Review: Chapter 1

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What Is Management Information Systems (MIS)?

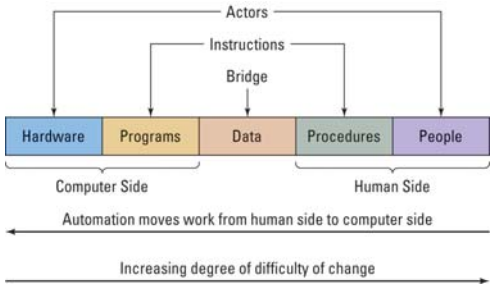
- MIS is the development and use of information systems that help businesses achieve their goals and objectives
- There are three key elements:
  - Components of an information systems
  - Development and use of information systems
  - Achieving business goals and objectives

Figure 1-1 Five Components of an Information System

Using the Five-Component Framework

- The five-component framework can help guide your learning and thinking about IS both now and in the future.
- This concept consists of:
  - Actors
  - Instructions
  - Bridge
- Automation occurs when a business process is moved to a computer to perform the business process

Figure 1-3 Characteristics of the Five Components



Information Characteristics: What Is Information?

- Information is defined as:
  - Knowledge derived from data
  - Data presented in a meaningful context
  - Data processed by summing, ordering, averaging, grouping, comparing, or other similar operations
  - A difference that makes a difference

Information Is Subjective

- Information in one person's context is just a data point in another person's context.
- Context changes occur in information systems when the output of one system feeds a second system.
- Information is always subjective.

Characteristics of Good Information

- Accurate
- Timely
- Relevant
  - To context
  - To subject
- Just barely sufficient
- Worth Its Cost

Information Technology vs. Information Systems

- Information technology and information systems are two closely related terms.
- Information technology refers to the products, methods, inventions, and standards that are used for the purpose of producing information.
- Information technology drives the development of new information systems.

Moore's Law

- Gordon Moore, cofounder of Intel Corporation, stated that because of technology improvements in electronic chip design and manufacturing the number of transistors per square inch on an integrated chip doubles every 18 months, and as a result the speed of computer chip, also doubles

Dramatic Reduction in Price/Performance Ratio

- As a result of Moore's Law, the price/performance ratio of computers has fallen dramatically for over 40 years
- The availability of increased computing power has enabled developments such as:
  - Laser printers
  - Graphical user interfaces
  - High-speed communications
  - Cell phones
  - PDAs
  - Email
  - Internet

Review: Chapter 2

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Information Systems for Competitive Advantage

- Businesses continually seek to establish competitive advantage in the marketplace.
- There are eight principles:
  - The first three principles concern products.
  - The second three principles concern the creation of barriers.
  - The last two principles concern establishing alliances and reducing costs.

Figure 2-1 Principles of Competitive Advantage

1. Create a new product or service
2. Enhance products or services
3. Differentiate products or services
4. Lock in customers and buyers
5. Lock in suppliers
6. Raise barriers to market entry
7. Establish alliances
8. Reduce costs

How this System Creates a ABC, Inc Competitive Advantage

- ABC information system provides the following:
  - Enhances an existing product
  - Differentiates the ABC package delivery product from competitors
  - Lock's customers into the ABC system
  - Raises the barrier to market entry
  - Reduces costs

A Customer Relationship Management System

- A Customer Relationship Management (CRM) system is an information system that maintains data about customers and all of their interactions with the system.
- CRM systems vary in their size and complexity.

Knowledge Management System

- A knowledge management system (KMS) is an information system for storing and retrieving organizational knowledge.
- This knowledge can be in the form of data, documents, or employee know-how.
- KMS goal is to make the organization knowledge available to
  - Employees
  - Vendors
  - Customers
  - Investors
  - Press and who else who needs the knowledge

