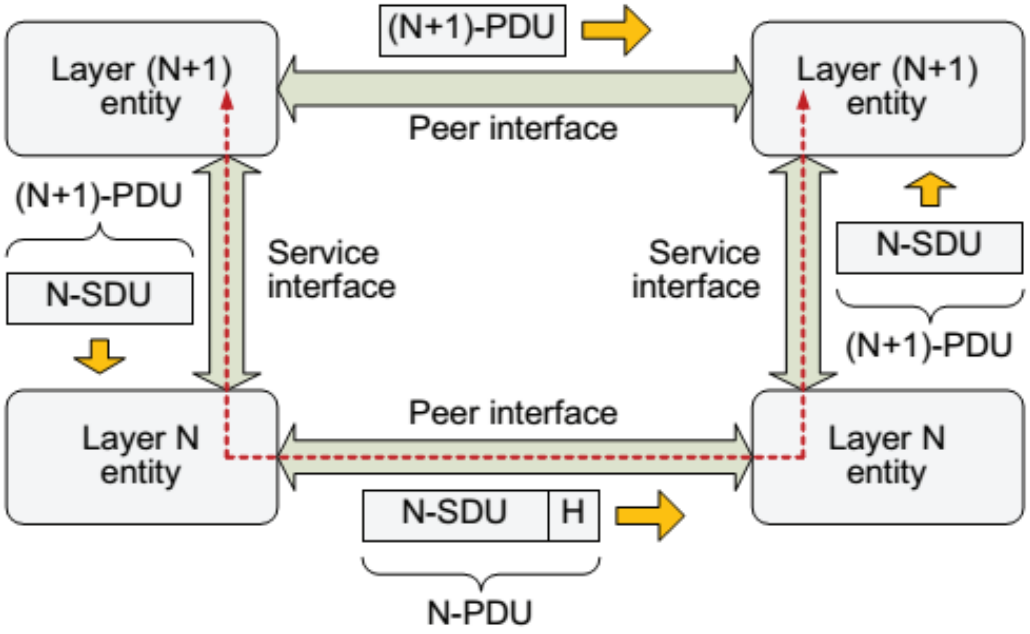
CSC 402 – Internet Technology

Recap

- Internet, intranet, and extranet
- Layering
- Standards
  - Pros and Cons
- RFC (Request For Comments)

Protocols

- In each layer, a process on one machine carries out a conversation with a peer process on the other machine across a peer interface.
- A protocol defines a set of rules, algorithms, messages, and other mechanisms that enable software and hardware in networked devices to communicate with each other



Protocols

- Processes at layer N are referred to as layer N entities
- Layer N entities communicate by exchanging **protocol data units (PDUs)**, each of which contains control information (a header) and some data
- The block of information passed between layer (N+1) and layer N entities is called a layer N **service data unit (SDU)**, which is the layer (N+1) PDU itself
- As a rule, the communication between peer entities is virtual (no direct communication link exists between them)
- The behavior of the layer N entities is specified by a set of rules called a **layer N protocol**
- Each protocol defines 2 kinds of interfaces:
  - A **service interface** to the other objects on the same machine (specifies the operations that local objects can perform)
  - A **peer interface** to its counterpart (peer) on another machine (specifies the form and meaning of messages exchanged between protocol peers to implement a communication service)

Protocols Vs Standards

Protocols

- Way of being able to “talk” to another device
- Essential for communication and authentication
- E.g. TCP/IP specifies of adressing format, no. of its used, data chunk size, etc.

Standards

- Compatibility and interoperability between devices/components from different vendors
- E.g. 802>>802.3>>802.3u for fast ethernet. If a new hardware or software is to be made they follow those specificaitons.

