Data Communications And Networking

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Textbooks and Unit Materials

- William Stallings, "Data and Computer Communication", 7th Edition
- Unit information on unit web page
  http://muso.monash.edu.au/webct/cobaltMainFrame.dowebct
- Unit Book
- On-line resources on the web

Study Requirements

- Lecture: 2 hrs per week Wednesday 12:00pm to 2:00pm at lecture theatre H6. If you miss a lecture you can access the on-line audio recording and/or attend a lecture at another campus.
- Tutorials/Practical Sessions: refer Allocate+ for booking a class. All classes are in building 19 room 111. Commence in week 2. You can only only change classes with the permission of your tutor.
- Reading

Unit Objectives

The unit is intended to enable you to understand:

- **various techniques to transmit data over a transmission medium**
- **characteristics of various transmission media**
- **various techniques for sharing a communication channel**
- **design issues of various flow and error control in data communication**
- **identify hardware and software used in developing a Local Area Network (LAN)**
- **design issues involved in developing various protocols for Local Area Network**
- **analysis, design and implementation of a LAN for a given communication need**
- **methods of connecting LAN with other LANs or connecting LAN with Wide Area Network (WAN)**
- **architecture of several switching networks**

Assessment

- 40% in two Assignments
- 60% by examination
- To pass the unit:
  - – both assignments must be attempted
  - – **must pass in assignment assessment**
  - – **must pass the final examination**
  - – **Final mark according to the following formula**
    - ***final mark = min(A+10, E+10, E*R+A*(1-R))***
    - **where *A* = overall assignment percentage,**
    - ***E* = exam percentage,**
    - ***R* = exam weighting (60% = 0.6)**

Assignments

- Assignment 1: Due date 1st September 12:00pm
- Assignment 2: Due date TBA
- Late submissions ONLY with prior permission and VALID reason.
- Plagiarism

Introduction to Data Communications And Networking

Reference:
Chapter 1 -Stallings

Introduction

- The 1970s and 1980s saw a merger of the fields of computer science and data communications
- It changed the technology, products, and companies of the now combined computer-communications industry
- Some of the revolutionary facts emerged are:
  - No fundamental difference between data processing and data communications

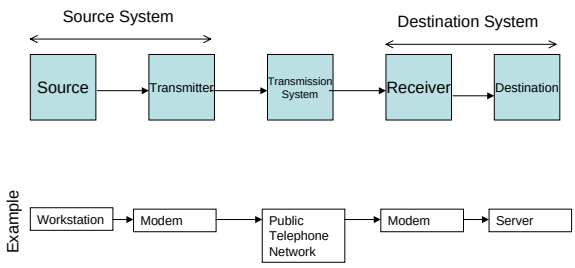
Introduction Contd.

  - No fundamental difference among data, voice and video communications
  - Blurred distinction among single-processor computer and multiprocessor computer and local, metropolitan and long-haul networks
- One effect of these trends has been a growing overlap of component fabrication to system integration
- Another result is the development of integrated systems that transmit and process all types of data and information

A Communications Model

- The fundamental purpose of a communications systems is the exchange of data between two parties
- A simple model of communications is illustrated in the next slide

A Communications Model Contd.



A Communications Model Contd.

- The key elements of the above model are:
  - Source
    - Generates the data to be transmitted
  - Transmitter
    - Transforms and encodes data in such a way as to produce electro-magnetic signals that can be transmitted across some sort of a transmission system
  - Transmission system
    - Can be a single transmission line or a complex network

A Communications Model Contd.

- Receiver
  - Accepts the signal from the transmission system and converts it into a form that can be handled by the destination device
- Destination
  - Takes the incoming data from the receiver

- The above communication model conceals a wealth of technical complexity

A Communications Model Contd.

- Some of the key tasks that must be performed in a data communication system are:

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

Key Tasks of a Communications Model

- **Transmission system utilisation** refers to the need to make efficient use of transmission facilities
- **Interfacing** is about linking the device that generate data with the transmission system
- **Signal generation** is transforming data into form that can be propagated through the transmission system
- The data transmitted must be **synchronised** between the sender and receiver
  - When a signal begins to arrive and when it ends

Key Tasks of a Communications Model Contd.

