The OSI Model and the TCP/IP Protocol Suite
To study

- To discuss the idea of multiple layering in data communication and networking and the interrelationship between layers.
- To discuss the OSI model and its layer architecture and to show the interface between the layers.
- To briefly discuss the functions of each layer in the OSI model.
- To introduce the TCP/IP protocol suite and compare its layers with the ones in the OSI model.
- To show the functionality of each layer in the TCP/IP protocol with some examples.
- To discuss the addressing mechanism used in some layers of the TCP/IP protocol suite for the delivery of a message from the source to the destination.
What is a protocol

A protocol is required when two entities need to communicate. When communication is not simple, we may divide the complex task of communication into several layers. In this case, we may need several protocols, one for each layer.

Let us use a scenario in communication in which the role of protocol layering may be better understood. We use two examples. In the first example, communication is so simple that it can occur in only one layer.
Example

Assume I and Student are with a lot of common ideas. However, I speaks only MARATHI, and Student speaks only TELUGU. Since both have learned the sign language, we talk. Communication is face to face and Happens in one layer as shown in Figure.
Example - Figure

Layer 1

Marathi

I

signs

Student

Telugu

Layer 1
Example
Now assume that I have to move to another town. But I have two small machines. The first machine can scan and transform a letter in MARATHI to a secret code or vice versa. The other machine can scan and translate a letter in TELUGU to the same secret code or vice versa.
Example
Established in 1947, the *International Standards Organization (ISO)* is a multinational body dedicated to worldwide agreement on international standards. Almost three-fourths of countries in the world are represented in the ISO. An ISO standard that covers all aspects of network communications is the *Open Systems Interconnection (OSI)* model. It was first introduced in the late 1970s.
Note

ISO is the organization; OSI is the model.
The OSI model

Layer 7: Application
Layer 6: Presentation
Layer 5: Session
Layer 4: Transport
Layer 3: Network
Layer 2: Data link
Layer 1: Physical
OSI Layer

Layer-to-layer communication:
- 7th layer: Application
  - 7-6 interface: Application
- 6th layer: Presentation
  - 6-5 interface: Presentation
- 5th layer: Session
  - 5-4 interface: Session
- 4th layer: Transport
  - 4-3 interface: Transport
- 3rd layer: Network
  - 3-2 interface: Network
- 2nd layer: Data link
  - 2-1 interface: Data link
- 1st layer: Physical
  - 1-2 interface: Physical

Device A
Intermediate node
Intermediate node
Device B

Physical communication
OSI Model
The physical layer is responsible for moving individual bits from one (node) to the next.
# Summary of OSI Layers

<table>
<thead>
<tr>
<th>Layer</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application</td>
<td>To allow access to network resources</td>
</tr>
<tr>
<td>Presentation</td>
<td>To translate, encrypt, and compress data</td>
</tr>
<tr>
<td>Session</td>
<td>To establish, manage, and terminate sessions</td>
</tr>
<tr>
<td>Transport</td>
<td>To provide reliable process-to-process message delivery and error recovery</td>
</tr>
<tr>
<td>Network</td>
<td>To move packets from source to destination; to provide internetworking</td>
</tr>
<tr>
<td>Data link</td>
<td>To organize bits into frames; to provide hop-to-hop delivery</td>
</tr>
<tr>
<td>Physical</td>
<td>To transmit bits over a medium; to provide mechanical and electrical specifications</td>
</tr>
</tbody>
</table>
TCP/IP protocol suite was developed prior to the OSI model. Therefore, the layers in the TCP/IP protocol suite do not match exactly with those in the OSI model. The original TCP/IP protocol suite was defined as four software layers built upon the hardware. Today, however, TCP/IP is thought of as a five-layer model with the layers named similarly to the ones in the OSI model.
The **Internet Protocol Suite** (commonly known as **TCP/IP**), also known as **TCP / IP PROTOCOL**, is the set of communications protocols used for the Internet and other similar networks.