Figure 2-8 Example Customer Relationship Management (CRM) System

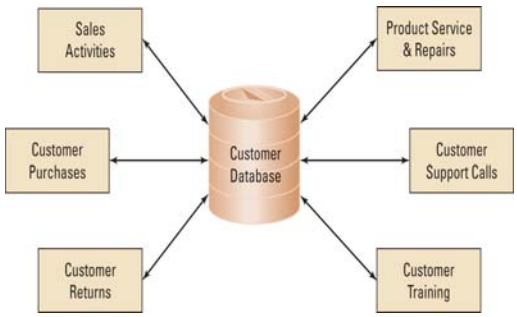
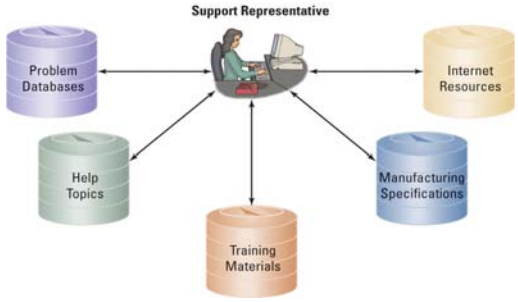


Figure 2-9 Customer Support Knowledge Management System



A Manufacturing Quality-Control Information System

- Many organizations believe that the optimal way to provide customer service is to eliminate the need for it.
- One way to improve customer service is to improve manufacturing quality.
- The type of system to develop depends on the way the organization defines the problem.
- Before developing the system, the organization must have a complete, accurate, and agreed-upon problem definition.

Information Systems for Decision Making

- Developing an information system is to facilitate decision making.
- Decision making in organizations is varied and complex.

Decision Level (1)

- Decisions occur at three levels in organizations.
- Operational decisions concern day-to-day activities.
  - Information systems that support operational decision making are called transaction processing systems (TPS).

Decision Level (2)

- Managerial decisions concern the allocation and utilization of resources.
  - Information systems that support managerial decision making are called management information systems (MIS).
- Strategic decision making concern broader-scope organizational issues.
  - Information systems that support strategic decision making are called executive information systems (EIS).

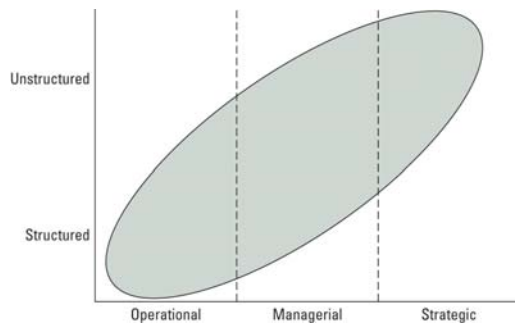
Figure 2-10 Decision-Making Dimensions

- Decision Level
  - Operational
  - Managerial
  - Strategic
- Decision Process
  - Structured
  - Unstructured

The Decision Process

- Two decision processes (method by which a decision is to be made) are structured and unstructured.
  - Structured decision process is one for which there is an understood and accepted method for making the decision.
  - Unstructured process is one for which there is no agreed on decision making process.
- The terms structured and unstructured refers to the decision process-not the underlying subject.

Figure 2-11 Relationship of Decision Level and Decision Type Figure



Different Types of Information Systems for Different Types of Decisions

- Automated information systems are those by which the computer hardware and program components do most of the work.
  - Humans start the programs and use the results.
- Augmentation information systems are those in which humans do the bulk of the work.
  - These systems augment, support, or supplement the work done by People (email, instant messaging, video-conferencing, etc) to aid in decision making.

Figure 2-12 Automated vs. Augmentation IS

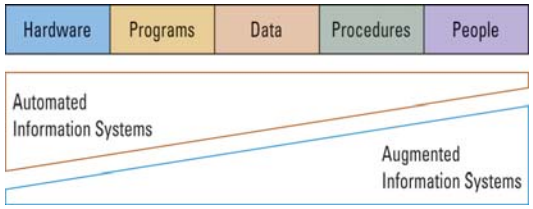
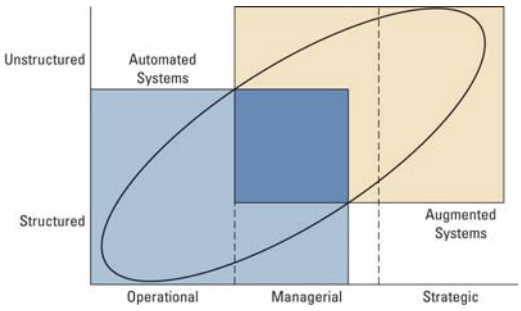


