

Objectives

- Identify organizations that set standards for networking
- Describe the purpose of the OSI Model and each of its layers
- Explain specific functions belonging to each OSI Model layer

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Objectives (continued)

- Understand how two network nodes communicate through the OSI model
- Discuss the structure and purpose of data packets and frames
- Describe the two types of addressing covered by the OSI Model

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Networking Standards Organizations

- Standards: documented agreements containing technical specifications or other precise criteria stipulating how particular products or services should be designed or performed
 - Define minimum acceptable performance
- Many different organizations have evolved to oversee computer industry's standards

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ANSI

- American National Standards Institute (ANSI)
 - Composed of more than a thousand representatives from industry and government
 - Represents United States in setting international standards
- ANSI standards documents available:
 - ANSI's Web site (www.ansi.org)
 - At university or public libraries

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EIA and TIA

- Electronic Industries Alliance (EIA): Trade organization composed of representatives from electronics manufacturing firms across US
 - Sets standards for its members
 - Helps write ANSI standards
 - Lobbies for legislation favorable to growth of computer and electronics industries
- Telecommunications Industry Association (TIA): Focuses on standards for information technology (IT), wireless, satellite, fiber optics, and telephone equipment

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IEEE

- Institute of Electrical and Electronics Engineers
- International society composed of engineering professionals
- Goals are to promote development and education in electrical engineering and computer science
- IEEE technical papers and standards are highly respected in the networking profession
 - Can purchase IEEE documents online from IEEE's Web site (www.ieee.org)

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ISO

- International Organization for Standardization
- Collection of organization standards representing 146 countries
- Goal is to establish international technological standards to facilitate global exchange of information and barrier-free trade
- Fewer than 300 of ISO's more than 14,250 standards apply to computer-related products and functions

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ITU

- International Telecommunication Union
- Regulates international telecommunications:
 - Radio and TV frequencies
 - Satellite and telephony specifications
 - Networking infrastructure
 - Tariffs applied to global communications
- Typically, documents pertain more to global telecommunications issues than to industry technical specifications

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ISOC

- Internet Society
- Professional membership society that helps to establish technical standards for the Internet
- Oversees groups with specific missions:
 - Internet Architecture Board (IAB): Technical advisory group of researchers and professionals
 - Interested in overseeing Internet's design and management
 - Internet Engineering Task Force (IETF): Sets standards for how systems communicate over the Internet
 - How protocols operate and interact

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IANA and ICANN

- Internet Protocol (IP) addresses: Addresses used to identify computers on the Internet and other TCP/IP-based networks
- Internet Assigned Numbers Authority (IANA): Used to keep records of available and reserved IP addresses and determines how addresses were doled out
 - In 1997, coordinated efforts with three Regional Internet Registries (RIRs)
 - Not-for-profit agency that manages distribution of IP addresses to private and public entities

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IANA and ICANN (continued)

- In late 1990s U.S. Department of Commerce (DOC) overhauled IP addressing and domain name management
- Internet Corporation for Assigned Names and Numbers (ICANN): Ultimately responsible for IP addressing and domain name management
 - IANA still performs system administration
- Individuals and businesses lease addresses from Internet Service Provider (ISP)
 - Business providing access to Internet and other services

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The OSI Model

- Open Systems Interconnection (OSI) Model: divides network communications into seven layers:
 - Physical, Data Link, Network, Transport, Session, Presentation, and Application
- Protocols perform services unique to layer
- Protocols interact with protocols in layers directly above and below
- Protocol: set of instructions to perform a function or group of functions
 - Written by a programmer

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The OSI Model (continued)

- Theoretical representation of what happens between two nodes communicating on a network
 - Does not prescribe type of hardware or software that should support each layer
 - Does not describe how software programs interact with other software programs or how software programs interact with humans
- Each layer communicates with same layer from one computer to another
- Model is imperfect

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The OSI Model (continued)

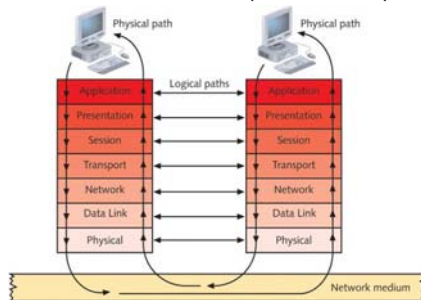


Figure 2-1: Flow of data through the OSI Model

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Application Layer

- Services facilitate communication between software and lower-layer network services
 - Helps software applications negotiate formatting, procedural, security, synchronization, and other requirements with network
- Hypertext Transfer Protocol (HTTP): formats and sends requests from client's browser to server
 - Also formats and sends Web server's response back to client's browser
- Application program interface (API): set of routines that make up part of a software application