OSI Reference Model

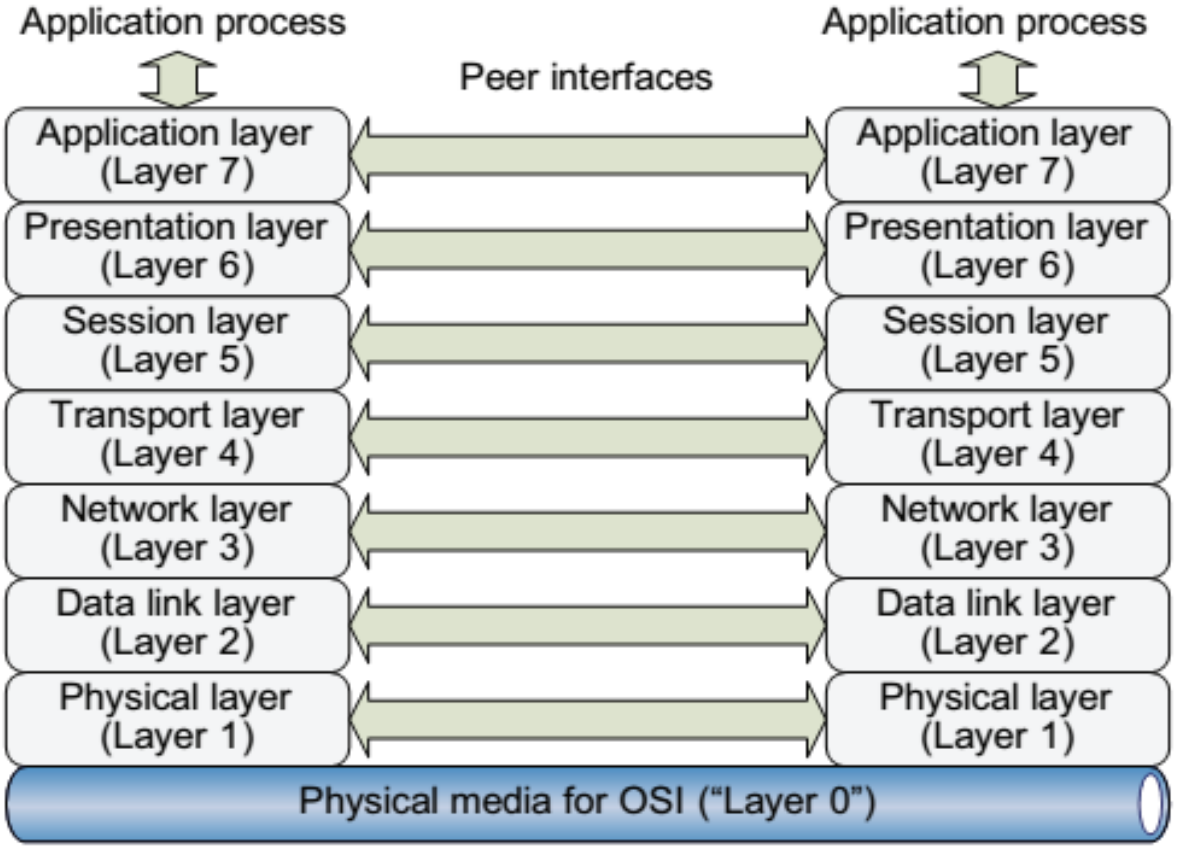
- ISO: International Standard for Organization.
- OSI: Open System Interconnection (started 1970).
- The ultimate goal of open standards is to make possible both interconnection (i.e., physical compatibility) and interoperability (i.e., logical compatibility) for equipment from different vendors.
- It promoted the idea of a common model of protocol layers, defining interoperability between network devices and software.
- **NOTE**: Do not confuse the OSI protocol suite with the OSI reference model.

OSI Reference Model

- The scope of the OSI reference model (ITU-T Rec. X.200):
  - The purpose of the OSI reference model is to provide a common basis for the coordination of standards development for the purpose of systems interconnection, while allowing existing standards to be placed into perspective within the overall reference model.
  - It is also the purpose of the OSI reference model to identify areas for developing or improving standards, and to provide a common reference for maintaining consistency of all related standards.
  - The OSI reference model **does not** specify services and protocols for OSI. OSI protocol suite specifies services and protocols.
  - It is neither an implementation specification for systems, nor a basis for evaluating the conformance of implementations.
  - Rather, the OSI reference model provides a conceptual and functional framework which allows international teams of experts to work productively and independently on the development of standards for each layer of the OSI reference model