Figure 2-13 How Decision Level, Decision Type and IS Type Are Related



Information Systems and Decision Steps

- A way to examine the relationship between information systems and decision making is to consider how an information system is used during the steps of the decision making process.
- There are five steps
  - Intelligence gathering
  - Alternative formulation
  - Choice
  - Implementation
  - Review

Figure 2-14 Decision-Making Steps

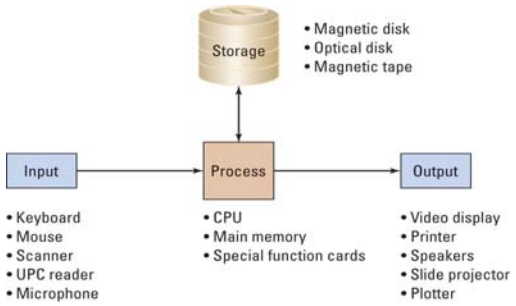
Decision Step	Description	Examples of Possible Information Systems
Intelligence gathering	• What is to be decided? • What are the decision criteria? • Obtain relevant data	• Communications applications (email, video conferencing, word processing, presentation) • Query and reporting systems • Data analysis applications
Alternative formulation	• What are the choices?	• Communications applications
Choice	• Analyze choices against criteria using data • Select alternative	• Spreadsheets • Financial modeling • Other modeling
Implementation	• Make it so!	• Communications applications
Review	• Evaluate results of decision. If necessary, repeat process to correct and adapt.	• Communications • Query and reporting • Spreadsheets and other analysis

Hardware and Software Chapter 3

Input, Processing, Output, and Storage Hardware

- One easy way to categorize hardware is by its primary function:
  - Input hardware
  - Processing hardware
  - Output hardware
  - Storage hardware
  - Communication hardware

Figure 3-1 Input, Process, Output, and Storage Hardware



Computer Instructions (1)

- Computers use bits for two purposes: instructions and data.
- A given instruction, say to add two numbers together, is represented by a string of digits (0111100010001110).
- When the CPU reads such an instruction from main memory, it adds the numbers or takes whatever action the instruction specifies.
- The collection of instructions that a computer can process is called the **computer's instruction set.**

Computer Instructions (2)

- All of the personal computers that run Microsoft Windows are based on an instruction set developed by Intel Corporation that is called **Intel instruction set.**
- Until 2006, all Macintosh computers used a different instruction set, the **PowerPC instruction set**, designed for Powerful PC processors.
- In 2006, Apple began offering Macintosh computers with a choice of either Intel or PowerPC processors.

Computer Data

- All computer data are represented by bits.
- The data can be numbers, characters, currency amounts, photos, recordings, or whatever.
- Bits are grouped into 8-bit chunks called **bytes.**
- For character data, such as letters in a person's name, one character will fit into one byte.
  - Thus, when you read a specification that a computing device has 100 million bytes of memory, you know that the device can hold 100 million characters.

Figure 3-5 Important Storage-Capacity Terminology

Term	Definition	Abbreviation
Byte	Number of bits to represent one character	
Kilobyte	1,024 bytes	K
Megabyte	1,024 K = 1,048,576 bytes	MB
Gigabyte	1,024 MB = 1,073,741,824 bytes	GB
Terabyte	1,024 GB = 1,099,511,627,776 bytes	TB

CPU and Memory Usage

- The **motherboard** is a circuit board upon which the processing components are mounted and/or connected.
- The *central processing unit (CPU)* reads instructions and data from main memory, and it writes data to main memory via a **data channel,** or **bus.**
- Main memory consists of a set of cells, each of which holds a byte of data or instruction.

CPU and Memory Usage (2)

- Each cell has an address, and the CPU uses the addresses to identify particular data items.
- Main memory is also called **RAM memory**, or just **RAM.**
- RAM stands for *random access memory.*
- The term *random* is used to indicate that the computer does not need to access memory cells in sequence; rather, they can be referenced in any order.

