

CprE 530

Advanced Protocols and Network Security Lecture 1

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Today's Topics

- Introduction
- Layered architecture
- Key terms
- Protocol Functions
- OSI model
- TCP/IP Model

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Course Overview

- Protocols
- Protocol Implementations
- Security Issues
- Performance Issues
- Several lab based assignments
 - New lab environment

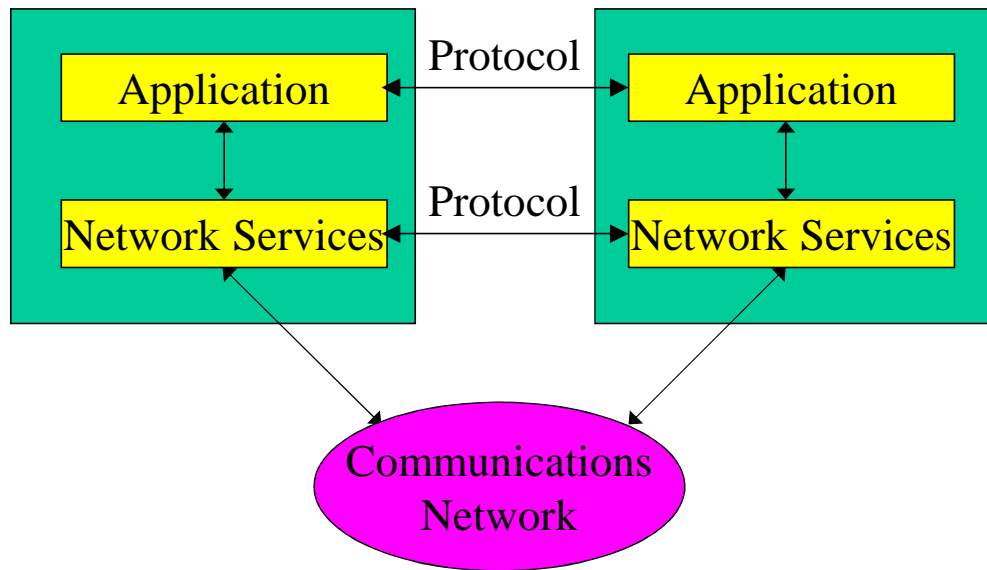
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1840	1844 First Telegraph line 1861 Over 2200 telegraph offices 1866 First transatlantic cable 1875 First words on a telephone
1900	1880 over 30,000 phones 1900 over 600,000 phones 1910 over 5,000,000 phones 1920 over 11,000,000 phones
1950s	Point-to-point network to main frames
1960	1968 300 baud modem 1969 ARPANET (4 nodes)
1970	1971 15 nodes in ARPANET 1973 TCP/IP development 1973 Ethernet was proposal in a Ph.D. Dissertation 1977 TCP/IP test bed 1979 UUCPnet
1980	1980 ARPANET virus (accidental) 1983 TCP/IP becomes the protocol for ARPANET 1984 over 1000 hosts 1986 NSFNET is started 1987 over 10,000 hosts 1988 Internet worm infects over 6,000 hosts 1989 over 100,000 hosts
1990	1991 WWW released by CERN 1992 over 1,000,000 hosts 1995 First ISPs started 1996 over 10,000,000 hosts
2000	

History of Networking

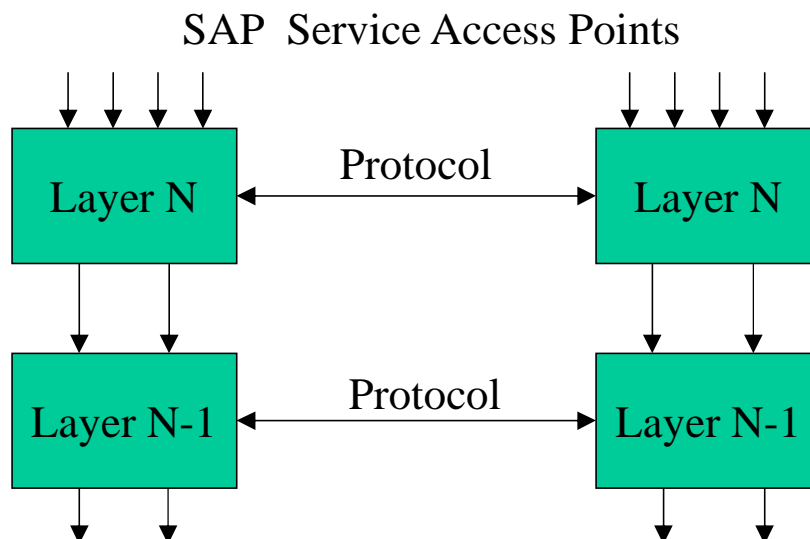
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Layered Architecture