OSI Reference Model

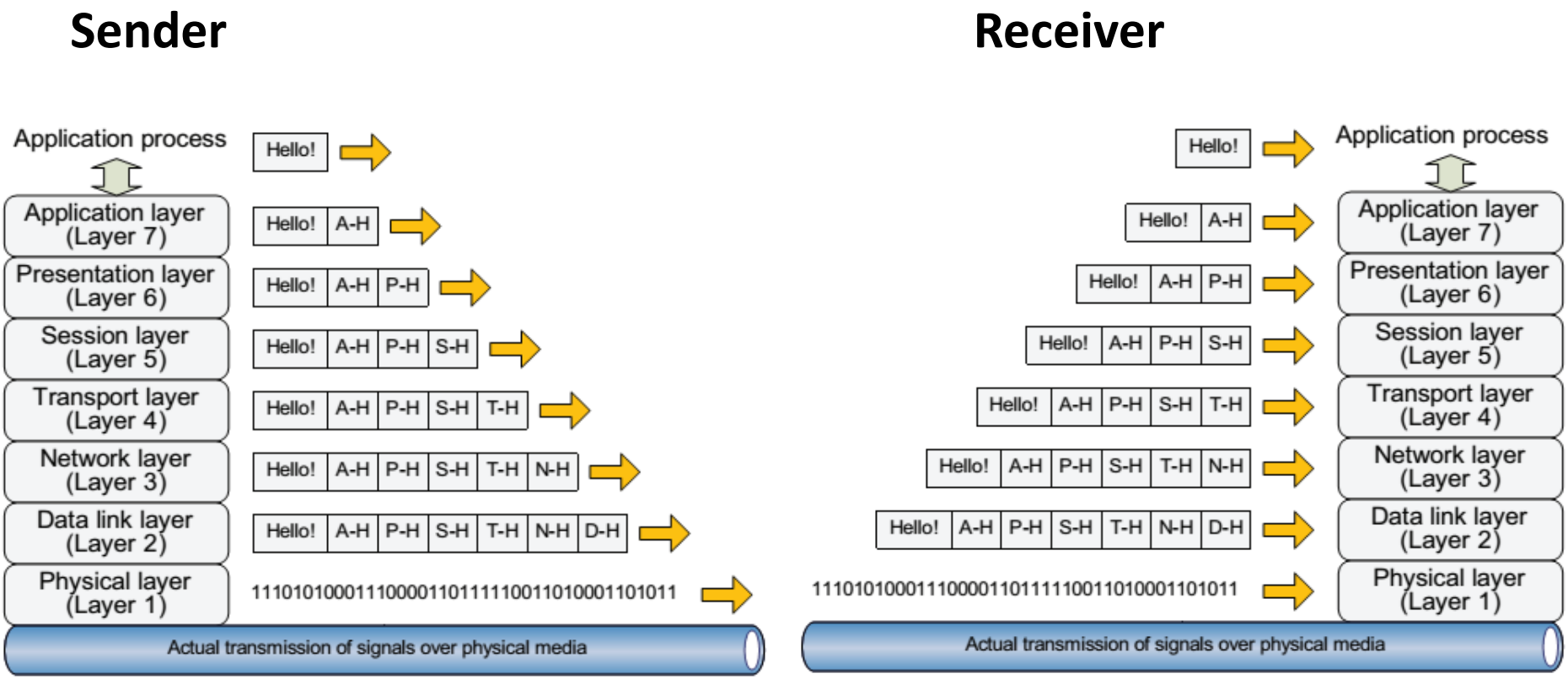
- It was decided to use seven layers , numbered 1 through 7 from bottom to top



OSI Reference Model

- The OSI layers use various forms of control information to communicate with their peer layers in other systems
- This control information consists of specific requests and instructions that are exchanged between peer OSI entities
- Control information typically takes one of two forms: headers and trailers
- Headers are pre-pended to data that has been passed down from upper layers
- Trailers are appended to that data

