OSI Model, Network Devices, and Network Standards

TELECOMMUNICATIONS AND NETWORKING

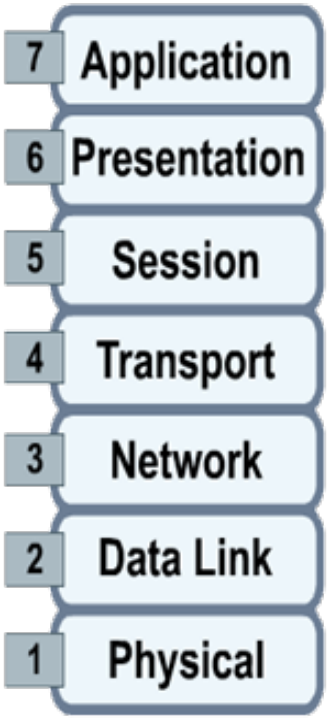
The OSI Model

1. **Open Systems Interconnection (OSI)**
2. Reference model
3. Industry standard framework
4. Breaks the network process into seven manageable layers

   Defined by the **ISO (International Organization Standardization)**

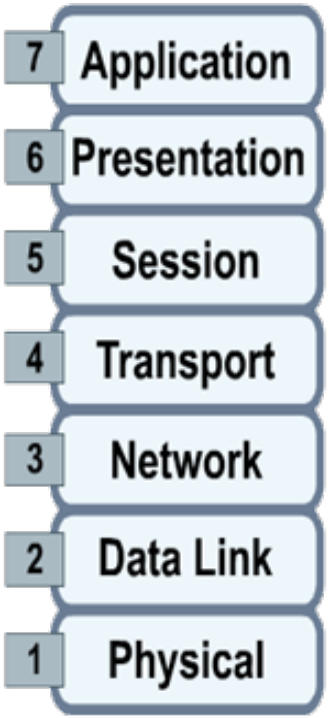
1. Used universally for teaching and understanding network functionality
2. Achieve greater compatibility and interoperability
3. Follow for:
   - Designing
   - Building
   - Upgrading
   - Troubleshooting

Reasons for using the OSI Model



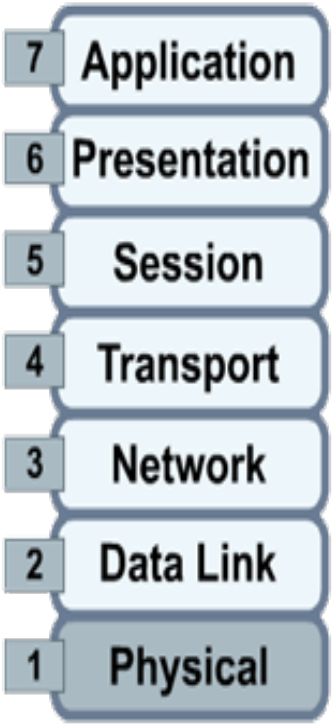
1. Divides the aspects of network operation into less complex elements
2. Standardizes interfaces and enables engineers to specialize design/development efforts on specific functions
3. Facilitates modular engineering and prevents changes in one area from affecting other areas
4. Ensures interoperability and allows network designers to choose the right networking devices
5. Accelerates evolution and helps with testing and troubleshooting the network

The 7 layers of the OSI Model



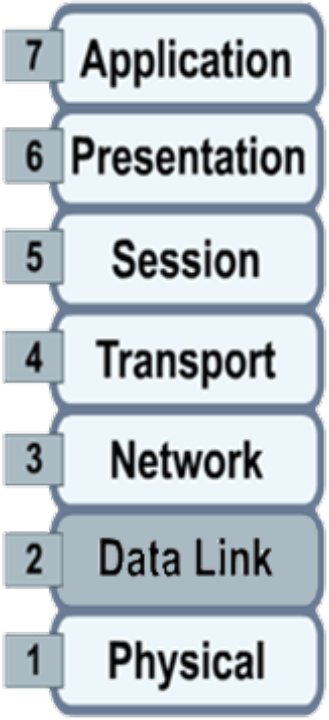
1. Always in the same order
2. Layer 1 on the bottom
3. Layer only communicate with the layer directly above or below it
4. All traffic must enter and exit through layer 1
5. Mnemonic device:
   - **P**lease **D**o **N**ot **T**hrow **S**ausage **P**izza **A**way