It is named from two of the most important protocols in it:

- the Transmission Control Protocol (TCP)
- the Internet Protocol (IP), which were the first two networking protocols defined in this standard.
TCP/IP Layers

- Application
- Transport
- Internet
- Network Interface
  - Hardware Devices
    - Original layers
TCP/IP and OSI model

Application

Presentation

Session

Transport

Network

Data link

Physical

OSI Model

TCP/IP Protocol Suite

Application

Transport

Network

Data link

Physical

Several application protocols

Several transport protocols

Internet Protocol and some helping protocols

Underlying LAN and WAN technology
A private internet
Communication at the physical layer

Legend

- Source
- Destination

Physical layer

A

Link 1

R1

Link 3

R3

Link 5

R4

Link 6

B

Physical layer

Legend

- Source
- Destination

Physical layer

A

Link 1

R1

Link 3

R3

Link 5

R4

Link 6

B

Physical layer

Legend

- Source
- Destination

Physical layer

A

Link 1

R1

Link 3

R3

Link 5

R4

Link 6

B

Physical layer

Legend

- Source
- Destination
The unit of communication at the physical layer is a bit.
Communication at the data link layer
The unit of communication at the data link layer is a frame.
Communication at the network layer
The unit of communication at the network layer is a datagram / packet.
Communication at transport layer

Legend

○ Source  ● Destination  D Data  H Header

A
Transport
Network
Data link
Physical

B
Transport
Network
Data link
Physical

R1  R3  R4

D4 H4
Segment

Link 1

A

Link 2

R1

Link 3

Link 4

R2

Link 5

Link 6

B

D4 H4
Segment
The unit of communication at the transport layer is a segment, user datagram, or a packet, depending on the specific protocol used in this layer.
Communication at application layer

Legend:
- Source
- Destination
- D Data
- H Header

Application
Transport
Network
Data link
Physical

Message: D5 D5

Link 1

Link 2

Link 3

Link 4

Link 5

Link 6

Message: D5 D5
The unit of communication at the application layer is a message/Data.
Four levels of addresses are used in an internet employing the TCP/IP protocols: physical address, logical address, port address, and application-specific address. Each address is related to a one layer in the TCP/IP architecture, as shown in Figure
Addresses in the TCP/IP protocol suite

- Message: Application layer
  - Application-Specific addresses
- Segment: Transport layer
  - Port addresses
- Datagram: Network layer
  - Logical addresses
- Frame: Data link layer
  - Physical addresses
- Bits:
As shown in figure a node with physical address 10 sends a frame to a node with physical address 87. The two nodes are connected by a link (a LAN). At the data link layer, this frame contains physical (link) addresses in the header. These are the only addresses needed. The rest of the header contains other information needed at this level. As the figure shows, the computer with physical address 10 is the sender, and the computer with physical address 87 is the receiver. The data link layer at the sender receives data from an upper layer. It encapsulates the data in a frame. The frame is propagated through the LAN. Each station with a physical address other than 87 drops the frame because the destination address in the frame does not match its own physical address. The intended destination computer, however, finds a match between the destination address in the frame and its own physical address.
Example: physical addresses

Data

Sender 10

87 10 Data

LAN

Source address

Destination address

Frame

10 28 53

Sender 28

packet discarded

2

3

Receiver 87

packet accepted

87 10 Data

Pritee Parwekar ANITS
Next Figure shows a part of an internet with two routers connecting three LANs. Each device (computer or router) has a pair of addresses (logical and physical) for each connection. In this case, each computer is connected to only one link and therefore has only one pair of addresses. Each router, however, is connected to three networks. So each router has three pairs of addresses, one for each connection. The computer with logical address A and physical address 10 needs to send a packet to the computer with logical address P and physical address 95. We use letters to show the logical addresses and numbers for physical addresses, but note that both are actually numbers.
Example *logical addresses*

