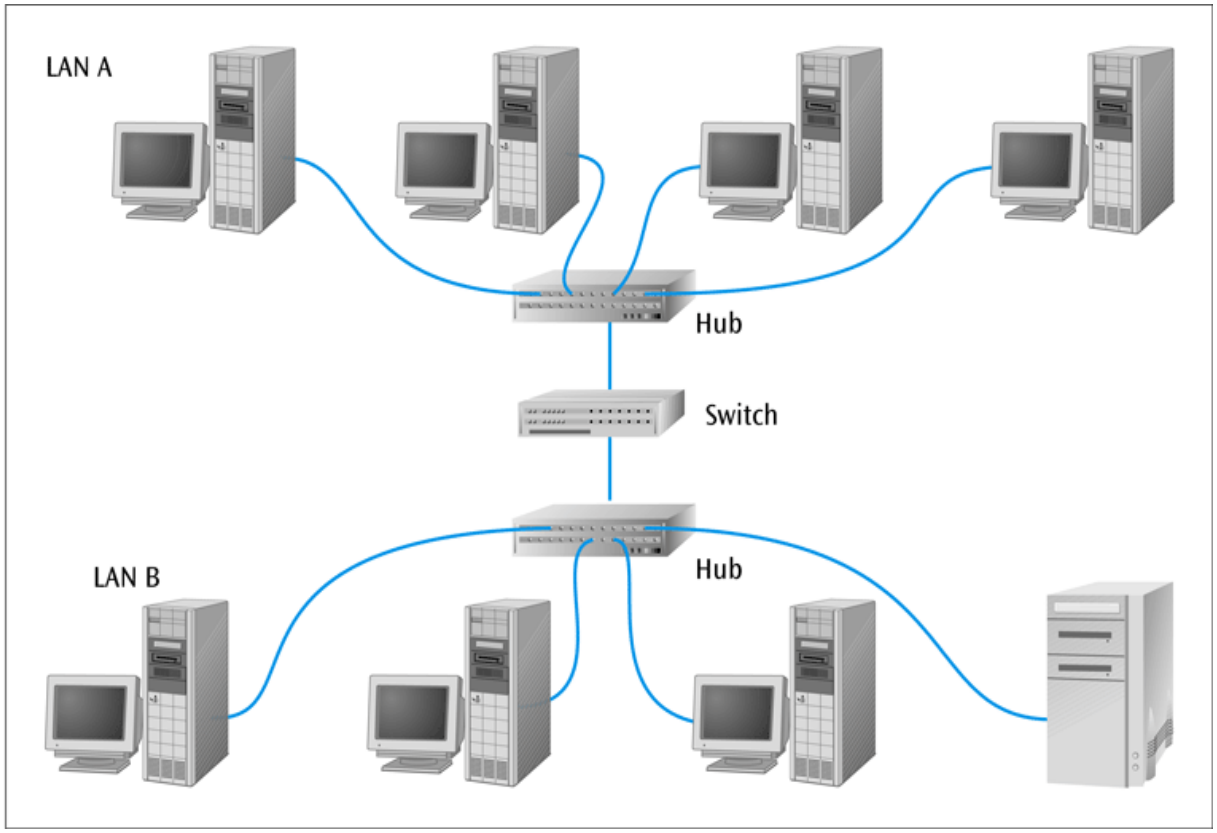
Figure 1-3
A microcomputer / workstation sending data over a DSL line to an Internet service provider

Local Area Network-to-Local Area Network Layout

- Found in systems that have two or more LANs and a need for them to intercommunicate
- A bridge-like device (such as a switch) is typically used to interconnect LANs
- Switch can filter frames

Local Area Network-to-Local Area Network Layout (continued)

Figure 1-4
Two local area networks connected by a switch

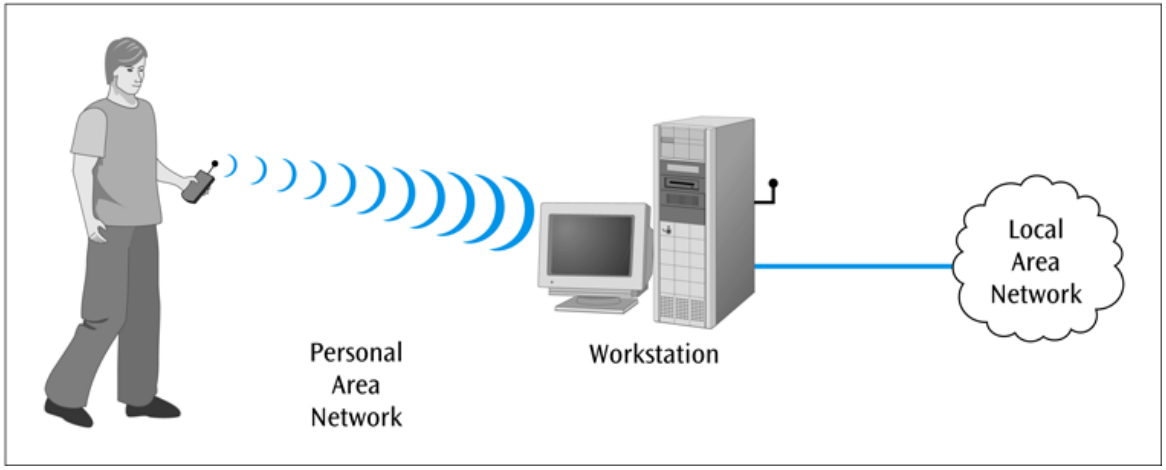


Personal Area Network-to-Workstation Layout

- Interconnects wireless devices such as PDAs, laptops and notebooks, and music playback devices
- Used over short distances such as a few meters

Personal Area Network-to-Workstation Layout (continued)

Figure 1-5
A user transferring data from a personal digital assistant via a personal area network to a workstation attached to a local area network

