Lecture 2: Network Architecture

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OUTLINE

- Protocol Hierarchy
- Interfaces and Services,
- Connection Oriented & Connectionless Services,
- Service Primitives,
- Design Issues & its functionality

Networking Protocols

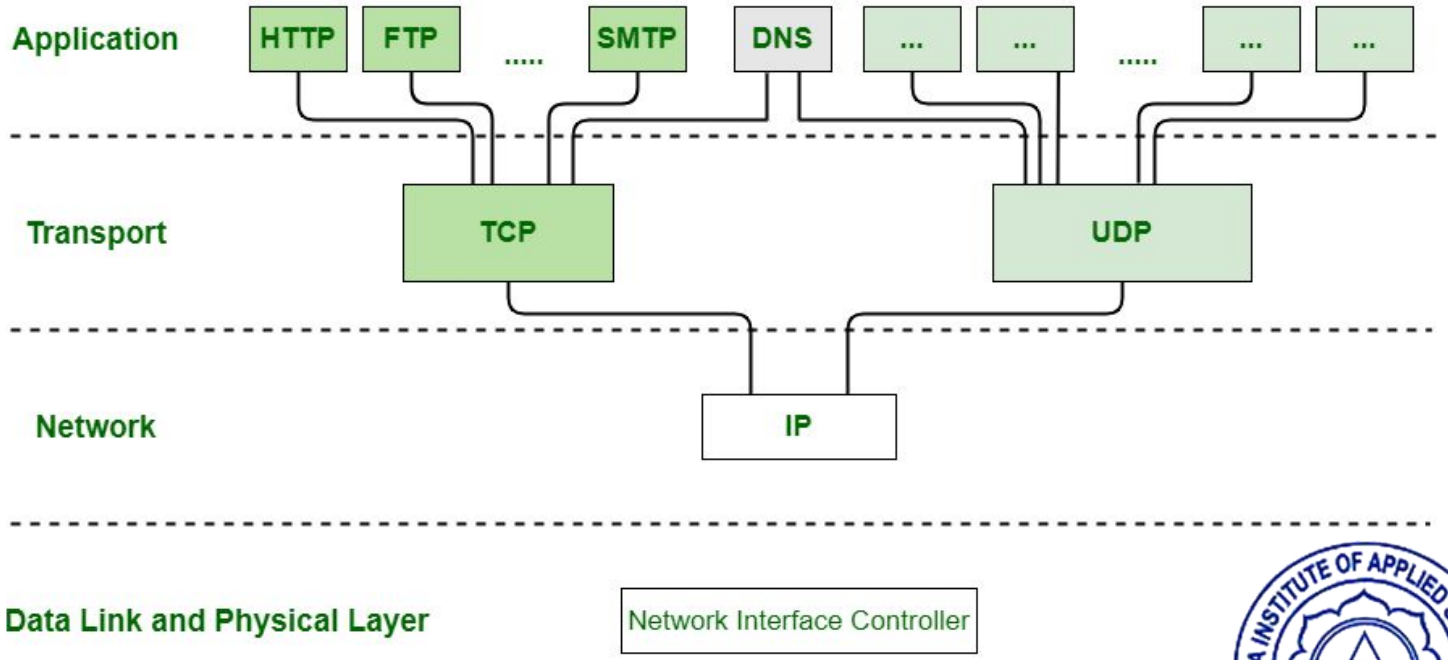
- A protocol is a set of rules that governs the communications between computers on a network.

- These rules include guidelines that regulate the following characteristics of a network: access method, allowed physical topologies, types of cabling, and speed of data transfer.

Layered Architecture

- Layers provide a division of the work done by a network.
- Networks are set up with a protocol hierarchy that divides the communication task into several layers.
- A **protocol** is a set of rules for communication *within* a layer.
- Protocols at one layer are unaware of issues at another layer.