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Layered Architecture



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Layered Architecture

- Brought about because of a need for standards
- Layers:
 - take information from above (layer N-1)
 - and pass information below (layer N+1)
- The services are provided through the *service access points* (SAPs)
- Layer functionality is implemented through an *entity*
- Each layer contains one or more entities which are responsible for providing services to the N+1 layer

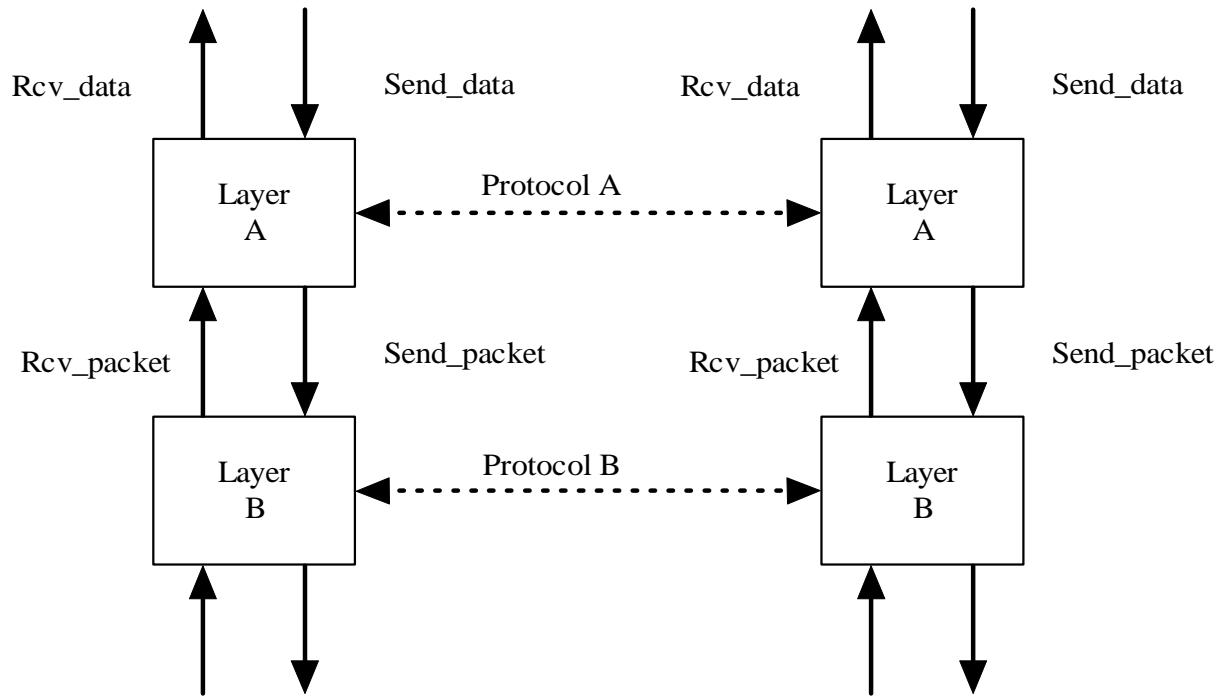
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Layered Architecture

- In order for layers to carry out functions, they need to communicate
- A layer N entity may need to communicate with another layer N entity, which does not reside on the same system, to provide the service.
- The layer N entity uses the layer N-1 services to communicate with the remote layer N entity.

