King Fahd University of Petroleum & Minerals
Computer Engineering Dept

COE 241 – Data and Computer Communications

Term 121

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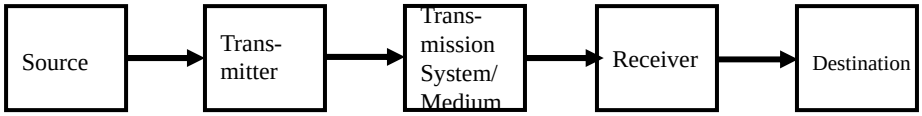
Lecture Contents

1. Communication Model:
   a. Main blocks and functionality
   b. Communication Tasks
2. Data Communications
3. Data Communication Networking:
   a. Wide area networks
      i. Circuit switching
      ii. Message switching
      iii. Packet switching
      iv. ATM
   b. Local area networks

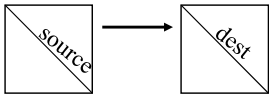
General Communications Model – Blocks and Functionality



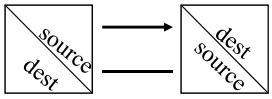
- **Source**: Generates signal or data to be communicated
- **Transmitter**: Transforms and/or encodes information to be communicated
  - E.g. modulation – data encoding
- **Transmission System/Medium**: Transmission line, space, interconnected switching nodes, etc
- **Receiver**: accepts message and undoes transmitter procedures
  - E.g. demodulation – data decoding
- **Destination**: receives raw signal or data

Communications Modes (Duplexity)

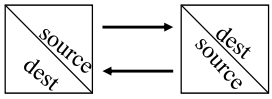
- **Modes:**
  - **Simplex: one way – e.g. TV/Radio signals**
  - **Half Duplex: one direction at a time – walky talky and CB**
  - **Full Duplex: both directions – e.g. telephone**
- **Due to device and/or communication medium limitations**



Simplex:
- only *one* path exists

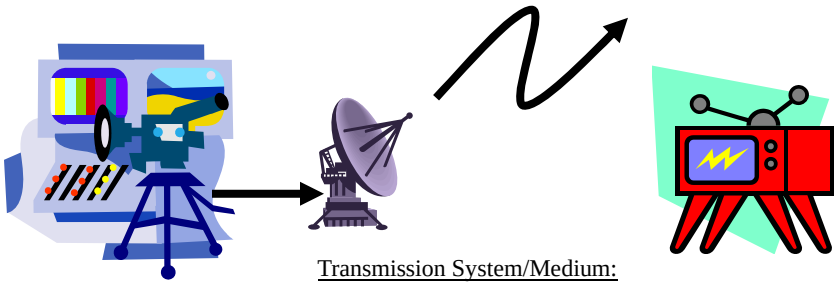


Half duplex:
- two paths exist
- one direction active at one time



Full duplex:
- two paths exist
- two directions may be active at one time

Communications Model – Example 1 - Analog (Simplex)



Source:
-Scene/audio to be transmitted

Transmission System/Medium:
- Overall signal broadcast
- Maybe relayed through intermediate satellite/ground station

Destination:
-Scene/audio

Transmitter:
- Converts info to electrical signals
- Electrical signals modulate carrier
- Amplification and transmission using antennas

Receiver:
- Receives electromagnetic signal
- Demodulates received signal and extracts original electrical signal
- generates original scene/audio information

Communications Model – Example 2 (Full Duplex)

Transmission System/Medium:
- Public switched telephony network

Source:
- User data to be *exchanged*

Destination:
- User data

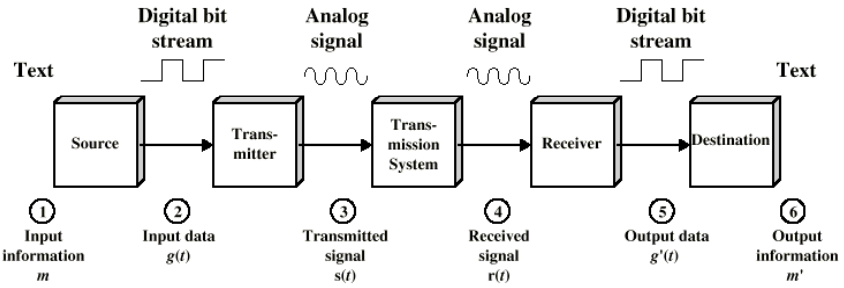
Transmitter (Modem):
- Encodes data
- Encoded data modulates carrier
- Amplification and transmission using phone line

Receiver:
- Receives electrical signal
- Demodulates received signal and extracts original encoded data
- data is decoded to obtain original data