Physical Layer - Layer 1



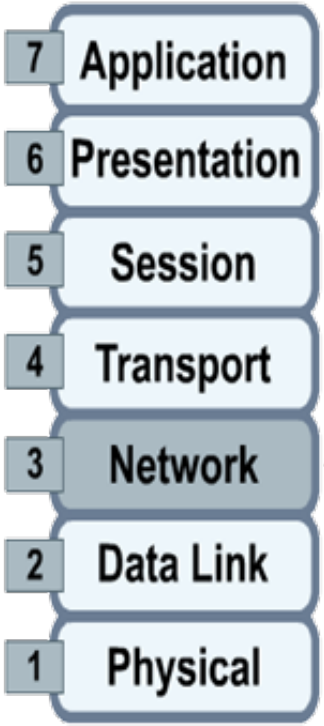
1. Keywords – bits or media
2. Converts information into bits
3. Uses twisted pair, fiber-optic, coaxial, or wireless
4. Provides the electrical, mechanical, procedural, and functional means for activating and maintaining whatever physical link exists between hosts
5. Repeaters, hubs, and transceivers
6. Common troubleshooting layer

Data Link Layer - Layer 2



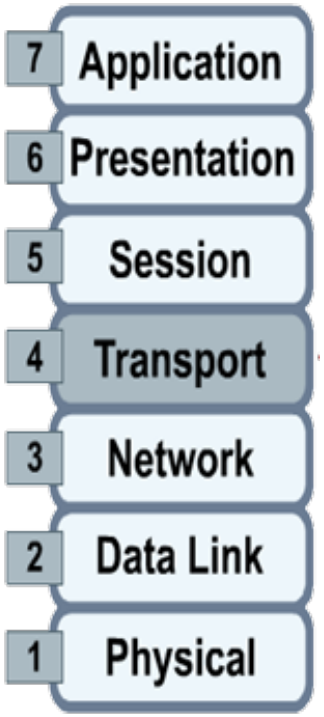
1. Keywords – MAC and LLC
2. Speed of transmission
3. Flow Control
4. Error Identification
5. Physical Topology
6. Bridges and Switches
7. **Media Access Control**
8. **MAC** addresses or **Physical** address
9. Written in hexadecimal

Network Layer - Layer 3



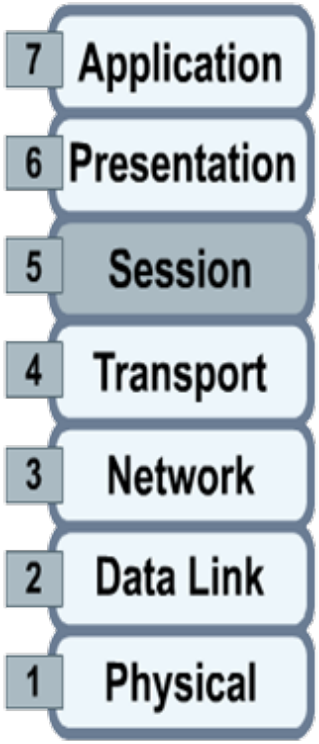
1. Keyword - IP
2. Deals with higher-level addressing schemes (IP) and path determination
3. Logical Topology
4. Indicates to which network and subnetwork a computer belongs
5. Routers

Transport Layer - Layer 4



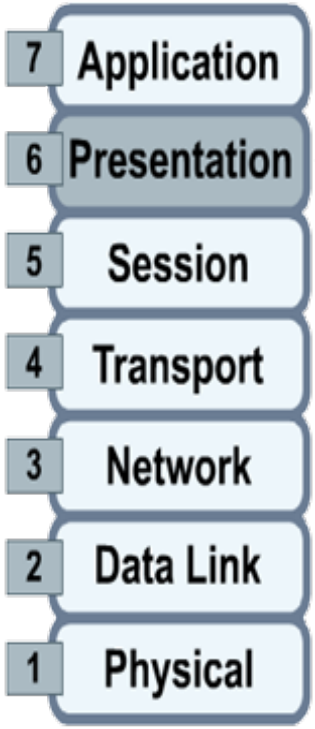
1. Keyword – Reliability
2. Responsible for segmenting data
3. Regulates the flow of information
4. Responsible for delivery of data between two hosts
5. TCP and UDP
6. Sequence numbers
7. Acknowledgements
8. Windowing