CPU and Memory Usage (3)

- To store data or instructions, main memory or RAM must have electrical power.
- When power is shut off, the contents of main memory are lost.
- The term **volatile** is used to indicate that data will be lost when the computer is not powered.
  - Main memory is **volatile.**

CPU and Memory Usage (4)

- Magnetic and optical disks maintain their contents without power and serves as storage devices.
- You can turn the computer off and back on, and the contents of both magnetic and optical disks will be unchanged.
  - Magnetic and optical disk are **nonvolatile.**

The Contents of Memory

- Memory is used for three purposes:
  - It holds instructions of the operating system
  - It holds instructions for application programs such as Excel or Acrobat.
  - It holds data.
- The operating system (OS) is a computer program that controls all of the computer's resources
  - It manages main memory.
  - It processes key strokes and mouse movements.
  - It sends signals to the display monitor.
  - It reads and writes disk files.
  - It controls the processing of other programs.

Figure 3-10 Contemporary Operating Systems

Name	Principal Use	Principal Proponent	Instruction Set
Windows	Business users Servers	Microsoft	Intel
Macintosh	Graphic artists Arts community	Apple	Power PC (as of 2006, also Intel)
Unix	Scientists Engineers	Sun Microsystems and others	Many
Linux	Servers Scientists Engineers	IBM	Many

Figure 3-11 Software Sources and Types

Software Type \ Software Source	Off-the-shelf	Off-the-shelf and then customized	Tailor-made
Horizontal applications			
Vertical applications			
Custom applications			

Firmware

- **Firmware** is computer software that is installed into devices like printers, print servers, and various types of communication devices.
- The software is coded just like other software, but it is installed into special, read-only memory of the printer or other device.
- Users do not need to load firmware into device's memory.
- Firmware can be changed or upgraded, but this is normally a task for IS professionals.

Chapter 4 – Database Processing

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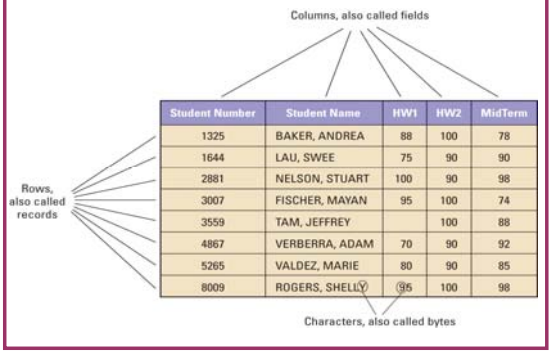
What Is a Database?

- A **database** is a self-describing collection of integrated records.
- A byte is a character of data.
- Bytes are grouped into **columns**, such as *Student Number* and *Student Name.*
- Columns are also called **fields.**

What Is a Database? (Continued)

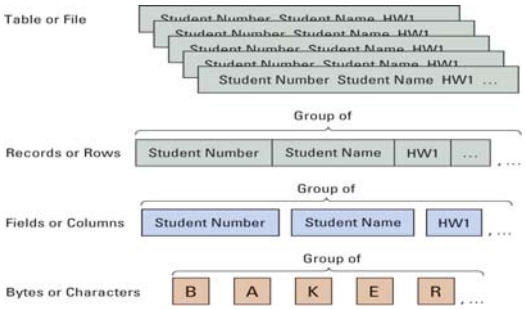
- Columns or fields, in turn, are grouped into **rows**, which are also called **records.**
- There is a hierarchy of data elements.
- A database is a collection of tables *plus* relationships among the rows in those tables, *plus* special data, called metadata.
- Metadata describes the structure of the database.

Figure 4-3 Student Table (also called File)



Student Number	Student Name	HW1	HW2	MidTerm
1325	BAKER, ANDREA	88	100	78
1644	LAU, SWEE	75	90	90
2881	NELSON, STUART	100	90	98
3007	FISCHER, MAYAN	95	100	74
3559	TAM, JEFFREY		100	88
4867	VERBERRA, ADAM	70	90	92
5265	VALDEZ, MARIE	80	90	85
8009	ROGERS, SHELLY	95	100	98

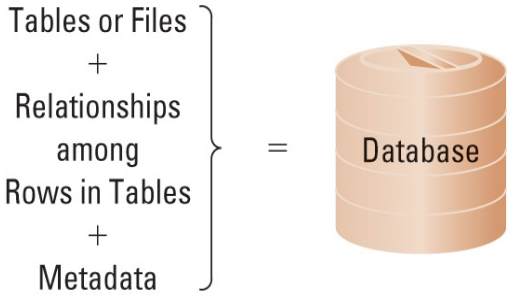
Figure 4-4 Hierarchy of Data Elements



Relationships Among Records

- A **key** is a column or group of columns that identifies a unique row in a table.
  - *Student Number* is the key of the Student table.
- A **foreign key** is a non-key column or field in one table that links to a primary key in another table.
  - *Student Number* in the *Email* and *Office_Visit* tables
- Relational databases store their data in the form of tables that represent relationships using foreign keys.