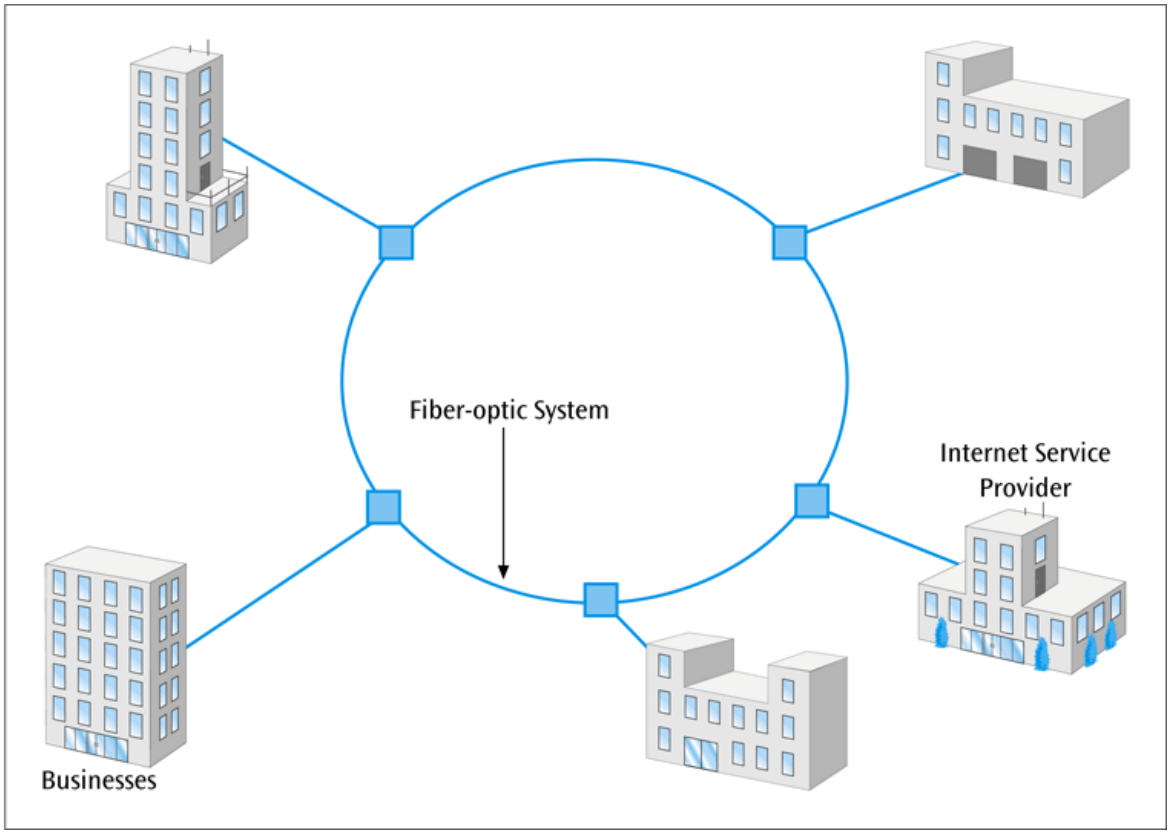


Local Area Network-to-Metropolitan Area Network Layout

- Used to interconnect companies (usually their local area networks) to networks that encompass a city
- High-speed networks with redundant circuits
- Metro Ethernet is latest form of metropolitan LAN

Local Area Network-to-Metropolitan Area Network Layout (continued)

Figure 1-6
Businesses interconnected within a large metropolitan area via a metropolitan area network

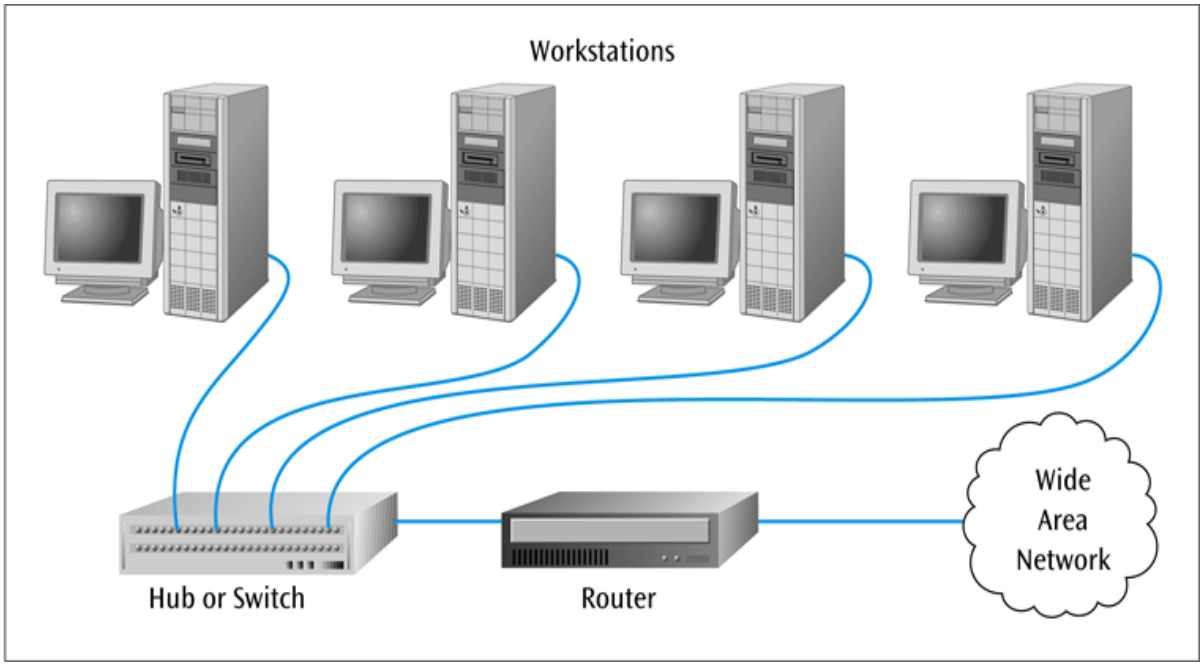


Local Area Network-to-Wide Area Network Layout

- One of the most common ways to interconnect a user on a LAN workstation to the Internet (a wide area network)
- A router is the typical device that performs LAN to WAN connections
- Routers are more complex devices than switches

Local Area Network-to-Wide Area Network Layout (continued)