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Layered Architecture



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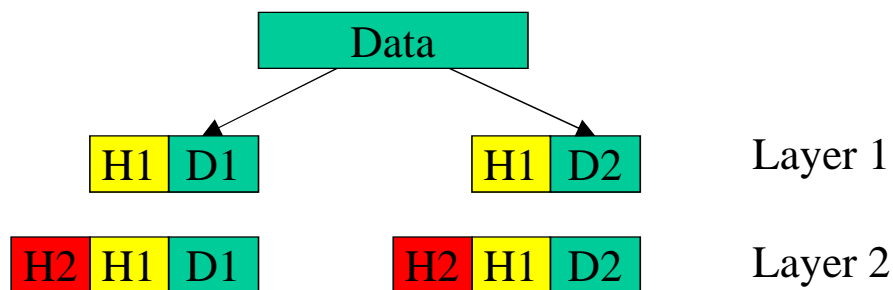
Layered Architecture

- **PROTOCOLS** are the rules that have been defined for the layer N to layer N communication.
- They represent extra information
 - example: saying “hello” on the telephone is a protocol
- Protocols indicate when to send data, what language to use, etc.
- A *layer specification* defines
 - what protocol it uses
 - what it expects as input (SAPs)
 - what functions it provides
- Layer specifications allow multiple vendors to have the same functionality.
 - (ie: different ethernet card brands)

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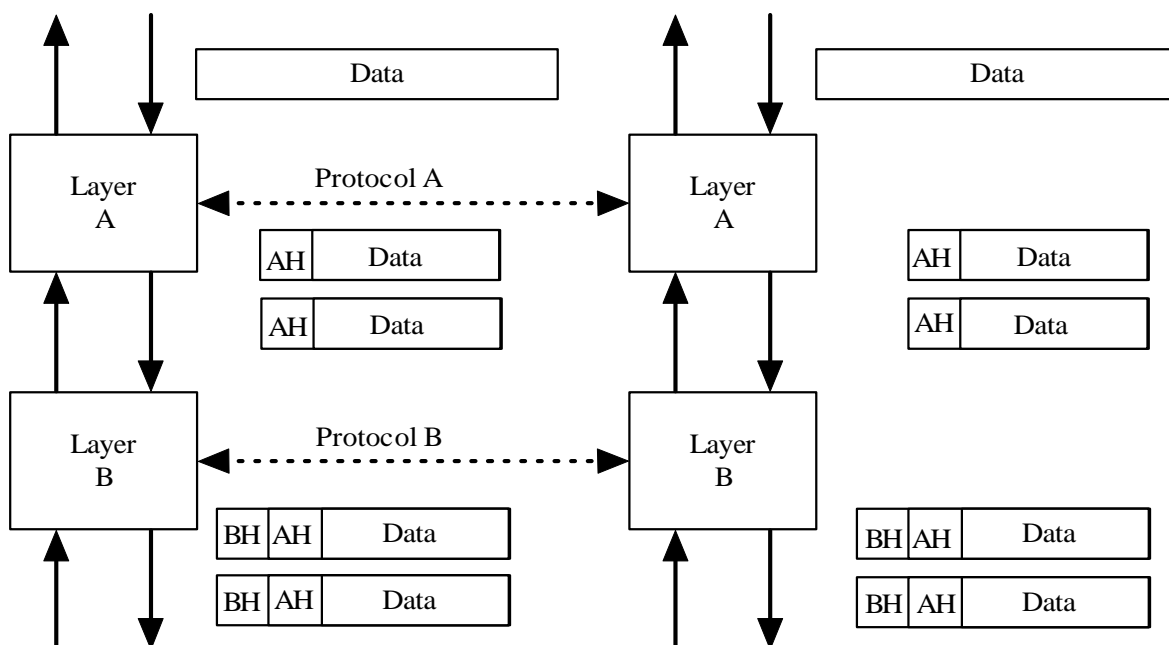
Protocol Data Unit

- **Protocol Data Unit (PDU)** is the combination of data from the higher layer and the protocol or control information.
- The protocol or control information created by a layer is called the **header**.
- Each layer adds it's own header



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Control Information Encapsulation



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Key Terms

- The **protocol** defines the rules for PEER entity communication
- **Service Access Points** (SAP) specify how the N entity communicates with the N-1 entity.
- **Services** are provided by the N entity to the N+1 entity
- **Functions** are provided by the entity in coordination with the peer entity.