Sender

A/10

LAN 1

20 10 AP Data

20 10 AP Data

Router 1

T/99

Physical addresses changed

Data A P20 10

To another network

F/20

Router 2

33 99 AP Data

Z/66

To another network

P/95

Receiver

LAN 3

Physical addresses changed

95 66 AP Data

95 66 AP Data

LAN 2

33 99 AP Data

N/33
The physical addresses will change from hop to hop, but the logical addresses remain the same.
Figure shows two computers communicating via the Internet. The sending computer is running three processes at this time with port addresses a, b, and c. The receiving computer is running two processes at this time with port addresses j and k. Process a in the sending computer needs to communicate with process j in the receiving computer. Note that although both computers are using the same application, FTP, for example, the port addresses are different because one is a client program and the other is a server program.
Example port numbers
The physical addresses change from hop to hop, but the logical and port addresses usually remain the same.
## OSI Layers summary

<table>
<thead>
<tr>
<th>OSI Model</th>
<th>Data unit</th>
<th>Layer</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Host layers</td>
<td>Data</td>
<td>7. <strong>Application</strong></td>
<td>Network process to application</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6. <strong>Presentation</strong></td>
<td>Data representation, encryption and decryption</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5. <strong>Session</strong></td>
<td>Interhost communication</td>
</tr>
<tr>
<td></td>
<td>Segments</td>
<td>4. <strong>Transport</strong></td>
<td>End-to-end connections and reliability, Flow control</td>
</tr>
<tr>
<td>Media layers</td>
<td>Packet</td>
<td>3. <strong>Network</strong></td>
<td>Path determination and <strong>logical addressing</strong></td>
</tr>
<tr>
<td></td>
<td>Frame</td>
<td>2. <strong>Data Link</strong></td>
<td>Physical addressing</td>
</tr>
<tr>
<td></td>
<td>Bit</td>
<td>1. <strong>Physical</strong></td>
<td>Media, signal and binary transmission</td>
</tr>
</tbody>
</table>
## OSI & TCP/IP

<table>
<thead>
<tr>
<th>OSI</th>
<th>TCP / IP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application (Layer 7)</td>
<td>Application</td>
</tr>
<tr>
<td>Presentation (Layer 6)</td>
<td></td>
</tr>
<tr>
<td>Session (Layer 5)</td>
<td>Transport</td>
</tr>
<tr>
<td>Transport (Layer 4)</td>
<td>Internet</td>
</tr>
<tr>
<td>Network (Layer 3)</td>
<td>Subnet</td>
</tr>
<tr>
<td>Data Link (Layer 2)</td>
<td></td>
</tr>
<tr>
<td>Physical (Layer 1)</td>
<td></td>
</tr>
</tbody>
</table>
## TCP/IP Layers

<table>
<thead>
<tr>
<th>OSI</th>
<th>TCP/IP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Application Layer</td>
<td>Application Layer</td>
</tr>
<tr>
<td>Presentation Layer</td>
<td>TELNET, FTP, SMTP, POP3, SNMP, NNTP, DNS, NIS, NFS, HTTP, ...</td>
</tr>
<tr>
<td>Session Layer</td>
<td>Transport Layer</td>
</tr>
<tr>
<td>Transport Layer</td>
<td>TCP, UDP, ...</td>
</tr>
<tr>
<td>Network Layer</td>
<td>Internet Layer</td>
</tr>
<tr>
<td>Data Link Layer</td>
<td>IP, ICMP, ARP, RARP, ...</td>
</tr>
<tr>
<td>Physical Layer</td>
<td>Link Layer</td>
</tr>
<tr>
<td></td>
<td>FDDI, Ethernet, ISDN, X.25, ...</td>
</tr>
</tbody>
</table>
OSI

- It has 7 layers
- Transport layer guarantees delivery of packets
- Horizontal approach
- Presentation layer
- Separate session layer
- Network layer provides both connectionless and connection oriented services
- It defines the services, interfaces and protocols very clearly and makes a clear distinction between them
- The protocol are better hidden and can be easily replaced as the technology changes
- OSI truly is a general model
- It has a problem of protocol filtering into a model
TCP/IP

- Has 4 layers
- Transport layer does not guarantees delivery of packets
- Vertical approach
- No session layer, characteristics are provided by transport layer
- No presentation layer, characteristics are provided by application layer
- Network layer provides only connection less services
- It does not clearly distinguishes between service interface and protocols
- It is not easy to replace the protocols
- TCP/IP can not be used for any other application
- The model does not fit any protocol stack.