Figure 1-7
Local area network-to-wide area network configuration



Wide Area Network-to-Wide Area Network Layout

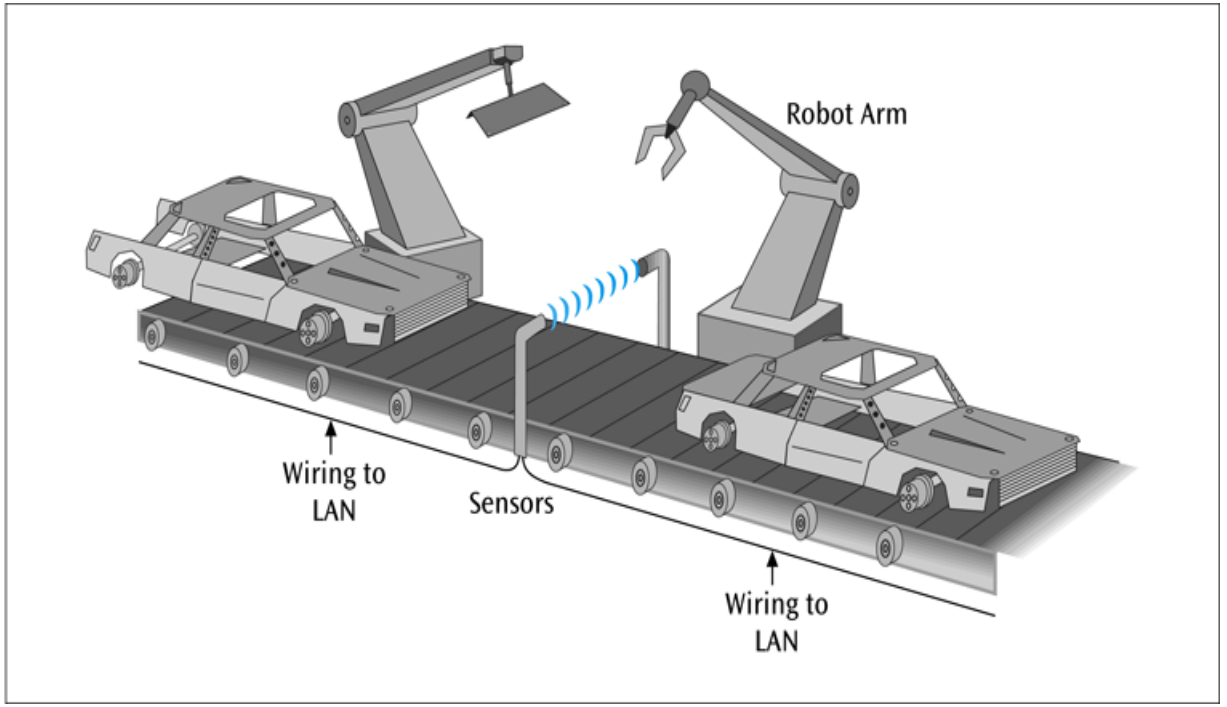
- High-speed routers and switches are used to connect one wide area network to another
- Thousands of wide area networks across North America, many interconnected via these routers and switches

Sensor-to-Local Area Network Layout

- Not all local area networks deal with microcomputer workstations
- Often found in industrial and laboratory environments
- Assembly lines and robotic controls depend heavily on sensor-based local area networks

Sensor-to-Local Area Network Layout (continued)

Figure 1-8
An automobile moves down an assembly line and triggers a sensor

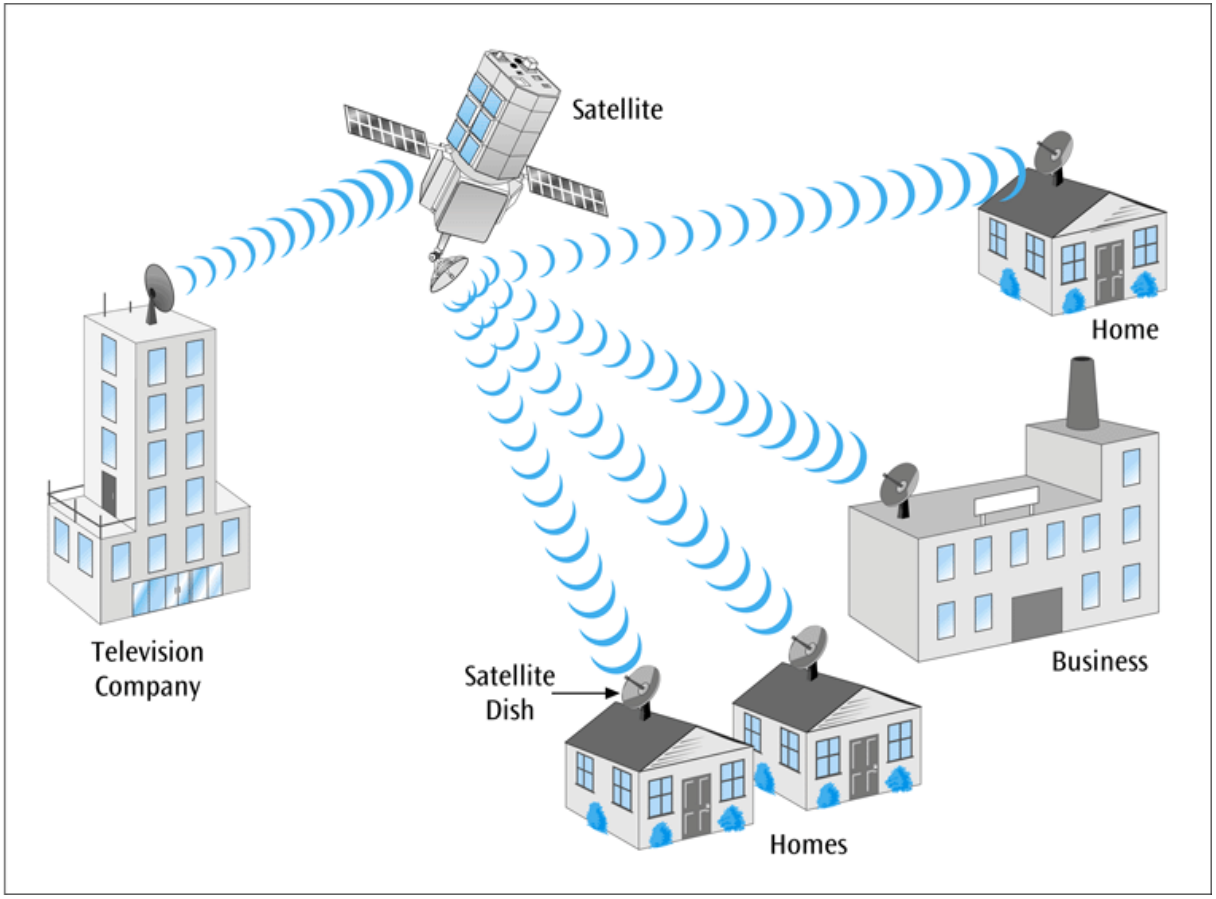


Satellite and Microwave Layout

- Typically long distance wireless connections
- Many types of applications including long distance telephone, television, radio, long-haul data transfers, and wireless data services
- Typically expensive services but many companies offer competitive services and rates
- Newer shorter-distance services such as Wi-Max

