CALIFORNIA STATE UNIVERSITY
LONG BEACH
College of Engineering

CECS 303: Networks and Network Security

Course Introduction

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Lecture 1

Course Information

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College of Engineering

- CECS 303
  - Networks and Network Security – 3.0 units
- Class meeting schedule
  - TuTH 5:00PM to 7:15PM
  - Lecture Room: VEC 402
  - Lab Room: ECS 413
- Class communication
  - chris.samayoa@csulb.edu
  - Cell: 562-706-2196
- Office hours
  - Thursdays 4pm-5pm
  - Other times by appointment only

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 layer of the OSI model
- Review how network nodes communicate through the OSI model
- Describe the two types of addressing covered by the OSI model

Networking Standards Organizations

- Standard
  - Documented agreement
  - Technical specifications/precise criteria
  - Stipulates design/performance of particular product or service
- Use of standards in networking
  - Applicable to wide variety of hardware and software
  - Ensures network design compatibility
- Standards define minimum acceptable performance
  - Not ideal performance

Networking Standards Organizations (cont'd)

- Various organizations set and oversee computer industry standards
- Examples: ANSI and IEEE set wireless standards
  - ANSI standards apply to type of NIC
  - IEEE standards involve communications protocols (https://standards.ieee.org/standard/802_11-2016.html)
- Why is this important?
  - Network professionals must be familiar with these groups settings network standards
  - Important to understand critical aspects of standards to properly design and maintain compatible networks

ANSI

- ANSI (American National Standards Institute
  - 1000+ representatives from industry and government
  - Determines standards for electronics industry and other fields
- Requests voluntary compliance with standards
- Obtaining ANSI approval requires rigorous testing
- ANSI standards documents available online

TIA

- TIA (Telecommunications Industry Association)
  - EIA (Electronics Industry Association – decommissioned in 2011) subgroup
- Focus of TIA
  - Standards for information technology, wireless, satellite, fiber optics, and telephone equipment
- TIA/EIA 568-B Series
  - Guidelines for installing network cable in commercial buildings

IEEE

- IEEE (Institute of Electrical and Electronics Engineers)
  - International society of engineering professionals
- Goal
  - Promote development and education in electrical engineering and computer science fields
- Hosts various gatherings (conferences, chapter meetings, etc.)
- Maintains a standards board
- IEEE technical papers and standards

IEEE – Networking Specifications

- IEEE's Project 802
  - Effort to standardize physical and logical network elements
    - Frame types and addressing
    - Connectivity
    - Networking media
    - Error-checking algorithms
    - Encryption
    - Emerging technologies
- 802.3: Ethernet
- 802.11: Wireless

IEEE – Network Standards

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Standard	Name	Topic
802.1	Bridging and Management	Routing, bridging, and network-to-network communications
802.2	Logical Link Control	Error and flow control over data frames
802.3	Ethernet	All forms of Ethernet media and interfaces
802.5	Token Ring LAN	All forms of token ring media and interfaces
802.11	Wireless LANs	Standards for wireless networking for many different broadcast frequencies and usage techniques
802.15	Wireless PANs	The coexistence of wireless personal area networks with other wireless devices in unlicensed frequency bands
802.16	Broadband Wireless MANs	The atmospheric interface and related functions associated with broadband wireless connectivity; also known as WiMAX
802.17	Resilient Packet Rings	Access method, physical layer specifications, and management of shared packet-based transmission on resilient rings (such as SONET)
802.20	Mobile Broadband Wireless Access	Packet handling and other specifications for multivendor, mobile high-speed wireless transmission, nicknamed "mobile WiMAX"
802.22	Wireless Regional Area Networks	Wireless, broadcast-style network to operate in the UHF/VHF frequency bands formerly used for TV channels

Image: Course Technology / Cengage learning

ISO

- ISO (International Organization for Standardization)
  - Headquartered in Geneva, Switzerland
  - Collection of standards organizations
    - Represents 167 countries (https://www.iso.org/members.html)
- Goal
  - Establish international technological standards to facilitate global information exchange and barrier free trade
- Organization has broad authority
- ISO 27001 (https://www.iso.org/isoiec-27001-information-security.html)

ITU

- ITU (International Telecommunication Union)
  - Specialized United Nations agency
  - Regulates international telecommunications
  - Provides developing countries with technical expertise and equipment
  - Founded in 1865; joined United Nations in 1947
  - Members from 193 countries
- Goals
  - Global telecommunications issues
  - Worldwide Internet services implementation