Communications Tasks

Task Name	Comments
Transmission System Utilization	Maximize usage of medium capacity through multiplexing, efficient/advanced comm techniques, etc.
Interfacing	The transport of signal from device to medium
Signal Generation	Creation of signal that is matched to the transmission medium and has original data
Synchronization	Orchestrated and coordinated operation of both transmitter and receiver
Error Detection and Correction	When errors can not be tolerated, a mechanism is required to detect and may be correct errors
Recovery	Reset of communication path
Addressing and Routing	For shared media – need to redirect comm using destination address
Network Management	Configuration – monitoring – signaling (typically not part of user comm)
Message formatting	The form of messages to be transmitted
Exchange Management	Coordination and cooperation of two communicating ends during session
Security	Encryption/Decryption of messages

Data Communications



- **Characteristics:**
  - May involve buffering and/or encoding of digital data (chapter 5)
  - Modulated signal s(t) matched to media (chapter 3/4)
  - Transmission impairments: noise, distortion, etc (section 3.3)
  - Ideally received info m' should be identical to original input info m (chapter 7)
  - If not, error correction may help restore m (chapter 7)
  - Else, retransmission is required (chapter 7)

Data Communication Networking

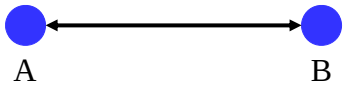
- **Full Connectivity of N nodes:**
  - Using dedicated links from each node to every other nodes – number of links is N*(N-1)/2 = $O(N^2)$
    - Expensive
    - Difficult manage and scale
    - Not reliable – one path *only* between any two nodes
  - Use a ***communication network*** to interconnect nodes
    - No dedicated links or connections for every path
    - reduced number of links
    - easier to manage – flexibility and scalability

Logical Topology Classification and Requirements

- **Logical Topology for Networks:**
  - Point-to-Point,
  - Multi-access links,
  - Internetworks
- **Logical topology point of view**
- **May differ from physical implementation**

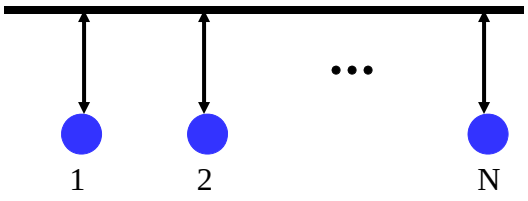
Logical Topology Classification and Requirements – cont'd

- **Point-to-Point:**
  - ***No addressing is required***
  - **Medium: cables, air (wireless), fiber, etc.**



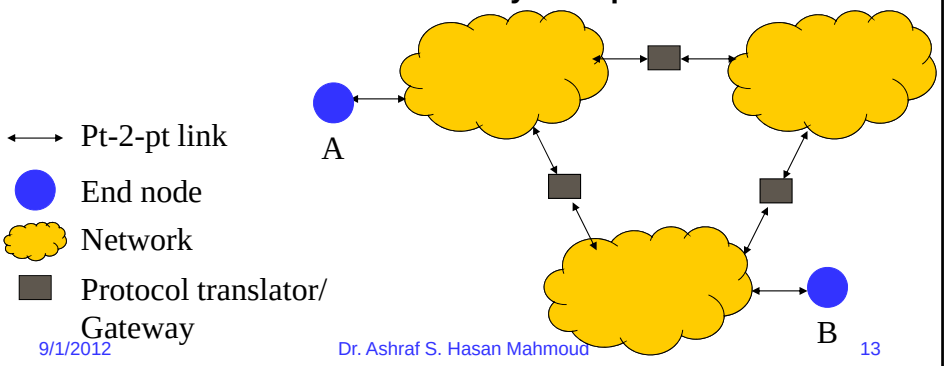
Logical Topology Classification and Requirements – cont'd

- **Multi-access links:**
  - ***Addressing is REQUIRED***
  - **Medium: cables, air (wireless), fiber, etc.**
  - **Media Access Control – is a main function**
    - **Bus arbitration and access coordination to resolve contention**



Logical Topology Classification and Requirements – cont'd

- **Internetworks:**
  - ***Addressing is REQUIRED***
  - ***Routing* is a main function:**
    - **Selection of optimal path**
    - **Protocol translation may be required**



Logical Topology Classification and Requirements – cont'd

- **Local Area Network (LAN):**
  - **Collection of nodes connected using point-to-point, or multi-access links**
  - **Example: Ethernet, token bus, FDDI, etc**
- **Wide Area Network (WAN):**
  - **Collection of LANs connected using protocol translators or gateways**
  - **Internetwork**
- **Metropolitan Area Networks (MAN)**
- **Wireless Networks**