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Basic Functions of a Protocol

1. Segmentation and reassembly:

- Often physical media or error control issues dictate a maximum data size
- Therefore the data must be divided into smaller packets (**Segmentation**)
- And eventually put back together (**Reassembly**)
- Reassembly instructions are included in the header

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Basic Functions of a protocol

2. Encapsulation:

The addition of control information to the data element in the form of a header.

- **Address:** The address of the sender and/or receiver.
- **Error Detection Code:** Some sort of code is often included for error detection.
- **Protocol Control:** Additional information needed to implement the protocol.

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Basic functions of a protocol

3. Connection Control:

– Connectionless Data Transfer

- Data is transferred without prior coordination
- No set path

– Connection-oriented Data Transfer

- A logical association, or **Connection**, is established between entities before any data is transferred
- Example: telephone

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Connection oriented

- The three phases of **Connection Control**
 - request/connect phase
 - data transfer phase
 - terminate phase

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Basic Functions of a protocol

4. Ordered Delivery

- Pieces arrive in the same order as sent
- Not provided by connectionless protocols
- Not required to be provided by Connection-oriented protocols, but it is common for most. (needed for file transfer)

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Basic Functions of a protocol

5. Flow Control:

- Technique for assuring that the transmitting entity does not overwhelm a receiving entity.
- Flow Control is typically implemented in several layers.
- Flow control is found in most connection-oriented protocols

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Basic Functions of a protocol

6. Error Control:

- Technique that allows a protocol to recover from lost or damaged PDUs.
- Three mechanisms:
 - Positive acknowledgment
 - Retransmit after timeout
 - Error detection

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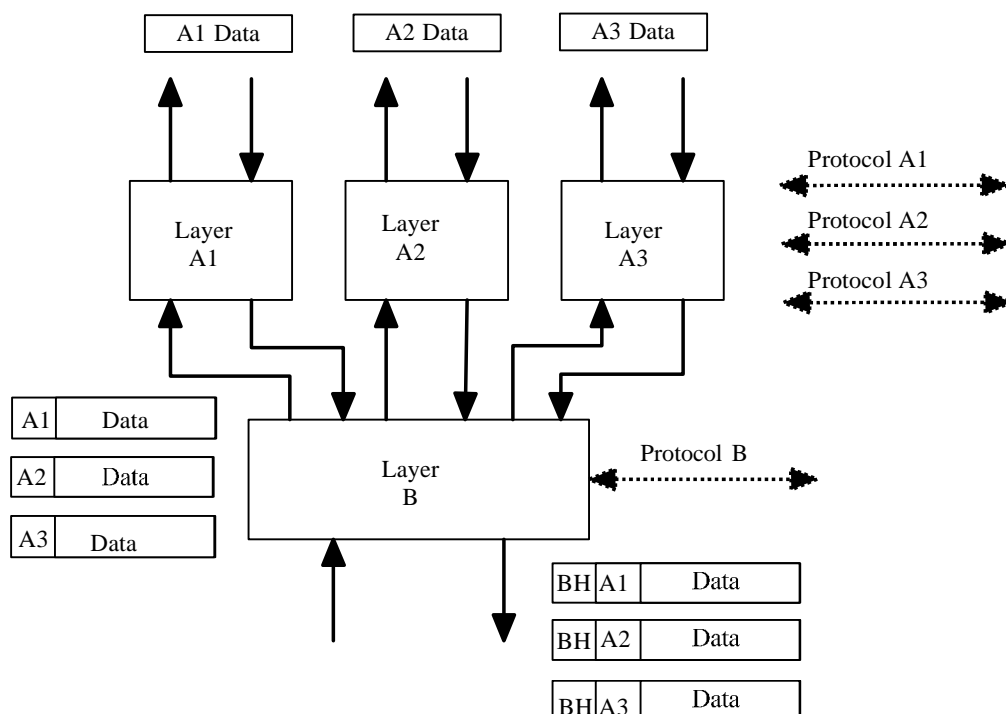
Basic Functions of a protocol