- Beyond the basic matter of deciding the nature and timing of signals, there is a variety of requirements for communication termed **exchange management**
- In a communication system, there is possibility that transmitted signals are distorted to some extent before reaching their destination
  - **Error detection and correction** are required in circumstances where errors cannot be tolerated

Key Tasks of a Communications Model Contd.

- **Flow Control** is required to assure that the source does not overwhelm the destination by sending data faster than they can be absorbed
- **Addressing** is required when more that two devices share the transmission facility
  - The transmission system must assure that only the intended destination receives data
- The transmission system must address the point **routing**, which deals with selecting a path to the destination

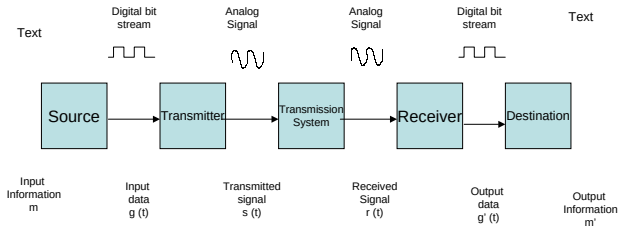
Key Tasks of a Communications Model Contd.

- Recovery techniques are needed in situations in which information exchange is interrupted due to a fault somewhere in the system
  - The idea is either to be able to resume activity at the point of interruption or at least restore the state to the condition that was prior to the beginning of the exchange
- Message formatting has to do with an agreement between 2 parties as to the form of data to be exchanged or transmitted

Key Tasks of a Communications Model Contd.

- It is important to provide some measure of **security** in a data communication system
  - The sender of data may wish to be assured that only the intended receiver actually receives data
  - The receiver wish to be assured that the received data have not been altered in transit and the data come from the purported sender
- **Network management** capabilities are needed to configure the system, monitor its status, react to failures and overloads and plan for future growth

Data Communications



Data Communications Contd.

- Suppose that the input device an transmitter are components of a personal computer
- The PC user wishes to send message m to another user
- The user activates the electronic mail package on the PC and enters the message via the keyboard
- The character strings are briefly buffered in main memory as a sequence of bits g (t)

Data Communications Contd.

- The PC is connected to some transmission medium, such as a local network or a telephone line by an I/O device, such as a local network transceiver or modem
- The input data are transferred to the transmitter as a sequence of voltage shifts [g (t)] representing bits on some communication bus or cable
- The transmitter converts the incoming stream [g (t)] into a signal [s (t)] suitable for transmission

Data Communications Contd.

- The received signal r (t) may differ from s(t), as s(t) is subjected to a number of impairments before it reaches the receiver
- The receiver will attempt to estimate the original s(t) based on r(t) and its knowledge of the medium, producing a sequence of bits g' (t)
- These bits are sent to the output PC where they are briefly buffered in memory

Data Communications Contd.

- The destination system will attempt to determine if an error has occurred and, if so, cooperate with the source system to obtain an error-free block of data
- These data are then presented to the user (receiver) via an output device such as a screen
- The message m' as viewed by the user will usually be an exact copy of the original message m

Data Communication Networking

- It is impractical for two communicating devices to be directly, point-to-point connected due to:
  - The devices are very far apart
  - A set of devices may require a link to many of the others at various times
    - It is impractical to provide a dedicated wire between each pair of devices
- The solution this problem is to attach each device to a communication network

Data Communication Networking Contd.

- Traditionally, communication networks are classified into two major categories:
  - Wide Area Networks (WANs)
  - Local Area Networks (LANs)

Wide Area Networks

- WANs generally cover a large geographical area and rely on circuits provided by a common carrier
- Typically a WAN consists of a number of interconnected switching nodes
  - A transmission from any one device is routed through these internal nodes to the specified destination
  - These nodes are not concerned with the content of the data
    - Their purpose is to provide a switching facility

Wide Area Networks Contd.

