



Indian Institute of Technology Kharagpur

Review of Network Technologies

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Lecture 2: Review of network technologies

On completion, the student will be able to:

1. Distinguish between a LAN and a WAN.
2. Explain the differences between circuit switching and packet switching.
3. Explain the differences between virtual circuit and datagram packet switching.
4. Explain the 7-layer OSI model.
5. Distinguish between the workings of hub, switch and router.
6. Illustrate the typical architecture of an organizational LAN.



Networking: Basic Concepts

- **Computer Network**
 - A communication system for connecting computers / hosts
- **Why?**
 - Better connectivity
 - Better communication
 - Better sharing of resources
 - Bring people together



Types of Computer Networks

- **Local Area Network (LAN)**
 - Connects hosts within a relatively small geographical area
 - Same room
 - Same building
 - Same campus
- **Wide Area Network (WAN)**
 - Hosts may be widely dispersed
 - Across campuses
 - Across cities / countries/ continents

Faster
Cheaper

Slower
Expensive



LAN and WAN: a Comparison

- LAN

- Typical speeds

- 10 Mbps to 10 Gbps

- Typical cost

- 1 crore for a hundred node LAN (one-time cost)

- WAN

- Typical speeds

- 64 Kbps to 8 Mbps

- Typical cost

- 30 lakhs (recurring cost)



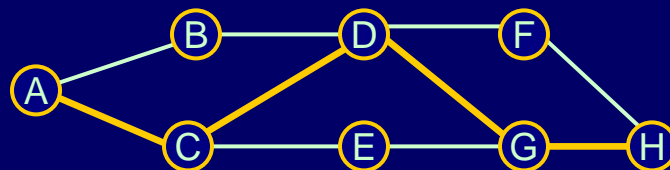
Circuit Switching

- A dedicated communication path is required between two stations.

- The path follows a fixed sequence of intermediate links.

- A logical channel gets defined on each physical link.

- Dedicated to the connection.





Circuit Switching (contd.)

- In circuit switching, three steps are required for communication:
 - Connection establishment
 - Required before data transmission.
 - Data transfer
 - Can proceed at maximum speed.
 - Connection termination
 - Required after data transmission is over.
 - For deallocation of network resources.



Circuit Switching (contd.)

- Drawbacks:
 - Channel capacity gets dedicated during the entire duration of communication.
 - Acceptable for voice communication.
 - Very inefficient for bursty traffic.
 - There is an initial delay.
 - For connection establishment.



Packet Switching

- Modern form of long-distance data communication.
 - Network resources are not dedicated.
 - A link can be shared.
- The basic technology has evolved over time.
 - Basic concept has remained the same.
 - Widely used for long-distance data communication.

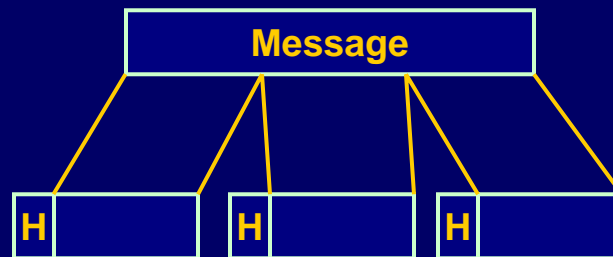


Packet Switching (contd.)

- Data are transmitted in short packets (~ Kbytes).
 - A longer message is broken up into smaller chunks.
 - The chunks are called packets.
 - Every packet contains a header.
 - Relevant information for routing, etc.



Packet Switching (contd.)



PACKETS



Packet Switching (contd.)

- Packet switching is based on store-and-forward concept.
 - Each intermediate network node receives a whole packet.
 - Decides the route.
 - Forwards the packet along the selected route.



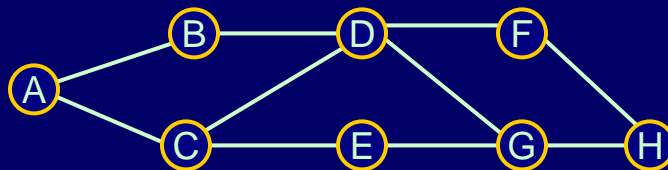
Packet Switching (contd.)

- Advantages:
 - Links can be shared; so link utilization is better.
 - Suitable for computer-generated traffic.
 - Typically bursty in nature.
 - Buffering and data rate conversion can be performed easily.
 - Some packets may be given priority over others, if desired.



Packet Switching (contd.)

- How are the packets transmitted?
 - Two alternative approaches:
 - Virtual Circuits
 - Datagram
- The abstract network model:





Virtual Circuit Approach

- Similar in concept to circuit switching.
 - A route is established before packet transmission starts.
 - All packets follow the same path.
 - The links comprising the path are not dedicated.
 - Different from circuit switching in this respect.
- Analogy:
 - Telephone system.



Virtual Circuit Approach (contd.)