7. Multiplexing:

- **Upward Multiplexing** occurs when multiple higher level connections are multiplexed on a single lower level connection. Example: many applications utilize TCP (telnet, ftp, email)
- **Downward Multiplexing** occurs when a single higher level connection is multiplexed on multiple lower level connections. (not as common)
- Addressing is needed to support multiplexing

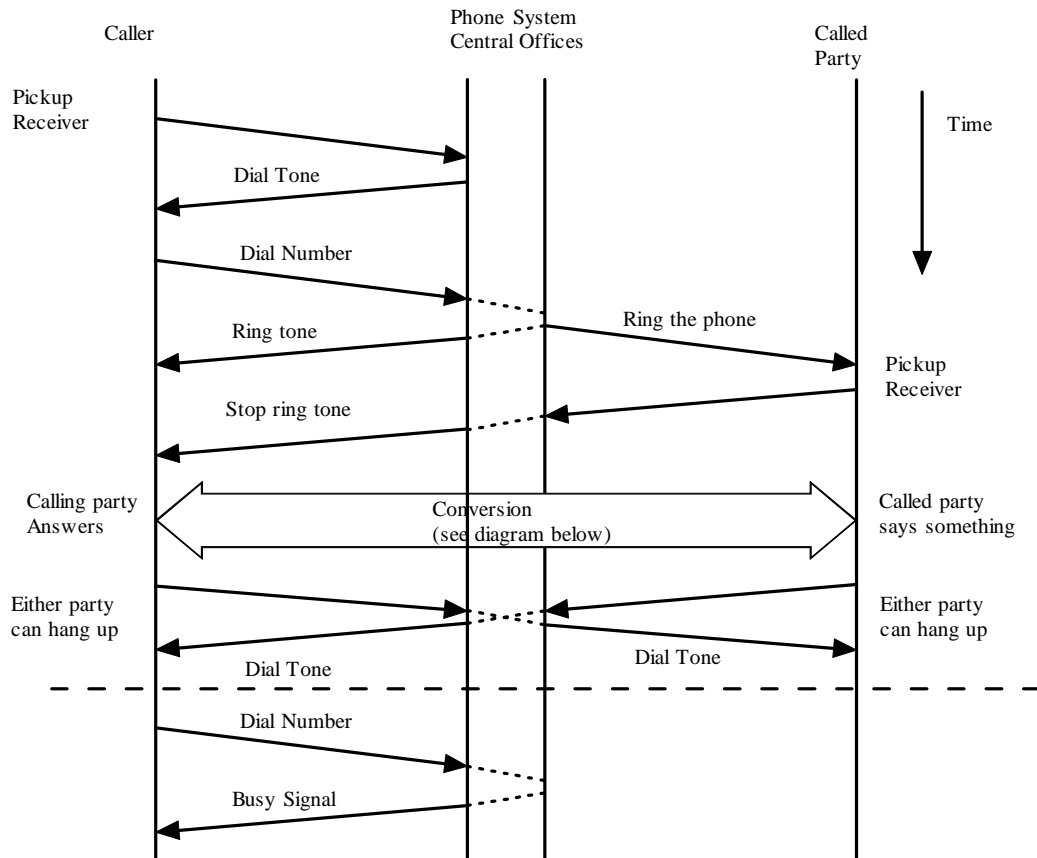
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Multiplexing