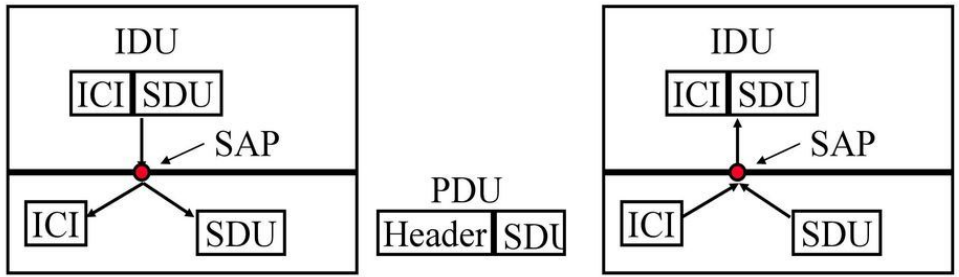
Protocol Hierarchy



Interface and Services

- A **service** is what the layer provides to the layer above it through an **interface**.
  - Upper layer is service user.
  - Lower layer is service provider.
- Services are available at SAPs (Service Access Points).
- The layer n SAPs are the places where layer n+1 can access the services offered.

Interface and Services



- IDU = Interface Data Unit = ICI + SDU
- ICI = Interface Control Information
- SDU = Service Data Unit
- PDU = Protocol Data Unit = Fragments of SDU + Header or Several SDUs + Header (blocking)
- SAP = Service Access Point

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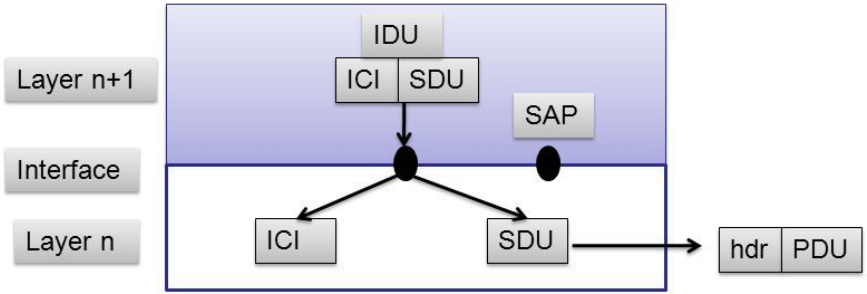
Interface and Services

- IDU=SDU+control information
- The SDU is passed across the network to the peer entity and then upto layer n+1
- Layer n fragment SDU into small pieces and add header and send as separate PDU (packet)



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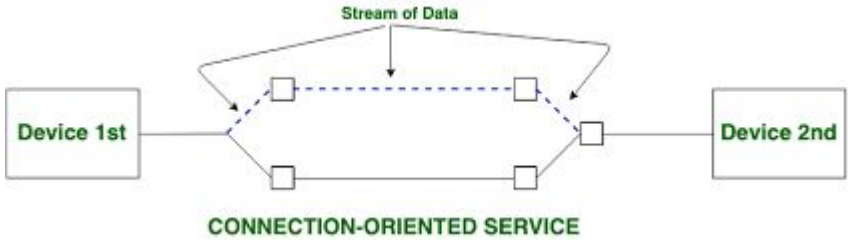
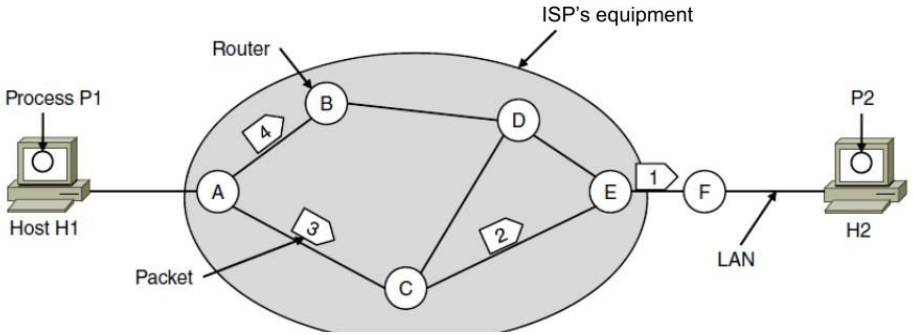
Connection Oriented Services



- A **connection-oriented service** is one that establishes a dedicated **connection** between the communicating entities before data communication commences.
- In **connection-oriented services**, the data streams/packets are delivered to the receiver in the same order in which they have been sent by the sender.