- How it works?
 - Route is established a priori.
 - Packet forwarded from one node to the next using store-and-forward scheme.
 - Only the virtual circuit number need to be carried by a packet.
 - Each intermediate node maintains a table.
 - Created during route establishment.
 - Used for packet forwarding.
 - No dynamic routing decision is taken by the intermediate nodes.



Datagram Approach

- **Basic concept:**
 - No route is established beforehand.
 - Each packet is transmitted as an independent entity.
 - Does not maintain any history.
- **Analogy:**
 - Postal system.



Datagram Approach (contd.)

- **Every intermediate node has to take routing decisions dynamically.**
 - Makes use of a routing table.
 - Every packet must contain source and destination addresses.
- **Problems:**
 - Packets may be delivered out of order.
 - If a node crashes momentarily, all of its queued packets are lost.
 - Duplicate packets may also be generated.



Datagram Approach (contd.)

- **Advantages:**
 - **Faster than virtual circuit for smaller number of packets.**
 - **No route establishment and termination.**
 - **More flexible.**
 - **Packets between two hosts may follow different paths.**
 - **Can handle congestion/failed link.**



Comparative Study

- **Three types of delays must be considered:**
 - **Propagation Delay**
 - **Time taken by a data signal to propagate from one node to the next.**
 - **Transmission Time**
 - **Time taken to send out a packet by the transmitter.**
 - **Processing Delay**
 - **Time taken by a node to “process” a packet.**



Circuit Switching

- After initial circuit establishment, data bits sent continuously without any delay.



Virtual Circuit Packet Switching

- Call request packet sent from source to destination.
- Call accept packet returns back.
- Packets sent sequentially in a pipelined fashion.
 - Store-and-forward approach.



Datagram Packet Switching

- No initial delay.
- The packets are sent out independently.
 - May follow different paths.
 - Follow store-and-forward approach.

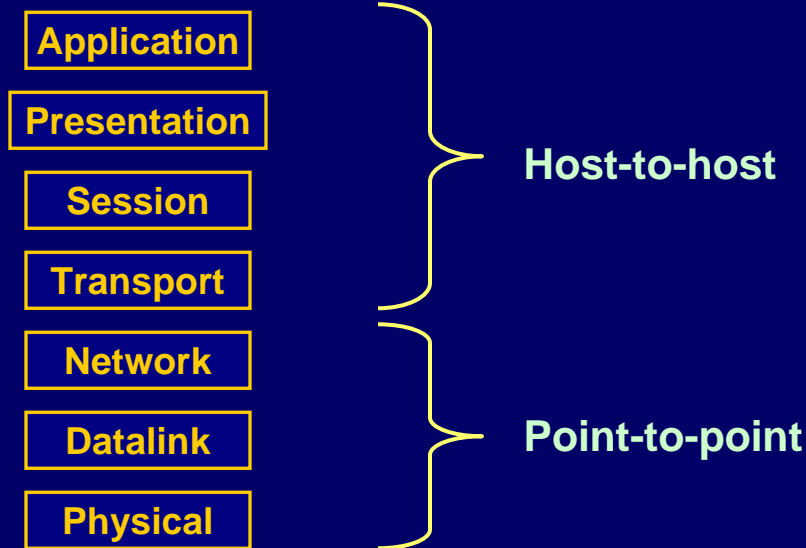


Layered Network Architecture

- Open systems interconnection (OSI) reference model.
 - Seven layer model.
 - Communication functions are partitioned into a hierarchical set of layers.
- Objective:
 - Systematic approach to design.
 - Changes in one layer should not require changes in other layers.



The 7-layer OSI Model



Layer Functions

- **Physical**
 - Transmit raw bit stream over a physical medium.
- **Data Link**
 - Reliable transfer of frames over a point-to-point link (flow control, error control).
- **Network**
 - Establishing, maintaining and terminating connections.
 - Routes packets through point-to-point links.

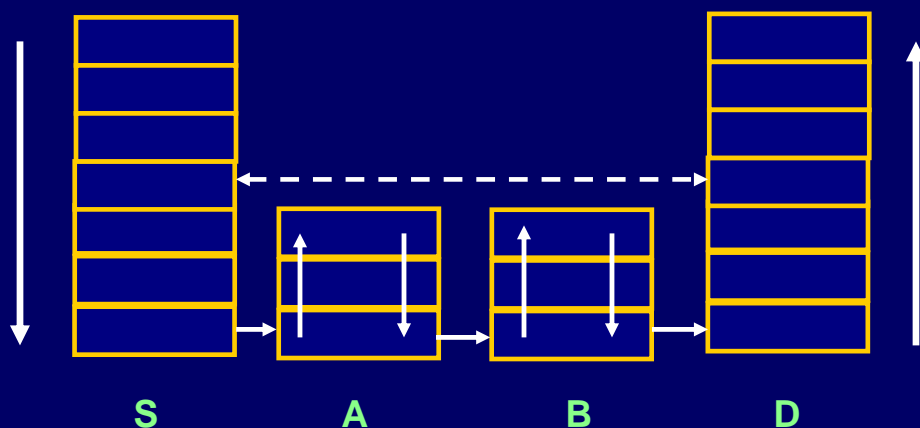


Layer Functions (contd.)