Satellite and Microwave Layout (continued)

Figure 1-9
Example of a television company using a satellite system to broadcast television services into homes and businesses

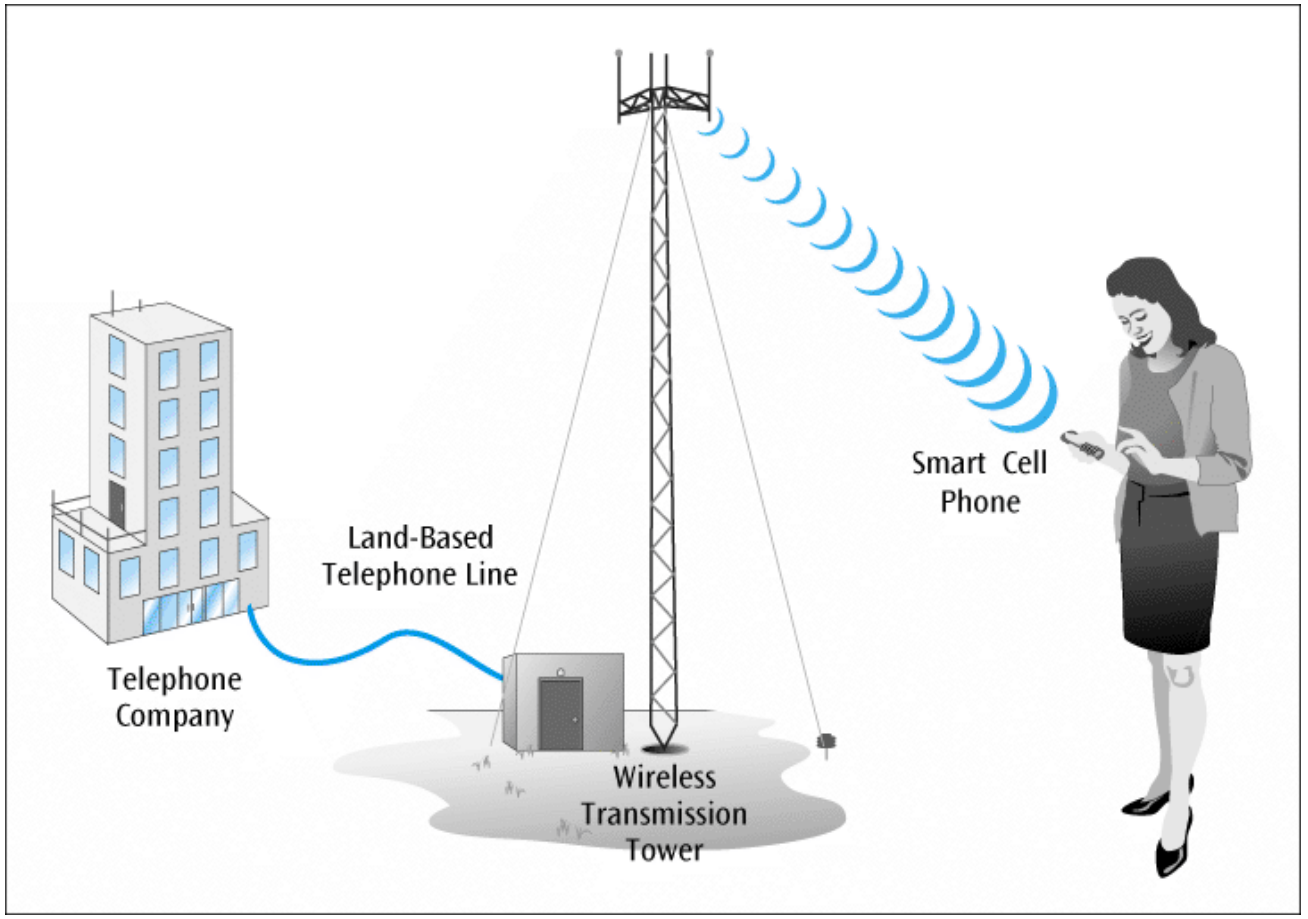


Cell Phone Layout

- Constantly expanding market across the U.S. and world
- Third generation services available in many areas and under many types of plans with fourth generation services starting to appear
- Latest generation includes higher speed data transfers (100s to 1000s of kilobits per second)

Cell Phone Layout (continued)

Figure 1-10
An example of a PDA connected to a wireless telephone system to transmit and receive data