Session Layer - Layer 5



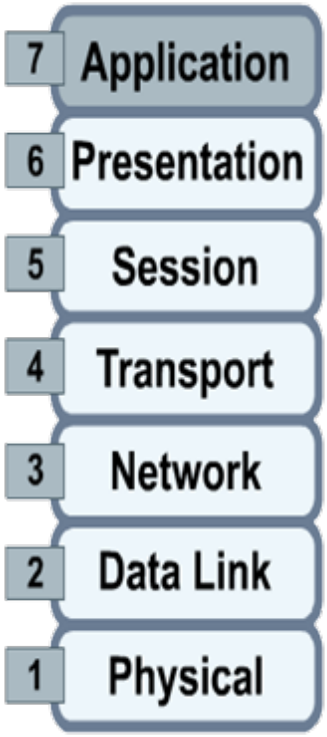
1. Keyword – communication
2. Establishes, maintains, and manages conversations called sessions
3. Dialog control
4. Provides services to the presentation layer

Presentation Layer - Layer 6



1. Keyword – syntax
2. Facilitates communication between applications on diverse computer systems to occur in such a way that it is transparent to the applications.
3. Data Formatting:
   - Encryption / De-encryption
   - Compression / De-compression
   - Syntax

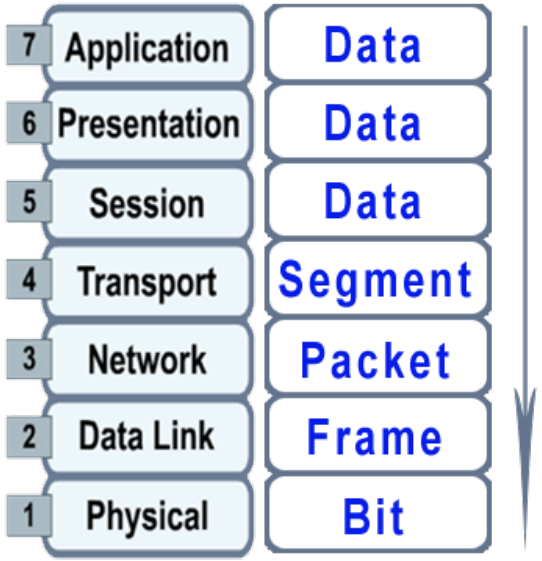
Application Layer - Layer 7



1. Keyword - WWW
2. Closest to the end user
3. Does not provide services to any other layer
4. Provides services to applications used by the end user:
   - Telnet
   - FTP
   - HTTP
   - Work processing programs
   - Spreadsheet programs
   - E-mail

Encapsulation

1. Process of placing one message format into another format so that the message can be delivered
2. Receives headers, footers, and other information
3. Five step process:
   - Data
   - Segments
   - Packets
   - Frames
   - Bits



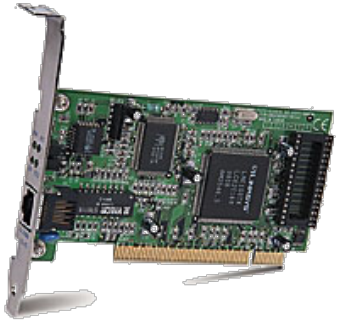
Networking Devices

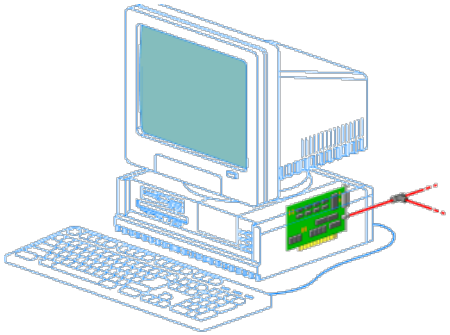
Layer 1 Networking Devices

1. Repeater
2. Hub
3. Modem
4. Transceiver
5. Provide no security options

Network Interface Card (NIC) – Layer 2

1. Plugs into a motherboard
2. Provides ports for the network cable connections
3. Computer's interface with the LAN
4. Considerations:
   - The type of network
   - The type of media
   - The type of system bus
5. It is common to find the network connected to USB