- **Transport**
 - End-to-end reliable data transfer, with error recovery and flow control.
- **Session**
 - Manages sessions.
- **Presentation**
 - Provides data independence.
- **Application**
 - Interface point for user applications.



How Data Flows





Internetworking Devices

- **Hub**
 - Extends the span of a single LAN.
- **Bridge / Layer-2 Switch**
 - Connects two or more LANs together.
 - Works at data link layer level.
- **Router / Layer-3 Switch**
 - Connects any combination of LANs and WANs.
 - Works at network layer level.



Campus Network Schematic



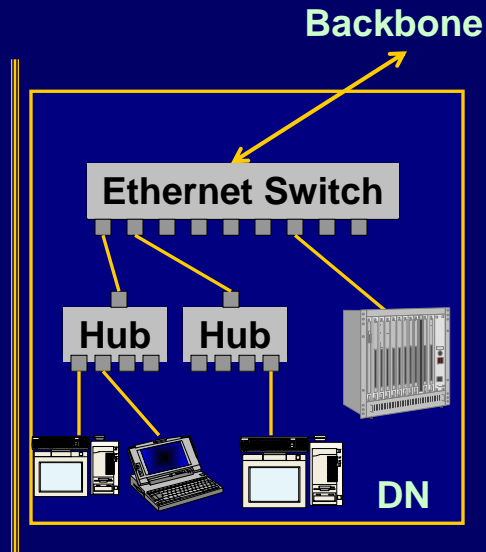
Backbone: Fast Ethernet, FDDI, ATM, Gigabit Ethernet

DN: Switched Ethernet, Bus-based Ethernet

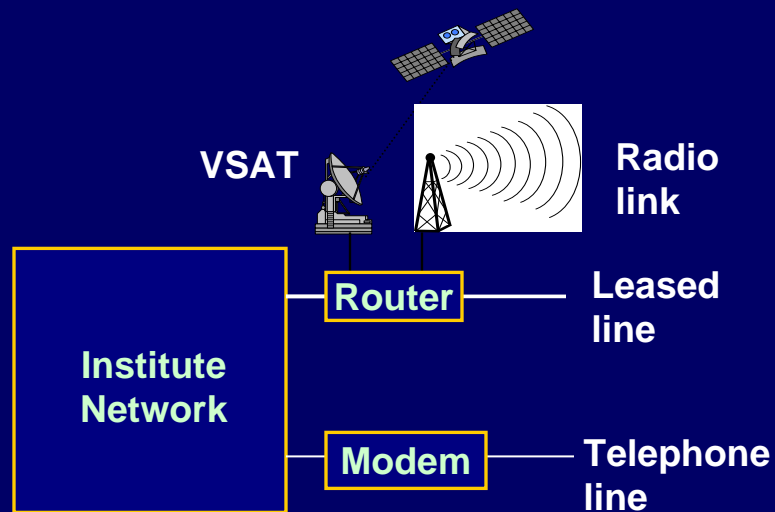


Connecting a Computer to DN

- Requires a network interface card (NIC).
- Connection through switch/hub.
- Typical scenario is shown.



Connecting to Outside World





End of Lecture 2



QUIZ QUESTIONS ON LECTURE 2



Quiz Questions on Lecture 2

1. With respect to speed of data transfer, which of LAN or WAN is faster?
2. What is the typical speed of a modern Ethernet backbone LAN?
3. Why is circuit switching not suitable for computer-to-computer traffic?
4. What are the three steps that are required for data communication using circuit switching?



Quiz Questions on Lecture 2

5. With respect to sharing of links, which of circuit switching or packet switching is more suitable?
6. Among virtual circuit and datagram, which approach requires less information in the packet header?
7. Which of virtual circuit and datagram makes better utilization of the links?
8. Which of virtual circuit and datagram will guarantee ordered delivery of packets in the absence of any errors?



Quiz Questions on Lecture 2

9. Under what circumstances will the datagram method of packet delivery prove useful?
10. Five packets need to be sent from a host A to another host B. Which of virtual circuit or datagram would be faster?
11. For a 5 Kbytes packets sent over a 10 Mbps transmission link, what is the transmission time of the packet?



Quiz Questions on Lecture 2

12. A 600-byte packet is sent over a 20 Kbps point-to-point link whose propagation delay is 10 msec. After how much delay will the packet reach the destination?
13. Which layers in the OSI model are host-to-host layers?
14. What is the responsibility of the network layer in the OSI model?
15. What is the responsibility of the data link layer in the OSI model?
16. What is the basic difference between a bridge and a router?