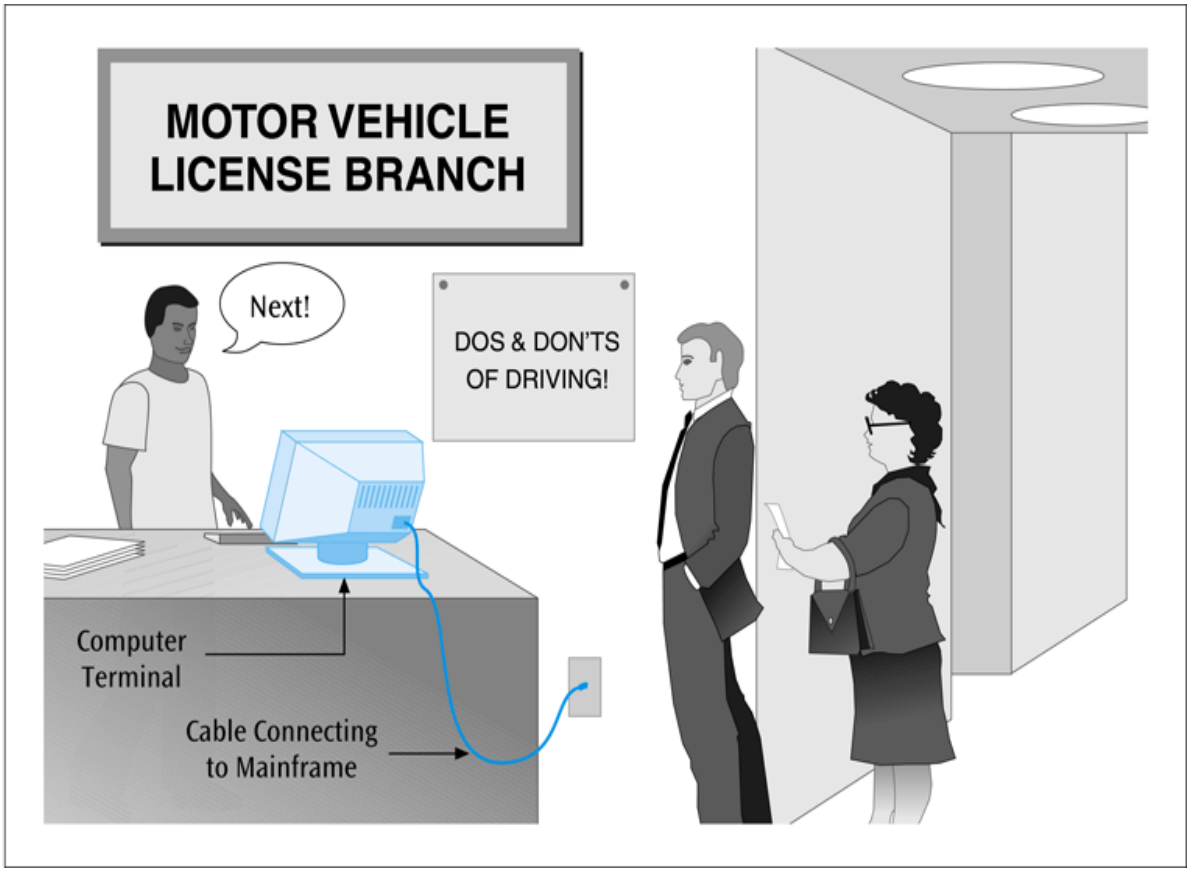


Terminal/Microcomputer-to-Mainframe Computer Layout

- Predominant form in the 1960s and 1970s
- Still used in many types of businesses for data entry and data retrieval
- Few dumb terminals left today – most are microcomputers with terminal emulation card, a web browser and web interface, Telnet software, or a thin client

Terminal/Microcomputer-to-Mainframe Computer Layout (continued)

Figure 1-11
Using a terminal to perform a text-based input transaction

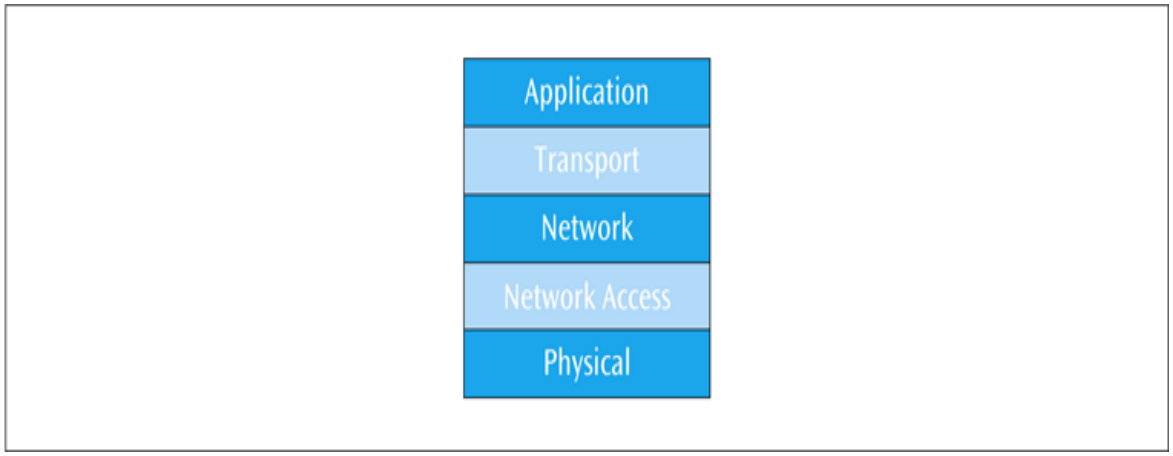


Network Architectures

- A reference model that describes the layers of hardware and software necessary to transmit data between two points or for multiple devices / applications to interoperate
- Reference models are necessary to increase likelihood that different components from different manufacturers will converse
- Two models to learn: TCP/IP protocol suite and OSI model

The TCP/IP Protocol Suite

Figure 1-12
The five layers of the TCP/IP protocol suite



Note: Some authors show only four layers, combining the two bottom layers.

The TCP/IP Protocol Suite (continued)

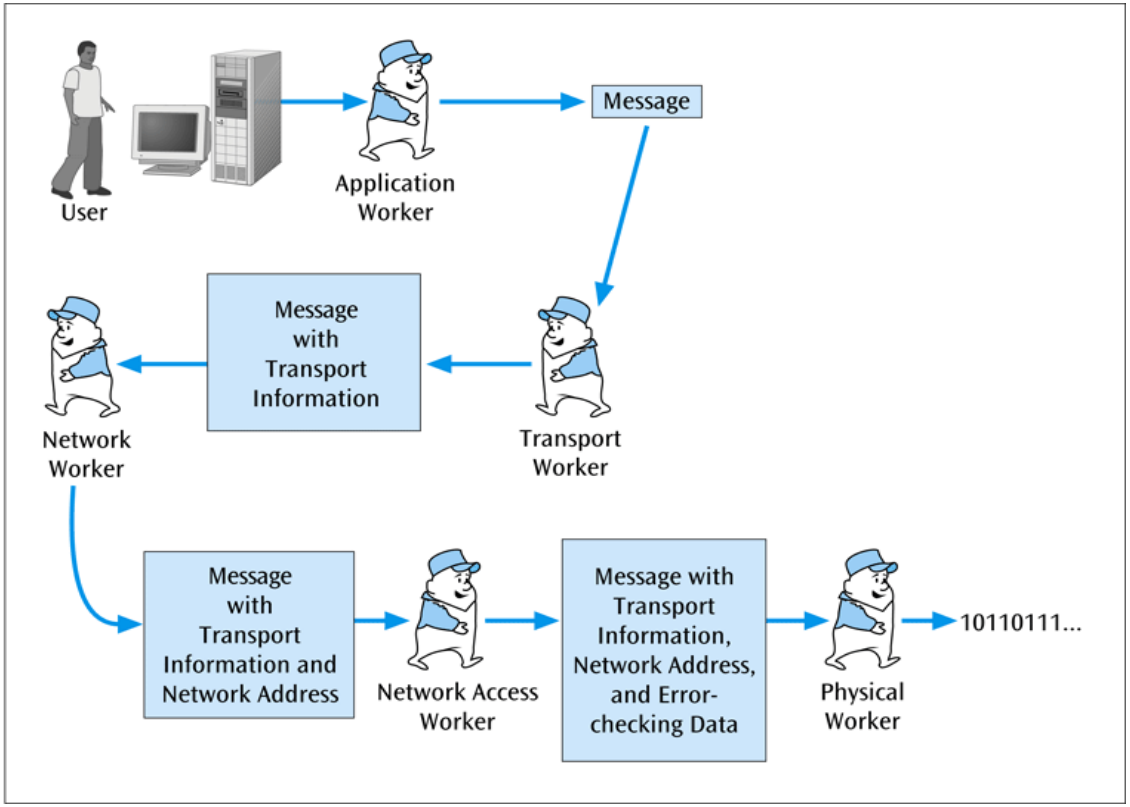
- Application layer
  - Where the application using the network resides
  - Common network applications include web browsing, e-mail, file transfers, and remote logins
- Transport layer
  - Performs a series of miscellaneous functions (at the *end-points* of the connection) necessary for presenting the data package properly to the sender or receiver