ISOC

- ISOC (Internet Society)
  - Founded in 1992
  - Professional membership society
  - Establishes technical Internet standards
- Ongoing ISOC concerns
  - Rapid Internet growth
  - Keeping Internet accessible
  - Information security
  - Open standards

ISOC (cont'd)

- ISOC oversight
  - IAB (Internet Architecture Board)
    - Technical advisory group
    - Oversees Internet's design and management
  - IETF (Internet Engineering Task Force)
    - Sets Internet system communication standards
    - Particularly protocol operation and interaction
    - Anyone may submit standard proposal
    - Elaborate review, testing, and approval processes

IANA and ICANN

- IP (Internet Protocol) address
  - Address identifying computers in TCP/IP based (Internet) networks
  - Reliance on centralized management authorities
- History
  - Initially: IANA (Internet Assigned Numbers Authority)
  - 1997: Three RIRs (Regional Internet Registries)
    - ARIN (American Registry for Internet Numbers)
    - APNIC (Asia Pacific Network Information Centre)
    - RIPE (Réseaux IP Européens)

IANA and ICANN (cont'd)

- History (cont'd)
  - Late 1990s: ICANN (Internet Corporation for Assigned Names and Numbers)
    - Private nonprofit corporation
    - Remains responsible for IP addressing and domain name management (DNS)
    - IANA performs system administration
- ISPs (Internet Service Providers) are responsible for distributing IP addresses to users and businesses

OSI Model

- Model for understanding and developing network host-to-host communications
- Developed by ISO in the 1980s
  - Best looked at as a conceptual model at this point
- Divides network communications into seven layers
  - Physical, Data Link, Network, Transport, Session, Presentation, Application

OSI Model (cont'd)

- Protocol interaction
  - Stacked approach – interact with layers directly above and below
- Application layer protocols
  - Interact with software
- Physical layer protocols
  - Cables and connectors
- Theoretical representation describing network communication between two nodes

OSI Model (cont'd)

- Hardware and software independent
- Every network communication process represented
- PDUs (protocol data units)
  - Discrete amount of data
  - Application layer function
  - Flow through layers 6, 5, 4, 3, 2, and 1
- Generalized model and often does not apply perfectly to real world networking protocols