Bridges and Switches – Layer 2

1. Make intelligent decisions
2. **Bridge**
3. **Switch** (multi-port bridge)
   - Vital part of today's LANs.
   - Stop collisions
   - Main functions:
     - Make intelligent decisions based on a computers MAC address (layer 2)
     - Used to connect network segments
     - Break collision domains
     - Interconnect switches to a high speed backbone

Routers – Layer 3

1. Slower than bridges and switches
2. Make "smart" decisions:
3. How to route (or send) packets
4. Interconnects networks
5. Blocks broadcasts
6. Path determination
7. Commonly perform DHCP and NAT services

Firewalls – Layer 4

1. Software or hardware
2. Protects networks
3. Blocks incoming packets
4. Makes intelligent decisions based on:
   - Port number
   - Protocol

Networking Standards

IEEE 802 Standards

- 802.1: High-level interface
- 802.2: Logical link control
- 802.3: CSMA/CD (Ethernet)
- 802.4: Token Bus
- 802.5: Token Ring
- 802.6: MANs
- 802.7: Broadband LANs
- 802.8: Fiber-optic LANs
- 802.9: Integrated data and voice networks
- 802.10: Security
- 802.11: Wireless networks

Ethernet

1. Most popular type of LAN architecture
2. Based on the IEEE 802.3 standard
3. **Carrier Sense Multiple Access with Collision Detection** (CSMA/CD)
4. Used by:
   - Wired
   - Wireless
   - Satellites
5. Directly connect one NIC card to the other with a **crossover cable**

Ethernet Networking

1. Advantages:
   - Fastest home-networking technology
   - Inexpensive
   - Reliable
   - Easy to maintain
   - Scalable
   - Technical support
2. Disadvantages:
   - Additional equipment needed
   - Expensive to wire
   - Set-up and configuration can be difficult
   - Technical jargon

Ethernet Variations, Distinguished by Speed

1. 10-Mbps Ethernet
2. 100-Mbps Ethernet or Fast Ethernet
3. 1000-Mbps or Gigabit Ethernet
4. 10 gigabit Ethernet
5. 40 Gb Ethernet

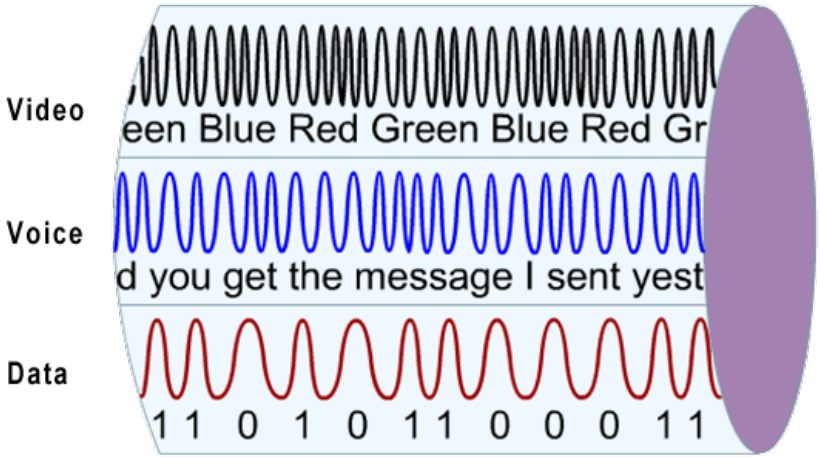
Connection Types

Dial-up

1. Uses the public switched telephone network (PSTN) or plain old telephone systems (POTS)
2. Establish connection to an Internet service provider (ISP) via telephone lines
3. Uses modems to encode and decode packets
4. Maximum transfer speed of 56 Kbps

Broadband

Describes a type of data transmission in which a single medium (fiber or copper wire) can carry several channels at once



DSL

1. Broadband connection
2. Brings data over the telephone line
3. An “Always On” technology
4. Cabling may be copper or fiber
5. Modem reads and splits out the data signal
6. Must use splitters on each telephone to separate out the voice signal
7. May use either:
   - **Asymmetric** (ADSL)
   - **Symmetric** (SDSL)