The TCP/IP Protocol Suite (continued)

- Network (Internet or internetwork or IP) layer
  - Responsible for creating, maintaining and ending network connections
  - Transfers data packet from node to node (e.g. router to router) within network
- Network access (data link) layer
  - Responsible for taking the data and transforming it into a frame with header, control and address information, and error detection code, then transmitting it between the workstation and the network
- Physical layer
  - Handles the transmission of bits over a communications channel
  - Includes voltage levels, connectors, media choice, modulation techniques

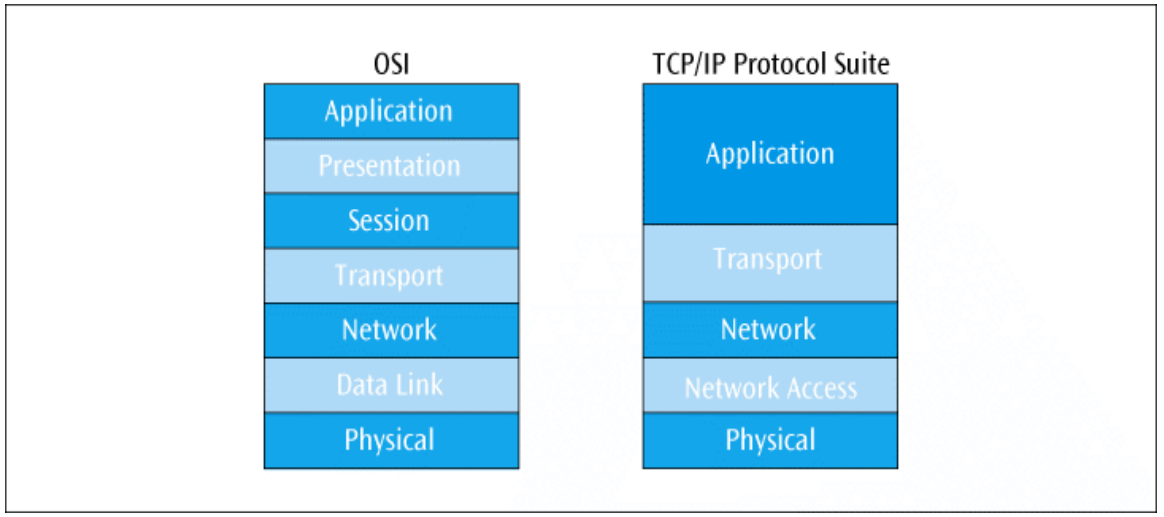
The TCP/IP Protocol Suite (continued)

Figure 1-13
Network workers perform their job duties at each layer in the model



The Open Systems Interconnection (OSI) Model

Figure 1-14
The seven layers of the OSI model compared to the five of the TCP/IP Protocol suite



The Open Systems Interconnection (OSI) Model (continued)

- Application layer
  - Equivalent to TCP/IP's application layer
- Presentation layer
  - Responsible for "final presentation" of data (code conversions, compression, encryption)
- Session layer
  - Responsible for establishing "sessions" between users

The Open Systems Interconnection (OSI) Model (continued)

- Transport layer
  - Equivalent to TCP/IP's transport layer
- Network layer
  - Equivalent to TCP/IP's network layer
- Data link layer
  - Responsible for taking the data and transforming it into a frame with header, control and address information, and error detection code

The Open Systems Interconnection (OSI) Model (continued)

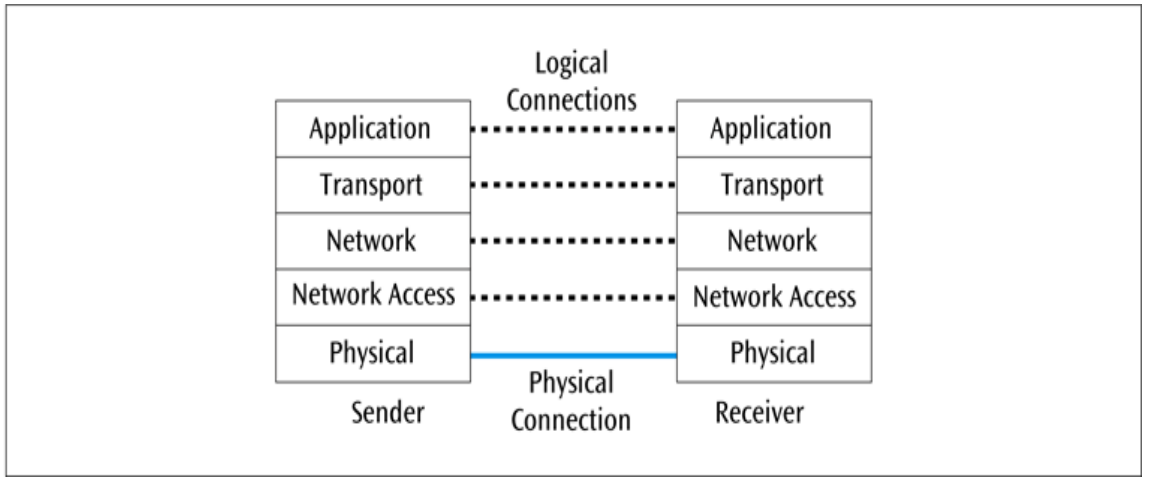
- Physical layer
  - Handles the transmission of bits over a communications channel
  - Includes voltage levels, connectors, media choice, modulation techniques