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Presentation Layer

- Protocols accept Application layer data and format it
 - So that one type of application and host can understand data from another type of application and host
 - e.g., translation and conversion between graphics file types
- Manages data encryption and decryption

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Session Layer

- Protocols coordinate and maintain communications between two network nodes
 - Establish and maintain communications link for duration of session
 - Keep communication secure
 - Synchronize dialogue between two nodes
 - Determine if communications have been cut off
 - Determine where to restart transmission
 - Terminate communications

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Session Layer (continued)

- Sets terms of communication
 - Decides which node will communicate first
 - Decides how long a node can communicate
- Monitors identification of session participants
 - Ensures that only authorized nodes have access

Transport Layer

- Protocols accept data from Session layer and manage end-to-end delivery of data
 - Ensure data transferred reliably, in correct sequence, and without errors
- Protocols also handle flow control
 - Gauging appropriate rate of transmission based on how fast recipient can accept data
- Transmission Control Protocol (TCP): Takes care of reliably transmitting HTTP requests from client to server and vice versa

Transport Layer (continued)

- Connection-oriented protocols: ensure that data arrives exactly as it was sent
 - Establish connection before transmitting data
 - TCP is connection-oriented
 - Client's TCP protocol first sends synchronization (SYN) packet request to server
 - Server responds with synchronization-acknowledgment (SYN-ACK) packet
 - Client responds with own acknowledgment (ACK)

Transport Layer (continued)

- Acknowledgments also used to ensure that data was properly delivered
 - For every data unit sent, connection-oriented protocol expects acknowledgment from recipient
 - If no acknowledgment, data retransmitted
- Connection-oriented protocols use a checksum
 - Unique character string allowing receiving node to determine if arriving data unit exactly matches data unit sent by source

Transport Layer (continued)

- Connectionless protocols do not establish connection before transmitting
 - No effort to ensure data delivered error-free
- Transport layer protocols break large data units received from Session layer into smaller segments (segmentation)
- Maximum transmission unit (MTU): largest data unit a given network will carry

Transport Layer (continued)

- Reassembly: process of reconstructing segmented data units
- Sequencing: method of identifying segments that belong to same group of subdivided data
 - Indicates where unit of data begins
 - Indicates order in which groups of data were issued
 - Transport layer protocols of two nodes must synchronize timing and agree on starting point for the transmission

Data Link Layer (continued)

- Error checking accomplished by 4-byte Frame Check Sequence (FCS) field
 - Ensures data at destination exactly matches data issued from source
 - When source node transmits data, performs Cyclic Redundancy Check (CRC) to get FCS
 - Destination node's Data Link layer services unscramble FCS via same CRC algorithm
- Data Link layer divided into two sub-layers:
 - Logical Link Control
 - Media Access Control

Data Link Layer (continued)

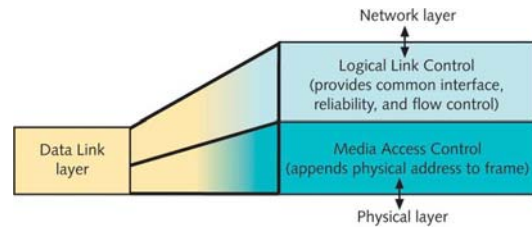


Figure 2-5: The Data Link layer and its sublayers

Data Link Layer (continued)

- Logical Link Control (LLC) sublayer:
 - Provides interface to Network layer protocols
 - Manages flow control
 - Issues requests for transmission for data that has suffered errors
- Media Access Control (MAC) sublayer:
 - Manages access to physical layer
 - Appends destination computer's physical address onto data frame (MAC address, Data Link layer address, or hardware address)

Data Link Layer (continued)



Figure 2-6: A NIC's MAC address

Data Link Layer (continued)

- MAC addresses contain two parts:
 - Block ID: six-character sequence unique to vendor
 - Device ID: six-character sequence based on NIC's model and manufacture date

Physical Layer

- Protocols accept frames from Data Link layer and generate voltage to transmit signals
- When receiving data, protocols detect voltage and accept signals
- Protocols also set data transmission rate and monitor data error rates
 - Cannot perform error correction
- NICs operate at both Physical layer and Data Link layer
- Network administrators mostly concerned with bottom four layers of OSI Model