Cable

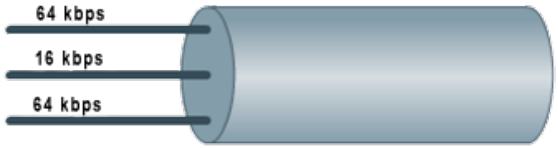
1. Broadband connection
2. Uses cable television infrastructure
3. Fastest connection speed available
4. Requires a cable modem at the customer's premises connected via coaxial cable
5. Shared technology
6. Download speeds are generally twice as fast as upload speeds
7. Uses F connectors and RG-6 cable

Satellite

1. Provided through geostationary satellites
2. Relies on four primary components:
   - A satellite in geosynchronous orbit
   - A number of ground stations (gateways) that relay the Internet signal to and from the satellite via microwaves
   - A dish antenna located at the subscriber's home or business
   - A modem at the user end that translates the signal

ISDN (Integrated Services Digital Network)

1. Digital service over existing telephone wire
2. Advanced Telephone Service
3. WAN Technology
4. Solves low bandwidth problems
5. Faster than phone, slower than DSL
6. Expensive



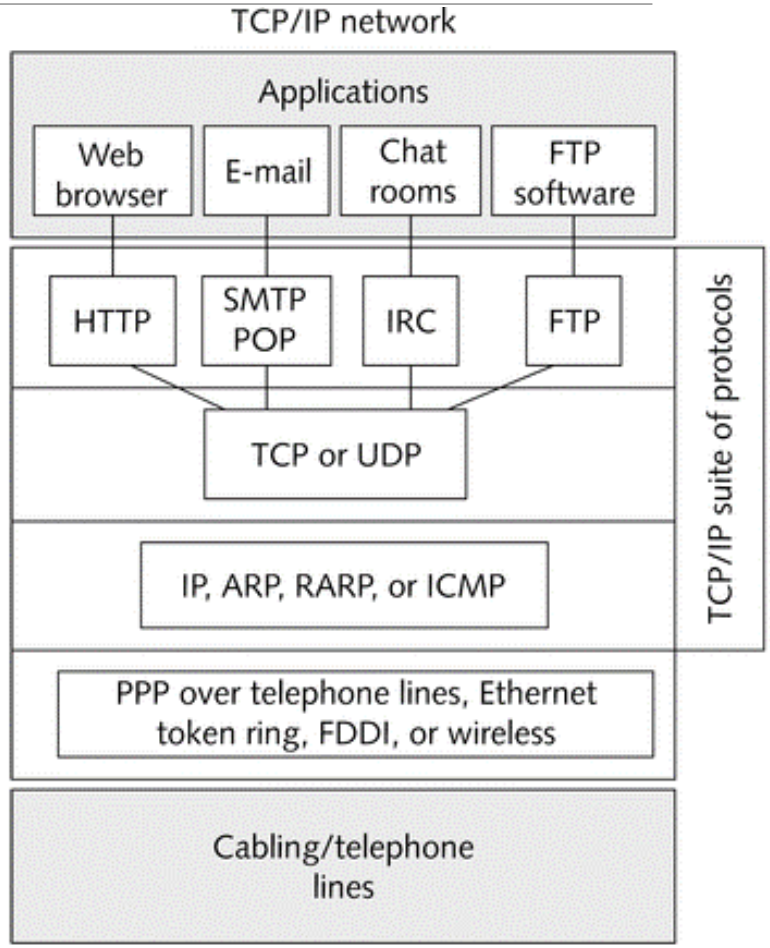
Cellular

1. Also known as **Mobile broadband**
2. Tethering
3. Supports voice, data, and video
   Devices include:
   - PC cards
   - Mobile broadband modems
   - Portable devices with built-in support for mobile broadband,
4. Internet access subscriptions are usually sold separately

TCP/IP Protocol and Utilities

TCP/IP Protocol Suite

1. A collection of protocols
2. Used to exchange information on the Internet
3. Works at layer 3, 4, & 6



TCP/IP Utilities

1. **Ping**
   - Command-line utility
   - Works by sending an ICMP echo request
   - Receiving computer then sends back an ICMP echo reply message
2. **Tracert**
   - Command-line utility
   - Displays a packets route