Connectionless Services

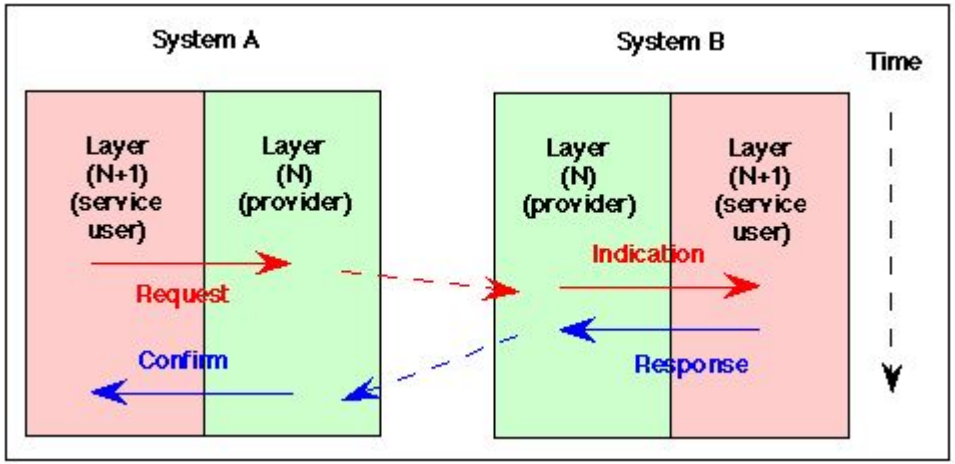


- A **Connectionless service** is a data communication between two nodes where the sender sends data without ensuring whether the receiver is available to receive the data.
- The data packets in a **connectionless service** are usually called datagrams.

Difference B/w Connection Oriented & Connectionless Services

- In CO service authentication is needed, while CL service does not need any authentication.
- CO protocol makes a connection and checks whether message is received or not and sends again if an error occurs, while CL service protocol does not guarantees a message delivery.
- CO service is more reliable than CL.
- CO service interface is stream based and CL is message based.

Service Primitives



- Communication between adjacent protocol layers are managed by calling functions, called **primitives.**
- There are various types of actions that may be performed by primitives.
- Examples of primitives include: Connect , Data, Flow Control, and Disconnect.

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Service Primitives

The four basic types of primitive are :

1. **Request**: A primitive sent by layer (N + 1) to layer N to request a service. It invokes the service and passes any required parameters.
2. **Indication**: A primitive returned to layer (N + l) from layer N to advise of activation of a requested service or of an action initiated by the layer N service.
3. **Response**: A primitive provided by layer (N + 1) in reply to an indication primitive. It may acknowledge or complete an action previously invoked by an indication primitive.
4. **Confirm**: A primitive returned to the requesting (N + l)st layer by the Nth layer to acknowledge or complete an action previously invoked by a request primitive.

Design Issues

- A number of design issues exist for the layer to layer approach of computer networks. Some of the main design issues are as follows −
- **Reliability**
- **Scalability**
- **Addressing**
- **Error Control**
- **Flow Control**
- **Resource Allocation**
- **Statistical Multiplexing**
- **Routing**
- **Security**

Reliability

- Network channels and components may be unreliable, resulting in loss of bits while data transfer.

- So, an important design issue is to make sure that the information transferred is not distorted.

Scalability

- Networks are continuously evolving.
- The sizes are continually increasing leading to congestion.
- Also, when new technologies are applied to the added components, it may lead to incompatibility issues.
- Hence, the design should be done so that the networks are scalable and can accommodate such additions and alterations.

Addressing

- At a particular time, innumerable messages are being transferred between large numbers of computers.

- So, a naming or addressing system should exist so that each layer can identify the sender and receivers of each message.

Error Control

- Unreliable channels introduce a number of errors in the data streams that are communicated.

- So, the layers need to agree upon common error detection and error correction methods so as to protect data packets while they are transferred.

Flow Control

- If the rate at which data is produced by the sender is higher than the rate at which data is received by the receiver, there are chances of overflowing the receiver.

- So, a proper flow control mechanism needs to be implemented.

Resource Allocation

- Computer networks provide services in the form of network resources to the end users.
- The main design issue is to allocate and deallocate resources to processes.
- The allocation/deallocation should occur so that minimal interference among the hosts occurs and there is optimal usage of the resources.

Statistical Multiplexing

- It is not feasible to allocate a dedicated path for each message while it is being transferred from the source to the destination.

- So, the data channel needs to be multiplexed, so as to allocate a fraction of the bandwidth or time to each host.

Routing

- There may be multiple paths from the source to the destination.
- Routing involves choosing an optimal path among all possible paths, in terms of cost and time.
- There are several routing algorithms that are used in network systems.

Security

- A major factor of data communication is to defend it against threats like eavesdropping and surreptitious alteration of messages.
- So, there should be adequate mechanisms to prevent unauthorized access to data through authentication and cryptography.