OSI Model - Data Flow

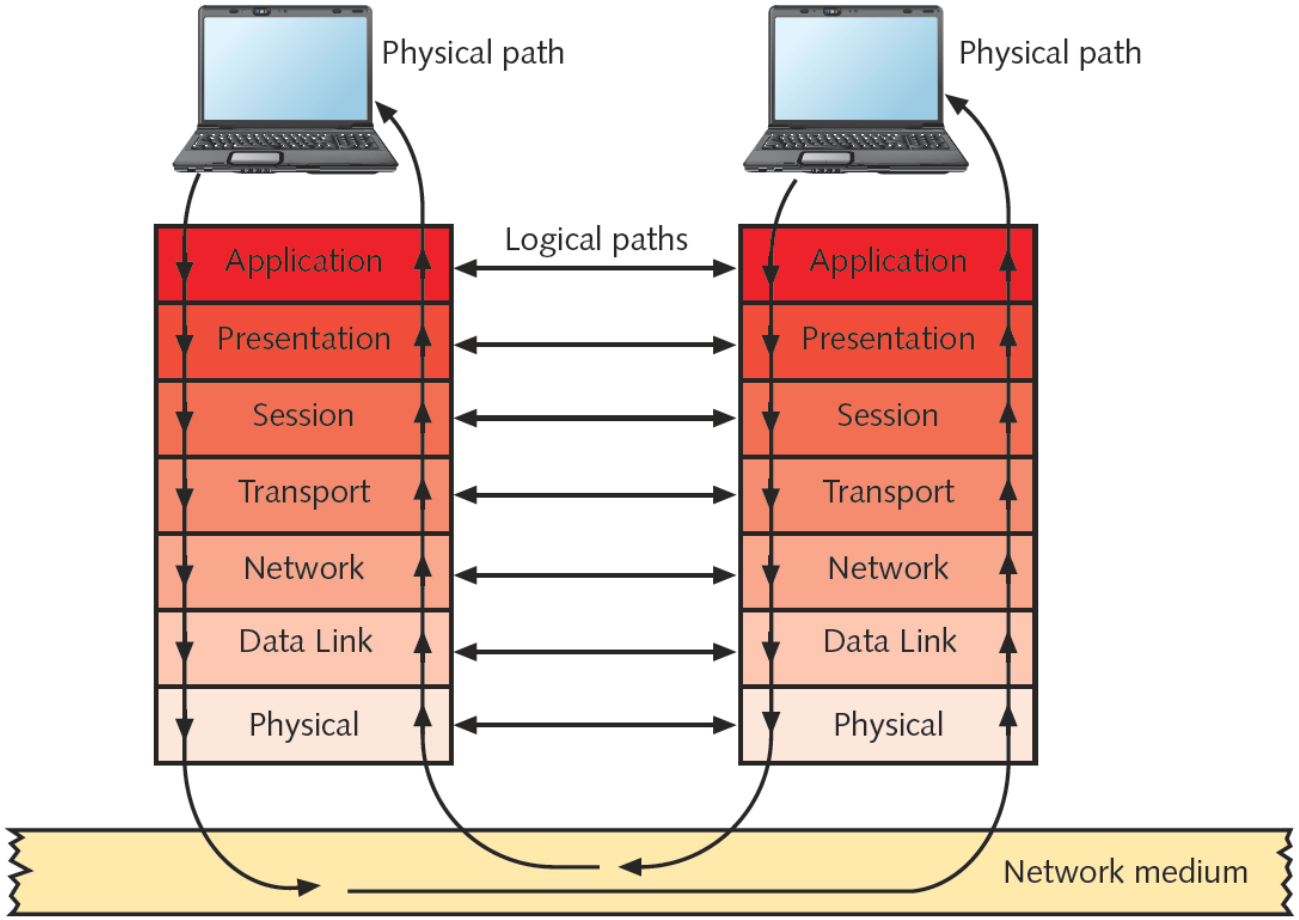


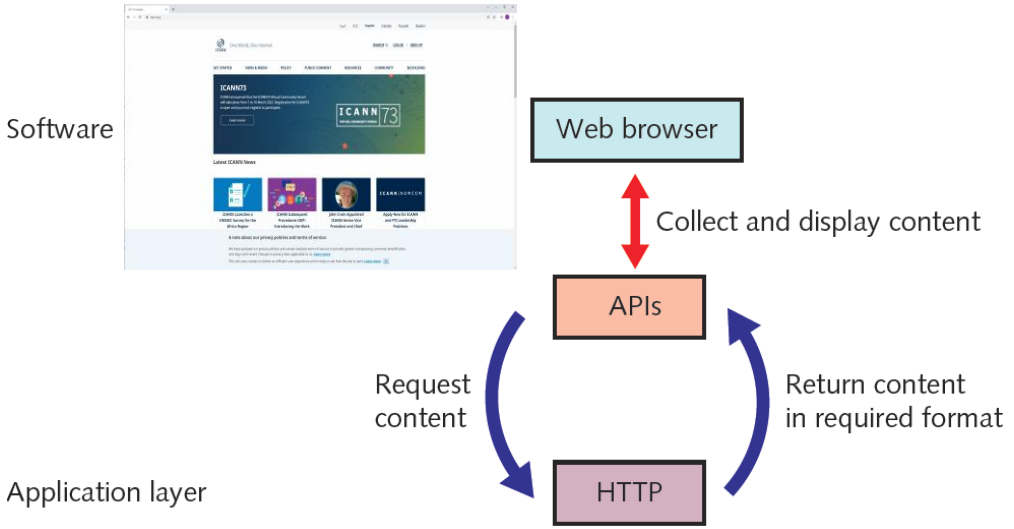
Image: Course Technology/Cengage Learning

Application Layer

- Top (seventh) OSI model layer
- Does not include software applications
- Protocol functions
  - Facilitates communication between software applications and lower-layer network services
  - Network interprets application request
  - Application interprets data sent from network

Application Layer (cont'd)