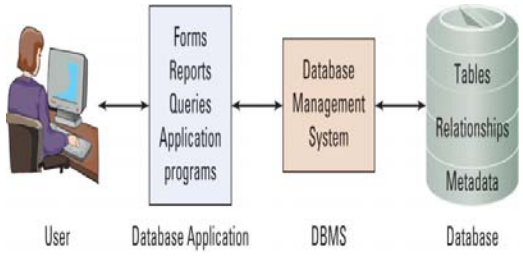
Figure 4-5 Components of a Database



Metadata

- Databases are self-describing because they contain not only data, but also data about the data in the database
- Metadata are data that describe data.
- The format of metadata depends on the software product that is processing the database.
- The presence of metadata makes databases much more useful.
- Because of metadata, no one needs to guess, remember, or even record what is in the database.
- Metadata make databases easy to use for both authorized and unauthorized purposes.

Figure 4-8 Components of a Database Application System



Database Management System

- A **database management system (DBMS)** is a program used to create, process, and administer a database.
- Almost no organization develops its own DBMS.
- Companies license DBMS products from vendors like IBM, Microsoft, Oracle, and others.

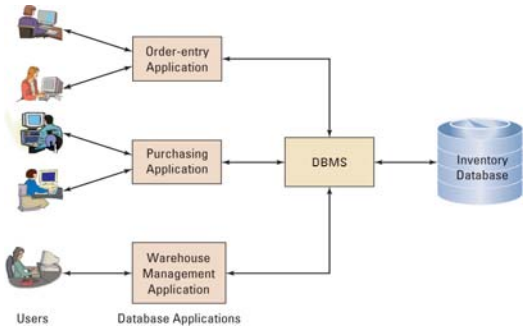
Database Management System (Continued)

- Popular DBMS products are:
  - **DB2** from IBM
  - **Access** and **SQL Server** from Microsoft
  - **MySQL,** an open-source DBMS product that is free for most applications
- The DBMS and the database are two different things:
  - A DBMS is a software program.
  - A database is a collection of tables, relationships, and metadata.

Database Applications

- A **database application** is a collection of forms, reports, queries, and application programs that process a database.
- A database may have one or more applications, and each application may have one or more users.
- Applications have different purposes, features, and functions, but they all process the same inventory data stored in a common database.

Figure 4-10 Use of Multiple Database Applications



Forms, Reports, and Queries

- Data entry forms are used to read, insert, modify, and delete data.
- Reports show data in a structured content.
  - Some reports also compute values as they present the data.
- DBMS programs provide comprehensive and robust features for querying database data.

Enterprise DBMS Versus Personal DBMS

- DBMS products fall into two broad categories: **Enterprise DBMS** and **Personal DBMS.**

Enterprise DBMS

- These products process large organizational and workgroup databases.
- These products support many users, perhaps thousands, of users and many different database applications.
- Such DBMS products support 24/7 operations and can manage dozens of different magnetic disks with hundreds of gigabytes or more data.
- IBM's DB2, Microsoft's SQL Server, and Oracle are examples of enterprise DBMS products.

Enterprise DBMS Versus Personal DBMS (Continued)

Personal DBMS

- These products are designed for smaller, simpler database applications.
- Such products are used for personal or small workgroup applications that involve fewer than 100 users, and normally fewer than 15.
- The great bulk of databases in this category have only a single user.
- Microsoft Access is the only available personal DBMS.