Applying the OSI Model

OSI Model Layer	Function
Application (Layer 7)	Provides interface between software applications and network for interpreting applications' requests and requirements
Presentation (Layer 6)	Allows hosts and applications to use a common language; performs data formatting, encryption, and compression
Session (Layer 5)	Establishes, maintains, and terminates user connections
Transport (Layer 4)	Ensures accurate delivery of data through flow control, segmentation and reassembly, error correction, and acknowledgment
Network (Layer 3)	Establishes network connections; translates network addresses into their physical counterparts and determines routing
Data Link (Layer 2)	Packages data in frames appropriate to network transmission method
Physical (Layer 1)	Manages signaling to and from physical network connections

Table 2-1: Functions of the OSI layers

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Communication Between Two Systems

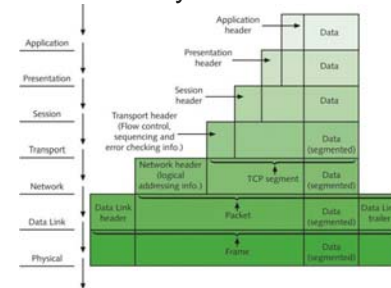


Figure 2-7: Data transformation through the OSI Model

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Frame Specifications

- The two major categories of frame types:
 - Ethernet
 - Four types of Ethernet frames
 - Most popular form characterized by unique way in which devices share a common transmission channel (described in IEEE 802.3 standard)
 - Token Ring: relies on direct links between nodes and a ring topology
 - Nodes pass around tokens (control frames that indicate to network when a node is about to transmit data)

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IEEE Networking Specifications

- Apply to connectivity, networking media, error checking algorithms, encryption, emerging technologies, and more
- Specifications fall under IEEE's "Project 802"
 - Effort to standardize physical and logical elements of a network

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IEEE Networking Specifications (continued)

Standard	Name	Topic
802.1	Internetworking	Routing, bridging, and network-to-network communications
802.2	Logical Link Control	Error and flow control over data frames
802.3	Ethernet LAN	All forms of Ethernet media and interfaces
802.4	Token Bus LAN	All forms of Token Bus media and interfaces
802.5	Token Ring LAN	All forms of Token Ring media and interfaces
802.6	Metropolitan Area Network (MAN)	MAN technologies, addressing, and services
802.7	Broadband Technical Advisory Group	Broadband networking media, interfaces, and other equipment
802.8	Fiber Optic Technical Advisory Group	Fiber optic media used in token-passing networks like FDDI
802.9	Integrated Voice/Data Networks	Integration of voice and data traffic over a single network medium

Table 2-2: IEEE 802 standards

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IEEE Networking Specifications (continued)

Standard	Name	Topic
802.10	Network Security	Network access controls, encryption, certification, and other security topics
802.11	Wireless Networks	Standards for wireless networking for many different broadcast frequencies and usage techniques
802.12	High-Speed Networking	A variety of 100 Mbps-plus technologies, including 100BASE-VG
802.14	Cable broadband LANs and MANs	Standards for designing networks over coaxial cable-based broadband connections
802.15	Wireless Personal Area Networks	The coexistence of wireless personal area networks with other wireless devices in unlicensed frequency bands
802.16	Broadband Wireless Access	The atmospheric interface and related functions associated with Wireless Local Loop (WLL)

Table 2-2 (continued): IEEE 802 standards

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Summary

- Standards are documented agreements containing precise criteria that are used as guidelines to ensure that materials, products, processes, and services suit their purpose
- ISO's OSI Model divides networking architecture into seven layers
- Each OSI layer has its own set of functions and interacts with the layers directly above and below it
- Application layer protocols enable software to negotiate their formatting, procedural, security, and synchronization with the network

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Summary (continued)

- Presentation layer protocols serve as translators between the application and the network
- Session layer protocols coordinate and maintain links between two devices for the duration of their communication
- Transport layer protocols oversee end-to-end data delivery
- Network layer protocols manage logical addressing and determine routes based on addressing, patterns of usage, and availability

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Summary (continued)

- Data Link layer protocols organize data they receive from the Network layer into frames that contain error checking routines and can then be transmitted by the Physical layer
- Physical layer protocols generate and detect voltage to transmit and receive signals carrying data over a network medium
- Data frames are small blocks of data with control, addressing, and handling information attached to them

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