Logical and Physical Connections

- A *logical connection* is one that exists only in the software, while a *physical connection* is one that exists in the hardware
- Note that in a network architecture, only the lowest layer contains the physical connection, while all higher layers contain logical connections

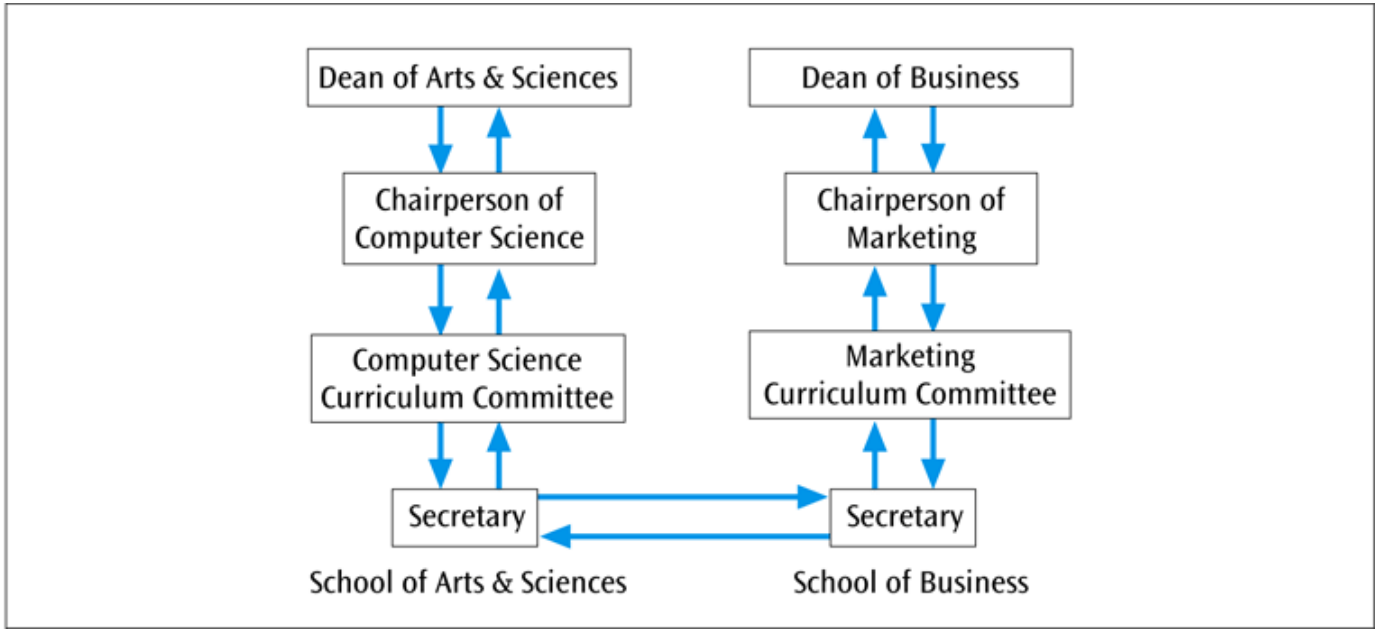
Logical and Physical Connections (continued)

Figure 1-16
Sender and receiver communicating using the TCP/IP protocol suite



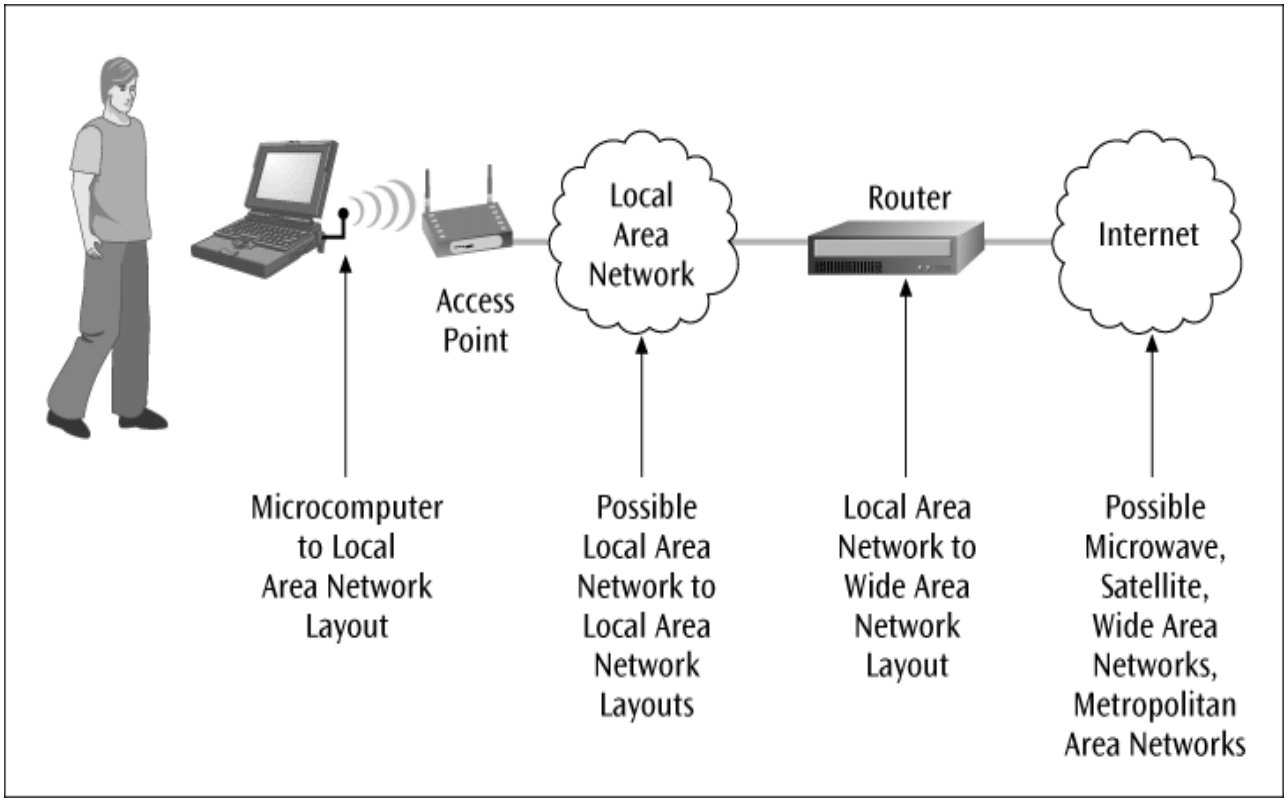
Logical and Physical Connections (continued)