OSI Reference Model

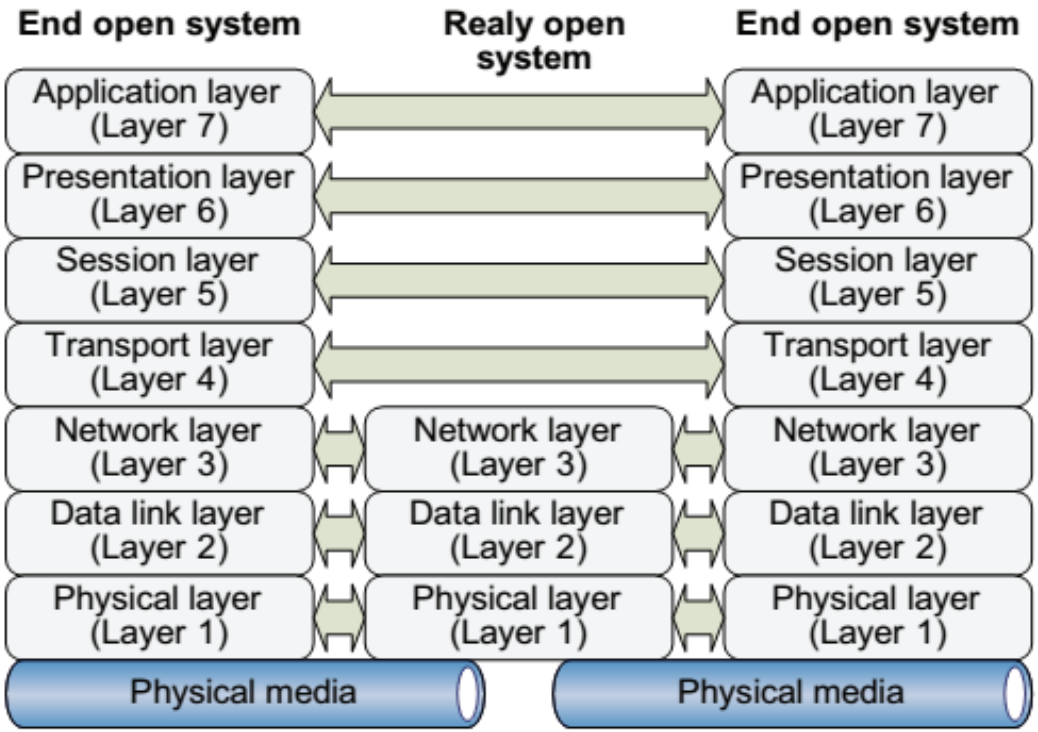


OSI Reference Model

- The highest is the application layer and it interfaces directly to and performs common application services for **application processes**
- The lower layers provide the services through which application processes on different open systems communicate
- Layers 1 to 6, together with the physical media for OSI provide a step-by-step enhancement of communication services
- Layers 2 to 7 perform encapsulation/de-capsulation
- When the physical media for OSI do not link all open systems directly, some intermediate open systems act only as **relay open systems**, passing data to other open systems
  - The functions and protocols which support the forwarding of data are then provided in the lower layers