- Traditionally, WANs have been implemented using one of two technologies:
  - Circuit Switching
  - Packet switching
- More recently Frame relay and ATM networks have assumed major roles

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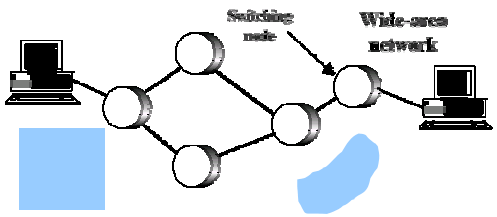

Circuit Switching

- In a circuit switching network a dedicated communication path is established between two stations through the nodes of the network
- The path is a connected sequence of physical links between nodes
  - On each link there is a logical channel dedicated to the connection
  - At each node, incoming data are routed or switched to the appropriate outgoing channel without delay

Packet Switching

- In packet switching, it is not necessary to dedicate transmission capacity along a path through the network
- Instead, data are sent out in a sequence of small chunks, called packets
- Each packet is passed through the network from node to node along some path leading from source to destination
- At each node, each packet is received, stored briefly and then transmitted to the next node

Frame Relay

- Packet switching was developed at a time when digital long-distance transmission facilities exhibited a relatively high error rate compared to today's rate
  - As a result, there is a considerable amount of overhead built into packet switching schemes to compensate for errors
- With modern high-speed telecommunications systems, this overhead is unnecessary and counterproductive
  - It is unnecessary because the rate of errors has been dramatically lowered and any remaining errors can easily be caught in the end systems

Frame Relay Contd.

- Frame relay was developed to take advantage of these high data rates and low error rates
- The original packet-switching networks were designed with a data rate to the end user of about 64kbps, frame relay networks are designed to operate up to 2Mbps
  - The key to achieving these high data rates is to strip out most of the overhead involved with error control

Asynchronous Transfer Mode (ATM)

- ATM, sometimes referred to as cell relay, is a culmination of circuit and packet switching
- ATM can also be viewed as an evolution from frame relay
  - The most obvious difference is that frame relay uses variable-length packets called frames, while ATM uses fixed length packets called cells
  - Similar to frame relay, ATM provides little overhead for error control, relying on inherent reliability of the transmission system

Asynchronous Transfer Mode (ATM)

- By using fixed packet length, the processing overhead is reduced even further for ATM compared to frame relay
- The result is, ATM is designed to work in the range of 10s and 100s of Mbps and in the Gbps range
- ATM can also be viewed as an evolution from circuit switching:
  - With circuit switching only fixed data rate circuits are available to the end system

Asynchronous Transfer Mode (ATM)

- By using small, fixed-size cells, ATM is so efficient that it can offer a constant-data-rate channel even though it is using a packet switching technique
- ATM allows the definition of multiple virtual channels with data rates that are dynamically defined at the time the virtual channel is created

Local Area Networks

- There are key distinctions between LANs and WANs
  - The scope of a LAN is small, typically a single building or a cluster of buildings
  - It is usually the case that a LAN is owned by the same organisation that owns the attached devices
    - There may be substantial capital investment for purchase and maintenance
    - The network management responsibility for a LAN falls solely on the user
  - The internal data rates of LANs are typically much higher than those of WANs

Metropolitan Area Networks

- MAN occupies a middle ground between LANs and WANs
- The primary market for MANs is the customers that have high capacity needs in a metropolitan area
  - The traditional point-to-point and switched network techniques used in WANs may be inadequate for growing needs of Organisations
- A MAN is intended to provide the required capacity at a lower cost and greater efficiency than obtaining an equivalent service from a telephone company

Standards

- Proliferation of computers and distributed processing has urged computer vendors to attempt monopolising customers by not adhering to standards
- With ongoing evolution of protocol standards , customers will no longer accept special-purpose protocol conversion software development
- The result is that standards now permeate all of the areas of technology discussed in this unit

Standards Contd.

- The principal advantages of standards are:
  - Assures that there will be a large market for a particular piece of equipment or software
    - This encourages mass production and, in some cases, the use of LSI and VSLI techniques resulting in lower costs
  - Allows products from multiple vendors to communicate, giving the purchaser flexibility in equipment selection

Standards Contd.

- The principal disadvantages of standards are:
  - Standards tend to freeze the technology
    - By the time a standard is developed, subjected to review and compromise, more efficient techniques are possible
  - There can be multiple standards for the same thing
    - In some areas there are multiple conflicting standards existing

Standards Contd.

- Various organisations have been involved in the development or promotion of the standards discussed in this unit
- The most important of these organisations are:

Internet Society (ISOC)
IEEE (Institute of Electrical and Electronic Engineers)
ITU-T (The International Telecommunication Standardisation Sector)
ATM Forum
ISO (The International Organisation for Standardisation)