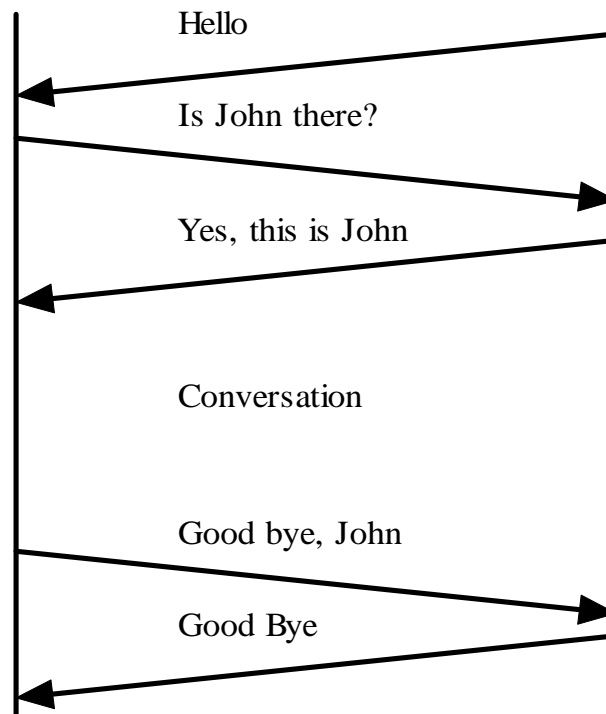
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Protocol Example (part 1)



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Protocol Example (part 2)



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OSI Model

- Application
- Presentation
- Session
- Transport
- Network
- Data Link
- Physical

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Physical Layer

- Responsible for the transparent transmission of bit streams across the physical interconnection of systems
- Two configurations:
 - Point-to-point
 - Multipoint
- Physical layer must provide the data link entities with a means to identify the end point.
- Physical connection can be **Full Duplex** or **Half Duplex**
- Physical connection can be either bit serial or N bit parallel
- Physical layer must deliver the bits in the same order in which they were offered for transmission by the Data Link Layer.

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Data Link Layer

- Main task is to shield higher layers from the characteristics of the physical transmission medium.
- Should provide the higher layers with a reliable transmission which is basically **Error-Free**, although errors may occur in the transmission on the physical connection.
- Services provided should be independent of the data transmitted.
- Data link layer connects two network entities in adjacent systems called **Data link connection**.

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Data Link Layer

- Each data-unit from the network layer is mapped into the data link protocol data unit along with the data link protocol information, and is called a **Frame**.
- The data link layer must provide a method of recognizing the start and end of the **Frame**.
- Frames must be presented to the network in the same order they are received.
- The data link layer should also implement **Flow Control** to prevent data overrun.

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Network Layer

- The primary responsibility of the network layer is to provide the transparent transfer of all data submitted by the transport layer to any transport entity anywhere in the network.
- The network layer must handle the routing of data packets.
- The network layer can be the highest layer in a device such as a gateway or router.
- IP protocol

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Transport Layer

- Responsible for a **reliable** transparent data transfer between two session layer entities.
- Transport connection is provide to the session entities independent of their location.
- Transport layer must optimize resources while maintaining a guaranteed quality of service.
- Session layer requests a level of service and once the transport connection is provided with a certain quality of service it must be maintained unless notified of the change.
- TCP protocol

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Transport Layer

- The transport layer is only concerned with transfer of data between session layers. It is not aware of the structure of the underlying layers or the topology.
- The transport layer will use the network layer to get a network connection from one transport entity to another.
- Depending on the quality of the network the transport layer may have to perform additional functions to offer the service.
- The transport layer provides flow and error control.

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Session Layer

- The session layer is not concerned with the network.
- The session layer's goal is to coordinate the dialog between presentation layers
- The session layer must provide the establishment of a session connection and the management of the dialog on that connection.
- Example: An atm maintains a constant connection with a bank (transport service). The session starts when the user logs in.