Figure 4-14 Personal Database System

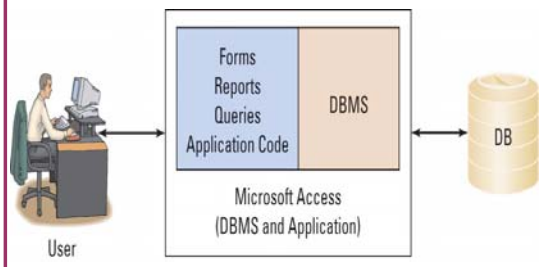
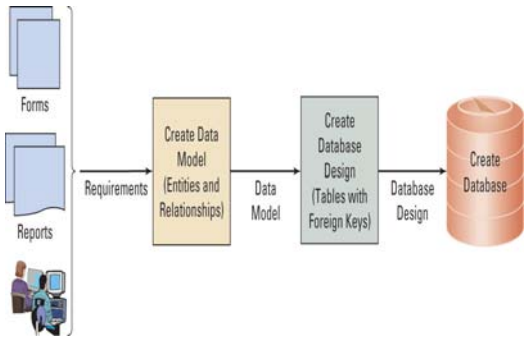


Figure 4-15 Database Development Process



Database Administration

- In light of both the importance and the management challenges of databases, most organizations have created a staff function called **database administration.**
- In smaller organizations, this function is usually served by a single person, sometimes even on a part-time basis.
- Larger organizations assign several people to an office of database administration.

Database Administration (Continued)

- Depending on the context, the letters **DBA** either stand for the *database administrator* or for the *office of database administration.*
- The purpose of database administration is to manage the development, operation, and maintenance of a database so as to achieve the organization's objectives.
- This function requires balancing conflicting goals: protecting the database while maximizing its availability for authorized use.

Figure 4-26 Summary of Database Administrative Tasks

Category	Database Administration Task	Description
Development	Create and staff DBA function	Size of DBA group depends on size and complexity of database. Groups range from one part-time person to small group.
	Form steering committee	Consists of representatives of all user groups. Forum for community-wide discussions and decisions.
	Specify requirements	Ensure that all appropriate user input is considered.
	Validate data model	Check data model for accuracy and completeness.
	Evaluate application design	Verify that all necessary forms, reports, queries, and applications are developed. Validate design and usability of application components.
Operation	Manage processing rights and responsibilities	Determine processing rights/restrictions on each table and column.
	Manage security	Add and delete users and user groups as necessary; ensure that security system works.
	Track problems and manage resolution	Develop system to record and manage resolution of problems.
	Monitor database performance	Provide expertise/solutions for performance improvements.
	Manage DBMS	Evaluate new features and functions.
Backup and Recovery	Monitor backup procedures	Verify that database backup procedures are followed.
	Conduct training	Ensure that users and operations personnel know and understand recovery procedures.
	Manage recovery	Manage recovery process.
Adaptation	Set up request tracking system	Develop system to record and prioritize requests for change.
	Manage configuration change	Manage impact of database structure changes on applications and users.

DBA Backup and Recovery Responsibilities

- As a protector of the database, the DBA has the responsibility to ensure that appropriate procedures and policies exist for backing up the database and that those procedures are followed.
- The DBA needs to ensure that users and operations personnel are appropriately trained with regard to backup and recovery procedures.
- Finally when failures occur, in many organizations the DBA is responsible for managing the recovery process.

Chapter 5: Computer Networks

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What's a protocol?

human protocols:
- "what's the time?"
- "I have a question"
- introductions

… specific msgs sent
… specific actions taken when msgs received, or other events

network protocols:
- machines rather than humans
- all communication activity in Internet governed by protocols

protocols define format, order of msgs sent and received among network entities, and actions taken on msg transmission, receipt

Network edge: connection-oriented service

Goal: data transfer between end systems
- *handshaking:* setup (prepare for) data transfer ahead of time
  - Hello, hello back human protocol
  - *set up "state"* in two communicating hosts
- TCP - Transmission Control Protocol
  - Internet's connection-oriented service

TCP service [RFC 793]
- *reliable, in-order* byte-stream data transfer
  - loss: acknowledgements and retransmissions
- *flow control:*
  - sender won't overwhelm receiver
- *congestion control:*
  - senders "slow down sending rate" when network congested

Network edge: connectionless service

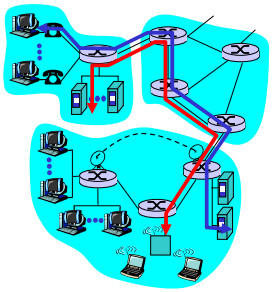
Goal: data transfer between end systems
  - same as before!
- UDP - User Datagram Protocol [RFC 768]:
  - connectionless
  - unreliable data transfer
  - no flow control
  - no congestion control

