Chapter 5

Introduction to Open System Interconnection Reference Model
Understanding The OSI Model

• Networking before Open Systems Interconnect (OSI)

• 1984, Networking with the OSI model
  – International Organization for Standardization (ISO)
  – Seven-layer network model
  – Used as a reference model
  – An ideal tool for learning how networks function
Reasons For Layering

• Layered networking model is advantageous because
  – Divides networking into less complex components
  – Enables programmers to specialize in a particular level
  – Allows upgrades to a specific layer without effecting other layers
  – Encourages interoperability
  – Allows for standardized interfaces
Reasons For Layering (continued)

Figure 1-1  OSI reference model
Peer OSI Communication

• Each layer will only communicate with its peer level
• Each layer is unaware of the activities of all other layers
• Each layer provide services to the layer above
• Each layer receive services from the layer below
• Each layer has its own method of data organization as it passes the data to the layer below
  – Data stream
  – Data encapsulation
Peer OSI Communication (continued)

Figure 1-2  Peer communication
Layered Functions

• OSI model was developed as an industry standard
• Used when developing network hardware and software
• Ensures complete compatibility
• OSI model vs. TCP/IP model
Physical (Layer 1)

- Physical layer has the following responsibilities
  - Defines the physical characteristics of network hardware
    - Cable
    - Connectors
    - Interfaces
  - Representation of binary encoding as voltages
  - Transmission of the signal on the medium
Physical (Layer 1) (continued)

- Physical layer defines the mechanical, electrical, and procedural events
- Transmission Medium
  - Cable/wire
  - Radio waves
  - Infrared
  - Fiber/glass
- Physical layer devices
  - Network card (also Data Link layer)
  - Hubs
  - Repeaters
  - Transceivers
  - Connectors
  - Wall Jacks
Physical (Layer 1) (continued)

- Encoding schemes
  - Manchester encoding method

- Considerations when choosing cable
  - Expense
  - Physical location
  - Distance
  - Security requirements
  - Transmission speed requirements
Physical (Layer 1) (continued)

![Diagram of wall jack and modular plug with color codes]

**Figure 1-3** 568B twisted-pair wiring scheme

<table>
<thead>
<tr>
<th>Color code option 1</th>
<th>Color code option 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 white/orange</td>
<td>1 black</td>
</tr>
<tr>
<td>2 orange</td>
<td>2 yellow</td>
</tr>
<tr>
<td>3 white/green</td>
<td>3 blue</td>
</tr>
<tr>
<td>4 blue</td>
<td>4 red</td>
</tr>
<tr>
<td>5 white/blue</td>
<td>5 green</td>
</tr>
<tr>
<td>6 green</td>
<td>6 orange</td>
</tr>
<tr>
<td>7 white/brown</td>
<td>7 brown</td>
</tr>
<tr>
<td>8 brown</td>
<td>8 slate</td>
</tr>
</tbody>
</table>
Data Link (Layer 2)

Layer 2 of the OSI model provides the following functions:

• Allows a device to access the network to send and receive messages
• Offers a physical address so a device’s data can be sent on the network
• Works with a device’s networking software when sending and receiving messages
• Provides error-detection capability
Data Link (Layer 2) (continued)

- Data Link sublayers
  - Logical Link Control (LLC) layer
    - Defines how data is packaged (frames)
    - Provides the linking function between the Physical Layer and the higher layers
  - Media Access Control (MAC) layer
    - Media access method
    - Provides a unique identifier for the NIC (Physical address)
Data Link (Layer 2) (continued)

Figure 1-4  Data Link layer subdivision
Data Link (Layer 2) (continued)

Network interface card (NIC)

MAC address
00-00-00-21-43-77

Figure 1-5 MAC address
Network (Layer 3)

• Network layer has the following responsibilities
  – Software/logical addressing
    • Depends on Network layer protocol
  – Defines how data is packaged (Packets)
  – Routes data and provides connectivity
  – Best path selection

• IP, IPX
Transport (Layer 4)

Some of the functions offered by the transport layer include:
• Application identification
• Client-side entity identification
• Confirmation that the entire message arrived intact
• Segmentation of data for network transport
• Control of data flow to prevent memory overruns
• Establishment and maintenance of both ends of virtual circuits
• Transmission-error detection
• Realignment of segmented data in the correct order on the receiving side
• Multiplexing or sharing of multiple sessions over a single physical link