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Presentation Layer

- The presentation layer provides the application layer with services related to the presentation of information in a form that is meaningful to the application entities.
- The presentation layer provides the mechanism for the application layer to translate its data into a common format that can be translated by the peer application entity.
- data format M1 → network format → data format M2

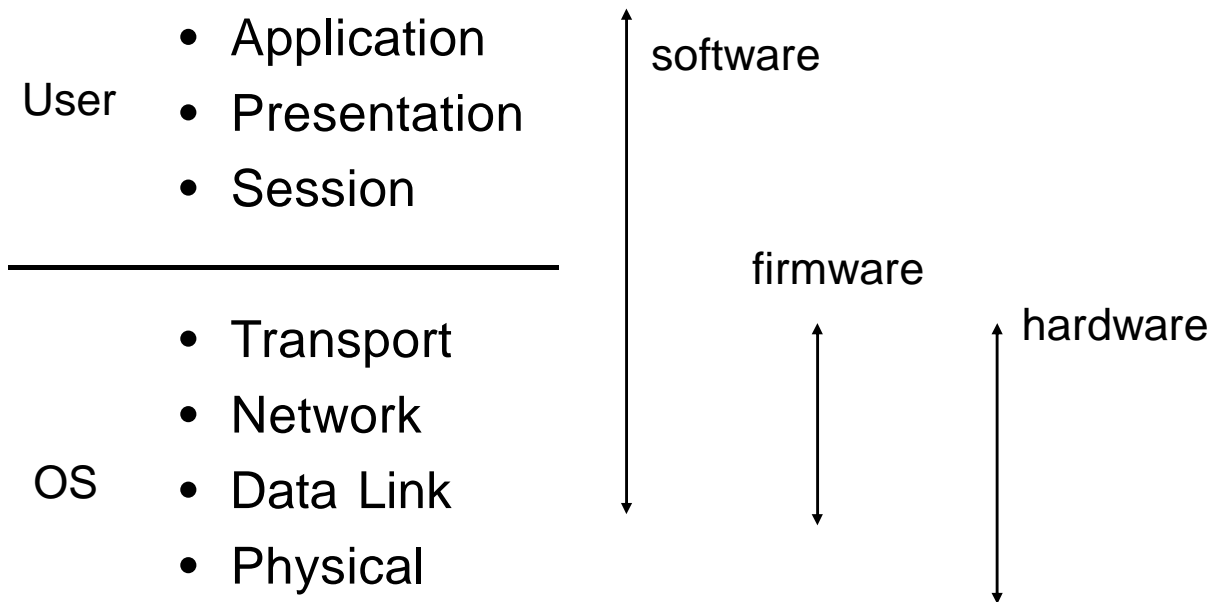
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Application Layer

- The highest layer and it provides a means for application processes to access the OSI stack.
- Provides both general services and application specific services.
- This is what the user sees
- Examples: telnet, ftp, web

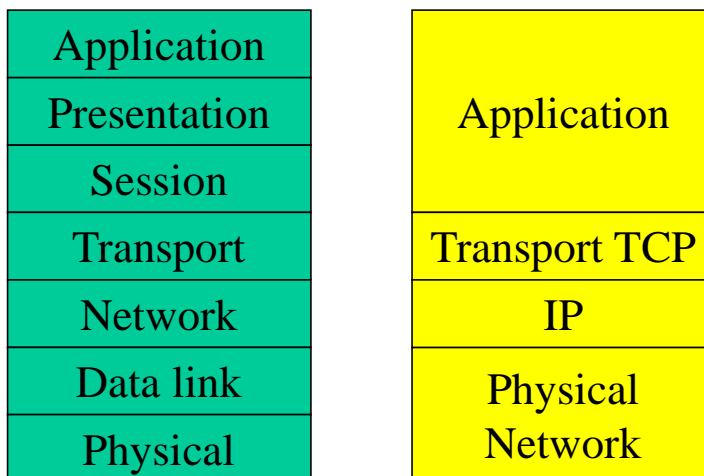
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Layered Network Model