Figure 1-17
Flow of data through the layers of bureaucracy



Network Layouts in Action

Figure 1-18
The numerous network connections involved with a user downloading a Web page at work



The TCP/IP Protocol Suite in Action

- Note the flow of data from user to Web browser and back
- At *each layer*, information is *either* added *or* removed, depending on whether the data is leaving or arriving at a workstation
- The adding of information over pre-existing information is termed **encapsulation**

The TCP/IP Protocol Suite in Action

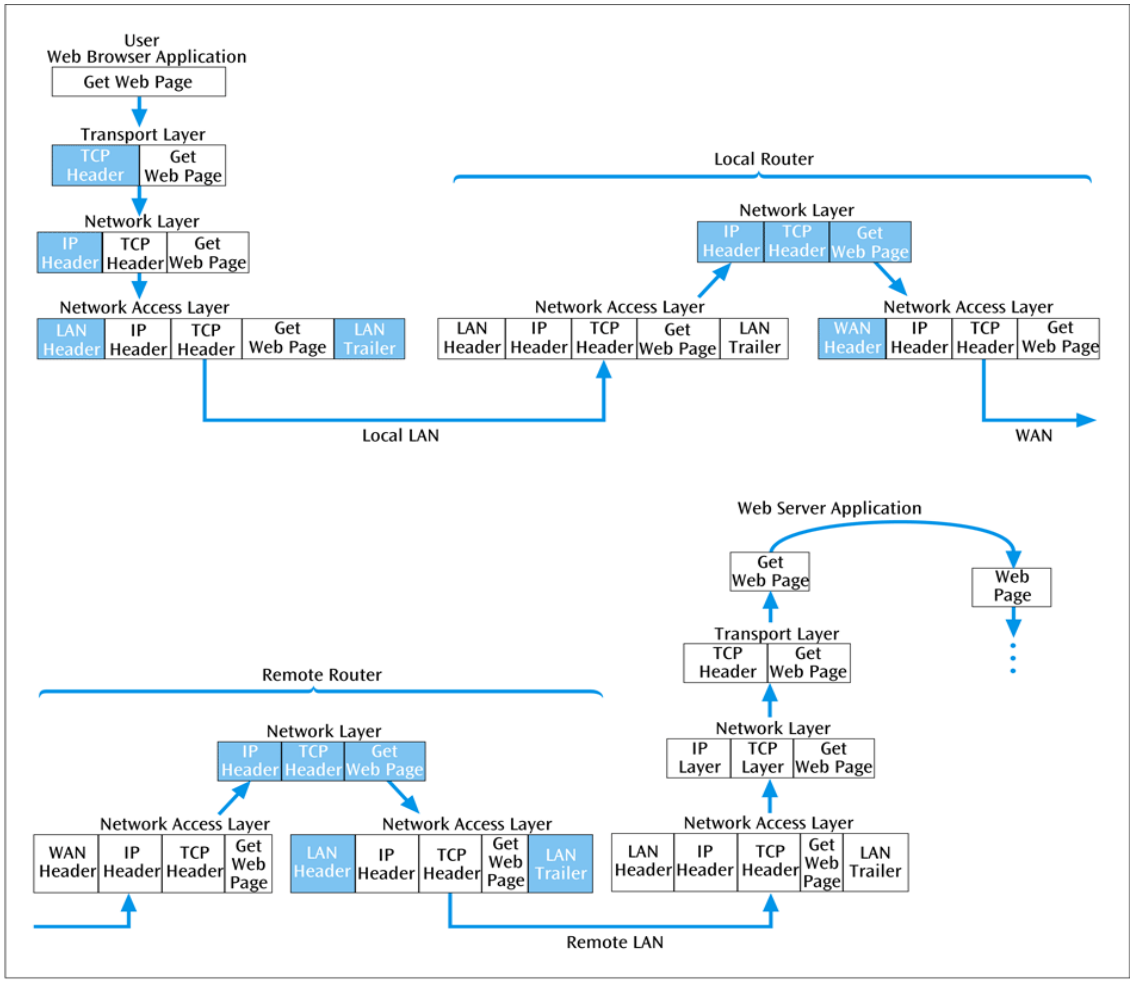


Figure 1-19
Path of a Web page request as it flows from browser to Internet server and back

Summary

- Many services and products that we use every day employ computer networks and data communications in some way
- Field of data communications and computer networks includes data networks, voice networks, wireless networks, local area networks, metropolitan area networks, wide area networks, and personal area networks

Summary (continued)

- Application areas can be understood in terms of general network layouts:
  - Microcomputer-to-local area network
  - Microcomputer-to-Internet
  - Local area network-to-local area network
  - Personal area network-to-workstation
  - Local area network-to-metropolitan area network
  - Local area network-to-wide area network
  - Wide area network-to-wide area network
  - Sensor-to-local area network
  - Satellite and microwave
  - Cell phone
  - Terminal/microcomputer-to-mainframe computer

Summary (continued)

- Key concept in networking is convergence
- A network architecture, or communications model, places network pieces in layers
  - Layers define *model* for functions or services that need to be performed
- The TCP/IP protocol suite is also known as the Internet model and is composed of five layers (some show four):
  - Application layer
  - Transport layer
  - Network layer
  - Network access layer
  - Physical layer

Summary (continued)

- The International Organization for Standardization (ISO) created the Open Systems Interconnection (OSI) model
  - OSI model is based on seven layers: application layer, presentation layer, session layer, transport layer, network layer, data link layer, physical layer
- A logical connection is a flow of ideas that occurs, without a direct physical connection, between the sender and receiver at a particular layer