App's using TCP:
- HTTP (Web), FTP (file transfer), Telnet (remote login), SMTP (email)

App's using UDP:
- streaming media, teleconferencing, DNS, Internet telephony

Network Core: Circuit Switching

End-end resources reserved for "call"
- link bandwidth, switch capacity
- dedicated resources: no sharing
- circuit-like (guaranteed) performance
- call setup required

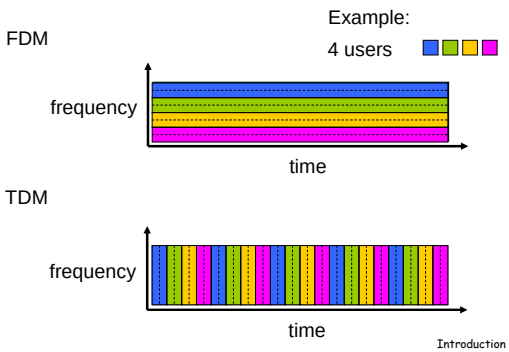


Network Core: Circuit Switching

network resources (e.g., bandwidth) divided into "pieces"
- pieces allocated to calls
- resource piece *idle* if not used by owning call *(no sharing)*

- dividing link bandwidth into "pieces"
  - frequency division
  - time division

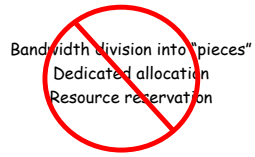
Circuit Switching: FDM and TDM



Network Core: Packet Switching

each end-end data stream divided into *packets*

- user A, B packets *share* network resources
- each packet uses full link bandwidth
- resources used *as needed*



resource contention:

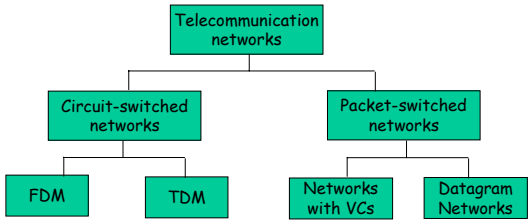
- aggregate resource demand can exceed amount available
- congestion: packets queue, wait for link use
- store and forward: packets move one hop at a time
  - Node receives complete packet before forwarding

Packet switching versus circuit switching

Is packet switching a "slam dunk winner?"

- Great for bursty data
  - resource sharing
  - simpler, no call setup
- Excessive congestion: packet delay and loss
  - protocols needed for reliable data transfer, congestion control
- Q: How to provide circuit-like behavior?
  - bandwidth guarantees needed for audio/video apps
  - still an unsolved problem (chapter 6)

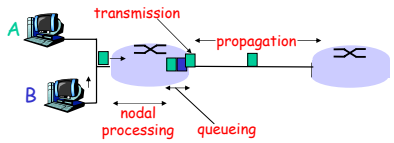
Network Taxonomy



- Datagram network is *not* either connection-oriented or connectionless.
- Internet provides both connection-oriented (TCP) and connectionless services (UDP) to apps.

Four sources of packet delay

- 1. nodal processing:
  - check bit errors
  - determine output link
- 2. queueing
  - time waiting at output link for transmission
  - depends on congestion level of router

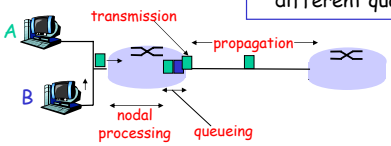


Delay in packet-switched networks

3. Transmission delay:
- R=link bandwidth (bps)
- L=packet length (bits)
- time to send bits into link = L/R

4. Propagation delay:
- d = length of physical link
- s = propagation speed in medium (~2×10^8 m/sec)
- propagation delay = d/s

Note: s and R are *very* different quantities!