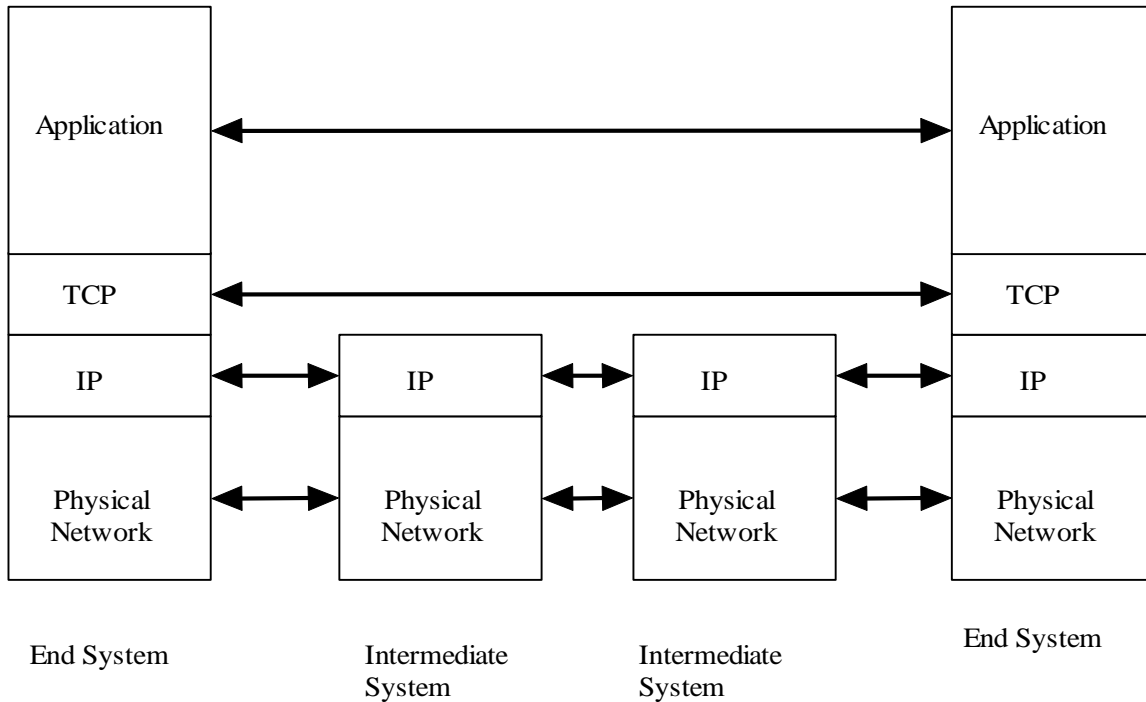
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TCP/IP vs OSI



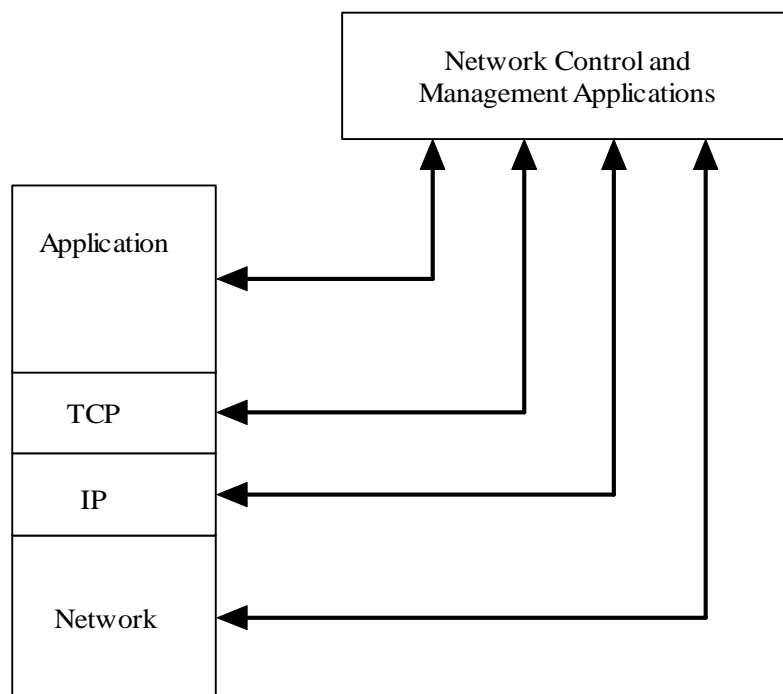
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TCP/IP Network



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Non-layered Services



TCP/IP 4 layer model

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