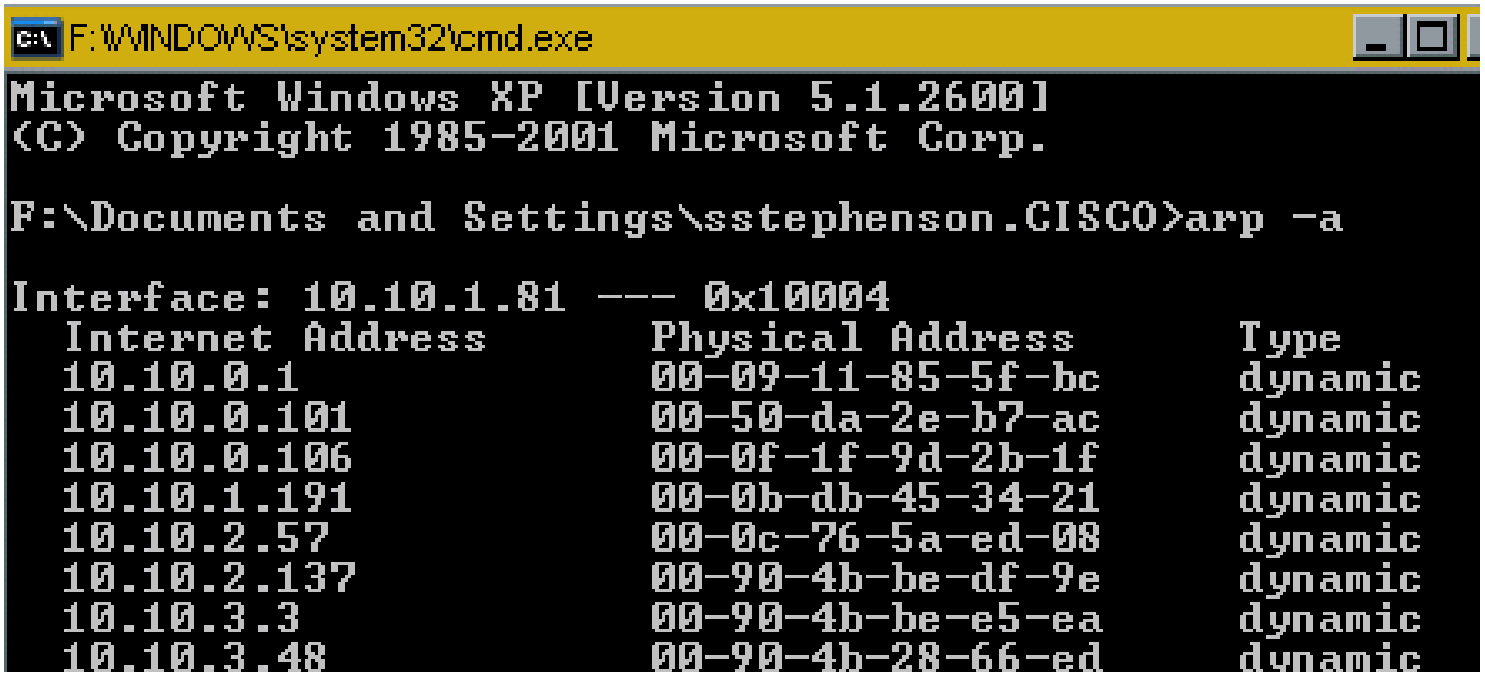
TCP/IP Utilities

Address Resolution Protocol (ARP)

1. Map Internet Protocol (IP) addresses to physical hardware (MAC) addresses
2. The ARP cache

TCP/IP Utilities

1. `arp -a`
2. `arp -d`



TCP/IP Utilities

Reverse Address Resolution Protocol (RARP)

1. Used to obtain IP address information based on the physical or MAC address

TCP/IP Utilities

Displayed using different utilities, depending on the operating system:

1. **`ipconfig`** – Windows NT, 2000, XP, 7, and 8 (command-line)
2. **`winipcfg`** –- Windows 95, 98, and 2000 (graphical interface)
3. **`ifconfig`** – UNIX and Linux (command-line)
4. **`config`** – NetWare (server console)

Utilities and Applications

1. **Telnet**
2. **Nbtstat**
3. **Netstat**
4. **Route**