Data Communication Networks

- **WANs (in more details):**
  - **Span a large geographical area**
  - **Consists of a number of interconnected switching nodes**
  - **Boundary v.s. Intermediate nodes:**
    - **Boundary:**
      - **May perform control, management, translation functions**
      - **Pass (switch) user traffic to destination**
    - **Intermediate:**
      - **Pass (switch) traffic to destination**

Data Communication Networks – cont'd

- **Switching Technologies for WANs:**
  - **Circuit Switching**
  - **Packet Switching**
  - **Frame Relay**
  - **ATM**

Data Communication Networks – cont'd

- **Circuit Switching**
  - **A dedicated "physical" communication path is established between the two ends**
  - **Path may be made of series of physical links**
  - **Intermediate nodes switch data or traffic from known input to know output ports with no delay**
  - **A communication session is usually divided into:**
    - **Call setup: dialup**
    - **Traffic exchange: conversation**
    - **Call termination: hang up**
  - **Example: public switching telephony network (PSTN)**

Data Communication Networks – cont'd

- **Packet Switching**
  - **Communicated data is divided into a sequence of chunks or "packets"**
  - **Each packet is passed from node to the next in the network along some path leading to the destination**
  - **At each node, the entire packet is received, stored briefly, and then forwarded to the next node**
  - **To combat errors:**
    - **Packets have overhead to correct/detect errors**
    - **Intermediate switching nodes may perform retransmission functions**
  - **Designed for link speed around 64 kbps**
- **Example: The Internet**

Data Communication Networks – cont'd

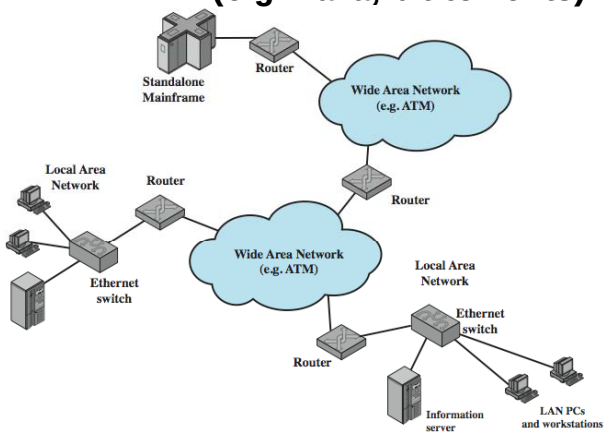
- **Frame Relay**
  - **Newer technology compared to packet switching**
  - **Assumes more reliable transmission links and higher speeds – hence:**
    - **Overhead is not required**
    - **End nodes can detect and correct errors**
  - **Variable frame length**
  - **Up to 2 Mpbs**

Data Communication Networks – cont'd

- **Asynchronous Transfer Mode (ATM)**
  - **Cell relay technology**
  - **Assumes even more reliable transmission links and higher speeds than frame relay**
  - **Negligible overhead and no error protection for payloads**
  - **Fixed payload sizes (48 Bytes)**
  - **Switching hardware – extremely fast**
  - **Speeds up to Giga bps**
  - **Because of it high speed and efficiency, it can provide constant data rate connections (circuit switching) between two nodes**

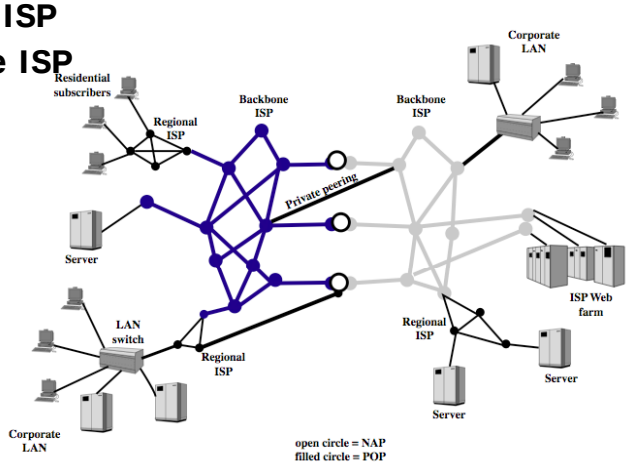
Internet Elements

- **Ethernet switch**
- **Router**
- **WAN**
- **Client-Server (e.g. http)**
- **P2P (e.g. Kaza, bit torrents)**



Internet Architecture

- **Subscriber and/or Corporate LANs**
- **Regional ISP**
- **Backbone ISP**



Networking Configuration - Example