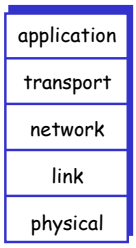
Nodal delay

$$d_{\text{nodal}} = d_{\text{proc}} + d_{\text{queue}} + d_{\text{trans}} + d_{\text{prop}}$$

- d_{proc} = processing delay
  - typically a few microsecs or less
- d_{queue} = queuing delay
  - depends on congestion
- d_{trans} = transmission delay
  - = L/R, significant for low-speed links
- d_{prop} = propagation delay
  - a few microsecs to hundreds of msecs

Internet protocol stack

- application: supporting network applications
  - FTP, SMTP, STTP
- transport: host-host data transfer
  - TCP, UDP
- network: routing of datagrams from source to destination
  - IP, routing protocols
- link: data transfer between neighboring network elements
  - PPP, Ethernet
- physical: bits "on the wire"



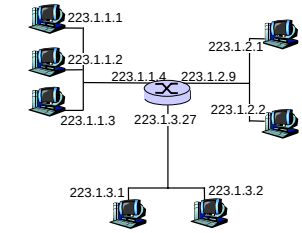
Why layering?

Dealing with complex systems:

- explicit structure allows identification, relationship of complex system's pieces
  - layered reference model for discussion
- modularization eases maintenance, updating of system
  - change of implementation of layer's service transparent to rest of system
  - e.g., change in gate procedure doesn't affect rest of system
- layering considered harmful?

IP Addressing: introduction

- IP address: 32-bit identifier for host, router *interface*
- *interface:* connection between host/router and physical link
  - router's typically have multiple interfaces
  - host may have multiple interfaces
  - IP addresses associated with each interface

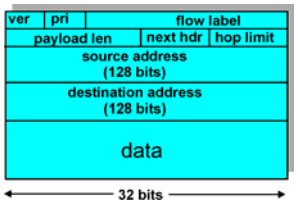


223.1.1.1 = 11011111 00000001 00000001 00000001

223 1 1 1

IPv6

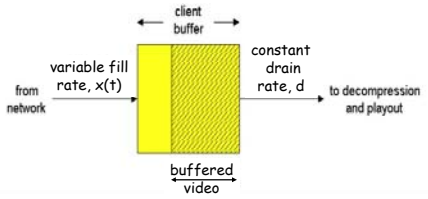
- Initial motivation: 32-bit address space soon to be completely allocated.
- Additional motivation:
  - header format helps speed processing/forwarding
  - header changes to facilitate QoS



MAC Addresses and ARP

- 32-bit IP address:
  - *network-layer* address
  - used to get datagram to destination IP subnet
- MAC (or LAN or physical or Ethernet) address:
  - 48 bit MAC address (for most LANs) burned in the adapter ROM

Streaming Multimedia: Client Buffering



- Client-side buffering, playout delay compensate for network-added delay, delay jitter

What is network security?

Confidentiality: only sender, intended receiver should "understand" message contents
- sender encrypts message
- receiver decrypts message

Authentication: sender, receiver want to confirm identity of each other

Message Integrity: sender, receiver want to ensure message not altered (in transit, or afterwards) without detection

Access and Availability: services must be accessible and available to users

There are bad guys (and girls) out there!

Q: What can a "bad guy" do?

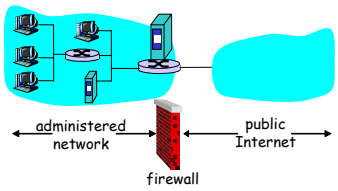
A: a lot!
- *eavesdrop:* intercept messages
- actively *insert* messages into connection
- *impersonation:* can fake (spoof) source address in packet (or any field in packet)
- *hijacking:* "take over" ongoing connection by removing sender or receiver, inserting himself in place
- *denial of service*: prevent service from being used by others (e.g., by overloading resources)

more on this later ……

Firewalls

firewall

isolates organization's internal net from larger Internet, allowing some packets to pass, blocking others.



Firewalls: Why

prevent denial of service attacks:
- SYN flooding: attacker establishes many bogus TCP connections, no resources left for "real" connections.

prevent illegal modification/access of internal data.
- e.g., attacker replaces CIA's homepage with something else

allow only authorized access to inside network (set of authenticated users/hosts)

two types of firewalls:
- application-level
- packet-filtering

Domain Name System

- IP addresses are useful for computer-to-computer communication, but they are not well suited for human use.
- The purpose of the **domain name system (DNS)** is to convert user-friendly names into their IP addresses.
- Any registered, valid name is called a **domain name.**
- The process of changing a name into its IP address is called *resolving the domain name.*