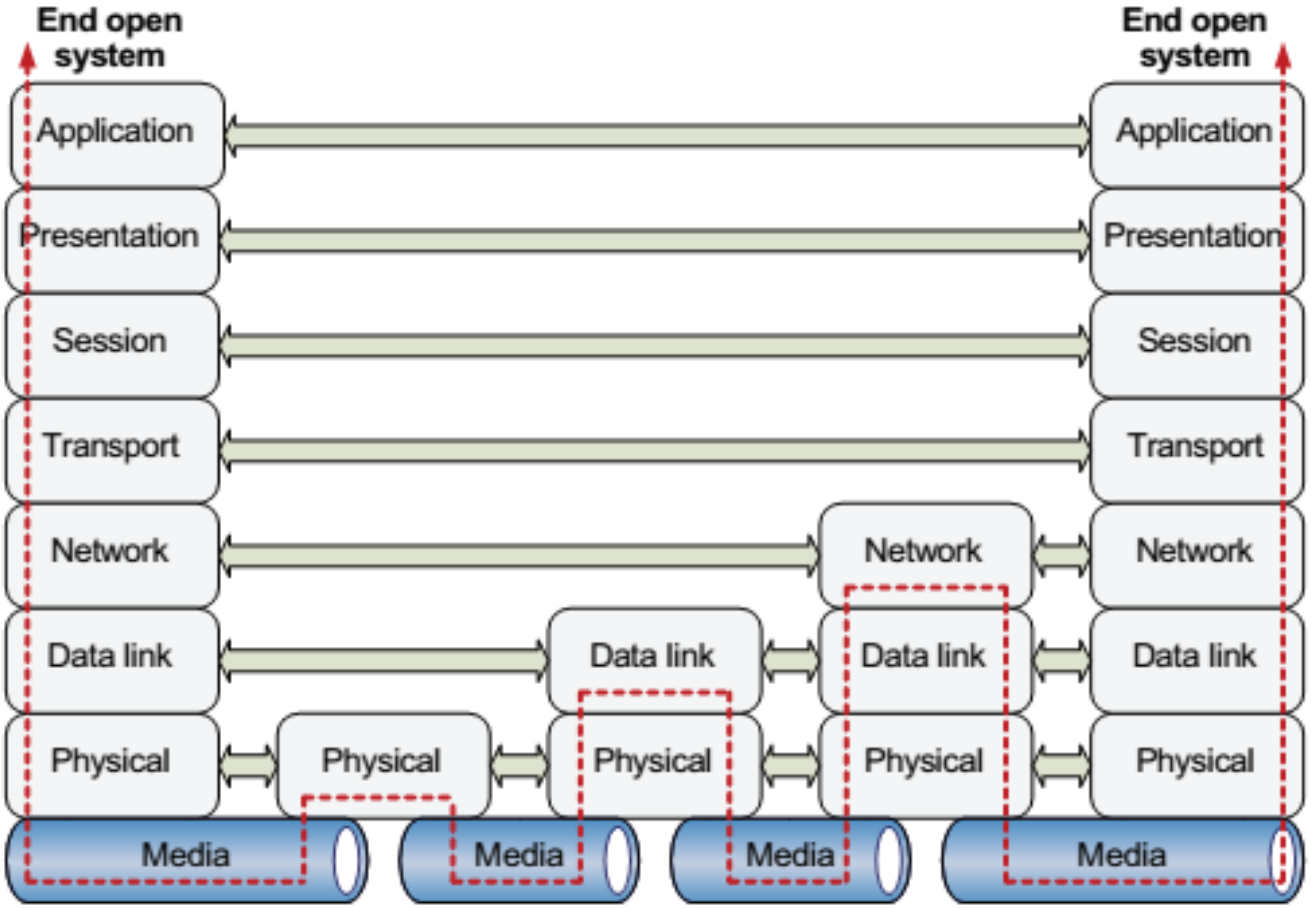
OSI Reference Model

- Communication involving single relay open system
- Layer 1-3 are chained i.e. communication is between a device and it's immediate neighbor.
- and layers 4-7 are end to end i.e. communication takes place directly between source and destination.



OSI Reference Model

- Communication involving different relay open system



Physical Layer (Layer 1)

- The physical layer provides the mechanical, electrical, functional, and procedural means to activate, maintain, and deactivate physical connections for bit transmission between data link entities
- Physical layer entities are interconnected by means of physical media
- Physical connections may be made using a variety of materials such as the following:
  - Twisted-pair cable
  - Coaxial cable
  - Fiber-optic cable
  - Wireless communications

Physical Layer (Layer 1)

- The physical layer gets PDUs from the data link layer above it and converts them into a series of signals
- These signals are sent across a transmission medium to the physical layer at the receiving end
- At the destination, the physical layer converts those signals into a series of bit values
- These values are grouped into PDUs and passed up to the data link layer

Physical Layer (Layer 1)

- Physical layer protocols specify 4 types of characteristics:
  - **Mechanical**: Physical dimensions of plugs or connectors, assignment of circuits to pins, connector latching, mounting arrangements, etc.
  - **Electrical** (or optical if an optical medium is used): Voltages or current levels, timings of signals (pulse rise times and durations), etc.
  - **Functional**: Meanings to circuits or pins like Data, Control, Timing, and Ground (alternative representations are needed with media such as fiber optics and air)
  - **Procedural**: Sequences of control and data messages to set up, use, and deactivate physical connections

Data Link Layer (Layer 2)

- The data link layer provides functional and procedural means for connectionless mode (i.e. ACK not required) of operation among network entities, and for connection-oriented mode of operation, including the establishment, maintenance, and release data link connections among network entities.
- The data link layer detects and possibly corrects errors which may occur in the physical layer.
- Data link layer protocols specify the following characteristics and mechanisms:
  - Physical (aka hardware) addressing (as opposed to logical addressing at the network layer)
  - Network topology
  - Flow control
  - Error control (recovery and/or error notification)
  - Sequencing of frames
    - A frame is a structured package for moving data that includes not only the raw data but also the sender's and receiver's physical addresses, error checking and control information

Network Layer (Layer 3)

- **The network layer** provides the functional and procedural means for connectionless mode of operation or connection-oriented mode of operation, supports transmission among transport entities and, therefore, provides to the transport entities independence of routing and relay considerations.
- Any relay functions and hop-by-hop service enhancement protocols used to support the network service between end open systems are operating below the transport layer, i.e. within the network layer or below.
- Thus, the network layer also provides for the end-to-end routing and delivery of packets through multiple networks.
- Responsible for handling congestion in the network i.e. prevent bottlenecks. QOS (e.g. Delay, jitter, etc) is also a network layer issue.