The most common transport layer protocols are the connection-oriented TCP transmission Control Protocol (TCP) and the connectionless UDP User Datagram Protocol (UDP).
Session (Layer 5)

Session layer functionality includes:

• Virtual connection between application entities
• Synchronization of data flow
• Creation of dialog units
• Connection parameter negotiations
• Partitioning of services into functional groups
• Acknowledgements of data received during a session
• Ability to interrupt and recover as session
• Retransmission of data if it is not received by a device
Presentation (Layer 6)

- Presentation has the following responsibilities
  - Data translation
  - Data formatting
  - Data syntax restructuring
  - Data encryption
  - Data compression
- BMP, WAV, JPEG, MIDI, HTML, ASCII
Application (Layer 7)

• Application has the following responsibilities
  – Initiate request for network services
  – Provides network services to applications such as e-mail and Web browsers

• Protocols and utilities
  – Telnet
  – FTP
  – DNS
  – SMTP
  – SNMP
Data Encapsulation

• Protocol data unit (PDU)
• Headers and trailers
• OSI encapsulation
  – Data stream
  – Segments
  – Packets
  – Frames
  – Bits
Data Encapsulation (continued)

Figure 1-6  Encapsulation
## Data Encapsulation (continued)

### Table 1-1  Five steps of data encapsulation

<table>
<thead>
<tr>
<th>Step Number</th>
<th>Event</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Data conversion</td>
<td>When the application generates a message to be sent out on the network, the data is converted into a standard data format. This occurs at OSI layers 5, 6, and 7, which are also known as the “upper layers.”</td>
</tr>
<tr>
<td>2</td>
<td>Segmentation header added</td>
<td>The Transport layer segments the data into maximum transmission units (MTUs) to ensure that hosts on both ends can communicate.</td>
</tr>
<tr>
<td>3</td>
<td>Packet creation with network header</td>
<td>Data is placed into a data packet or datagram, and a network header with logical addressing information is added. This occurs at layer 3, the Network layer.</td>
</tr>
<tr>
<td>4</td>
<td>Frame header and trailer for network link</td>
<td>The data frame is prepared for the type of network protocol that is in use. A frame header (including the source and destination MAC addresses) and trailer are added at the Data Link layer.</td>
</tr>
<tr>
<td>5</td>
<td>Bit transmission</td>
<td>The frame is sent across the wire as bits at the Physical layer; ones and zeros are encoded and transmitted along the physical network as pulses.</td>
</tr>
</tbody>
</table>
Summary

• Two or more computers connected by media form a network.
• Computers can use a network to share resources such as printers, disk space, and applications.
• Before computers were networked, file transfers were usually conducted by users physically walking copies of data (on floppy disk or other magnetic media) to another computer, a system called “sneakernet.”
• The earliest networks had no standardization, so interoperability between the various proprietary network implementations was rare.
• The ISO developed the OSI model in the mid-1980s to standardize networking models.
Summary (continued)

• Data transmission can be connection-oriented or connectionless
• Connection-oriented transmission requires that packets be acknowledged as received
• Connectionless transmission does not require acknowledgments
• The OSI networking model has seven layers, which simplify the networking model by dividing it into less complex components
• This layering allows engineers to specialize in specific layers, and the modularity allows them to upgrade components at one layer without affecting other layers
Summary (continued)

• The layered model also encourages interoperability among the various networking vendors by providing them with a standard architecture

• The Physical layer, the first and lowest layer of the OSI model, handles the physical transmission of data across the network

• The Data Link layer, the second layer of the OSI model, interacts with the networking hardware by controlling the link and supporting communications with the network interface; this layer also interacts with the MAC address
Summary (continued)

• The Network layer, the third layer of the OSI model, supports logical addressing and routing of data packets.
• The Transport layer, the fourth layer, segments and optimizes data that is to be sent out on the network.
• The Session layer, the fifth layer, establishes and maintains connections between computers during data transfers.
• The Presentation layer, the sixth layer, handles data translation, encryption, and formatting for transmission on the network or for interpretation by the Application layer.
• The Application layer, the seventh and highest layer, handles the interface between the network and the user.
Summary (continued)

• When the network user sends data to the network, it goes through a five-step data encapsulation process

• This process takes place as the data packet travels down the OSI protocol stack