Network Layer (Layer 3)

- Network layer protocols specify the following:
  - Determining addresses or translating from physical to logical (aka network) addresses.
    - One of the functions of the network layer is, in fact, to provide capabilities needed to **communicate on an internetwork** i.e. routes are preset (static table) but can be updated automatically to avoid failed components (or devices) in the network.
  - Finding a route between the source and the destination or between two intermediate devices.
  - Establishing and maintaining a logical connection between these two nodes, to establish either a connectionless or a connection-oriented communication.
  - Fragmentation of large packets of data into fragments which are small enough to be transmitted by the underlying data link layer.

Transport Layer (Layer 4)

- Accept data from session layer and split it in to smaller units.
- It also optimizes the use of the available network service to provide the performance required by each session entity at minimum cost.
- In the OSI reference model, the transport layer is responsible for providing data transfer at an agreed-upon level of quality, such as at specified transmission speeds and error rates.
- It is released from any concern with routing and relaying since the network service provides data transfer from any transport entity to any other.
- The transport layer protocols operate only *between end systems*.
- The transport layer detects and possibly corrects errors which may occur at the lower layers.

Transport Layer (Layer 4)

- Function of Transport layer protocols:
  - Set up, maintain, and tear down a connection between two session entities.
  - Provide the reliable or unreliable delivery of data across this connection.
  - Segment data into smaller, more manageable sizes (segmentation).
  - Multiplex connections, allowing multiple application processes to send and receive data simultaneously on the same networking device.
  - Implement **flow control** and **congestion control** to ensure one component does not overflow another with too much data.

Session Layer (Layer 5)

- The session layer provides the means necessary for cooperating presentation entities to organize and to synchronize their dialogue and to manage their data exchange.
- To do this, the session layer provides services to establish a session connection between two presentation entities, to support orderly data exchange interactions, and to release the connection in an orderly manner.
- The only function of the session layer for connectionless mode of operation is to provide a mapping of transport addresses to session addresses.

Session Layer (Layer 5)

- Session layer protocols are responsible for the following:
  - Establishing, maintaining, and ending a session
    - Session might be used to log into another machine or to transfer a file. Allowing user to continue from where they left in case of a crash or recovery.
  - Dialogue control
    - When a device is contacted, the session layer is responsible for determining which device participating in the communication will transmit at a given time, as well as controlling the amount of data that can be sent in a transmission.
  - Token management
    - It is useful when both sides are not allowed to perform the same operation at the same time.
    - To schedule these operations, a token is issued only to one process at each given time, allowing only the process that holds the token to perform the critical task.

Presentation Layer (Layer 6)

- The presentation layer provides for common representation of the data transferred between application entities.
- The presentation layer ensures that the information content of the application layer data is preserved during transfer.
- The presentation layer formats data for screen display or for printing and also takes care of the job of sending the bits in the correct order.
  - As with bit order, different computers read the order of bytes in different ways (some computers read the least significant byte first; others read the most significant byte first).

Presentation Layer (Layer 6)

- Presentation layer protocols have 3 main jobs:
  - Data presentation
    - The main task of the presentation layer is the representation of data (e.g., integers, floating point numbers, or character strings)
    - As different systems may use varying internal data representations (abstract syntax), the data sent are converted to an appropriate transfer syntax and are transformed back to the receiver's internal data format upon receipt
    - **Abstract syntax** is the format of data in the application layer before it is converted to any other format by the presentation layer (e.g., Extended Binary Coded Decimal Interchange Code, EBCDIC)
    - **Transfer syntax** is the format of data after it has been converted by the presentation layer into a "common language" format (e.g., American Standard Code for Information Interchange, ASCII)

Presentation Layer (Layer 6)

- Data compression
  - **Data compression** is the reformatting of data to make it smaller.
  - This allows data to be transferred more quickly across a network.
- Data encryption
  - **Encryption** is the process of converting data into a random set of characters that is unrecognizable to everyone except the intended recipient.

Application Layer (Layer 7)

- The application layer provides the sole means for application processes to access the OSI environment.
- Hence, the application layer has no boundary with a higher layer and provides services not to other layers, but directly to application processes.
  - Application processes use application layer protocols.
  - This allows the application processes to transfer files, send E-mails, database access services, web browsing (HTTP service) etc.
- **NOTE:**
  - Contrary to what its name implies, the application layer does not include user applications, such as Microsoft Internet Explorer.
  - Instead, through application layer protocols, user applications negotiate their formatting, procedural, security, synchronization, and other requirements with the network.