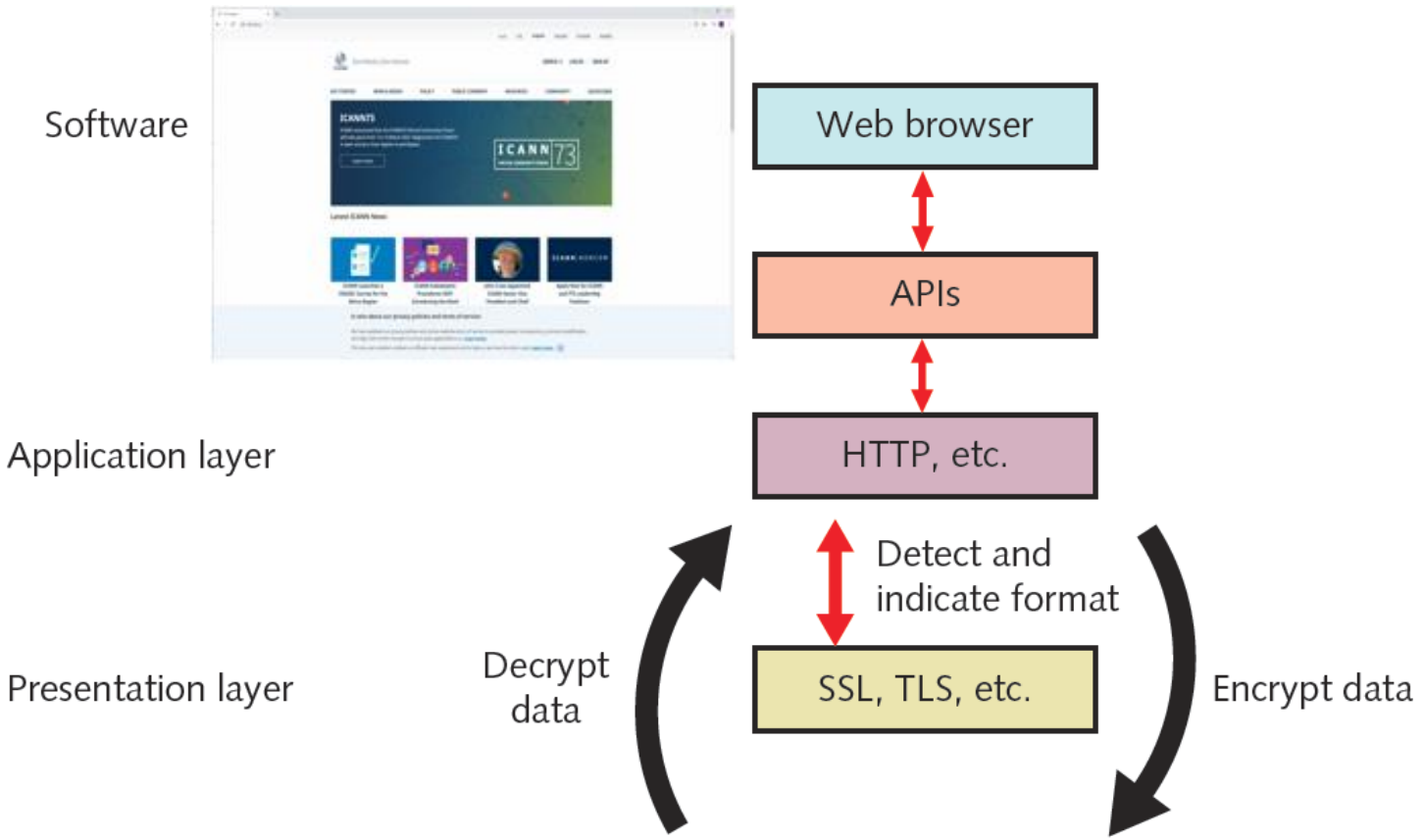
- Software applications negotiate with application layer protocols
  - Formatting, procedural, security, synchronization, and other requirements
- Examples of Application layer protocol: HTTP



Presentation Layer

- Protocol Functions
  - Accept Application layer data
  - Format data
    - Understandable to different applications and hosts
- Examples of file types translated at the presentation layer
  - GIF, JPG, TIFF, MPEG
- Presentation layer services manage data encryption and decryption
  - e.g. Secure Sockets Layer (SSL)

Presentation Layer (cont'd)



Session Layer

- Protocol Functions
  - Coordinate and maintain communications between two network nodes
- Session
  - Connection for ongoing data exchange between two parties
    - Connection between remote client and access server
    - Connection between Web browser client and Web server
- Functions
  - Establishing and keeping alive communications link
    - Throughout duration of session

Session Layer (cont'd)

- Functions (cont'd)
  - Keeping communications secure
  - Synchronizing dialogue between two nodes
  - Determining if communications ended
    - Determining where to restart transmissions if needed
  - Terminating communications
  - Set terms of communication
  - Identify session participants

Session Layer (cont'd)

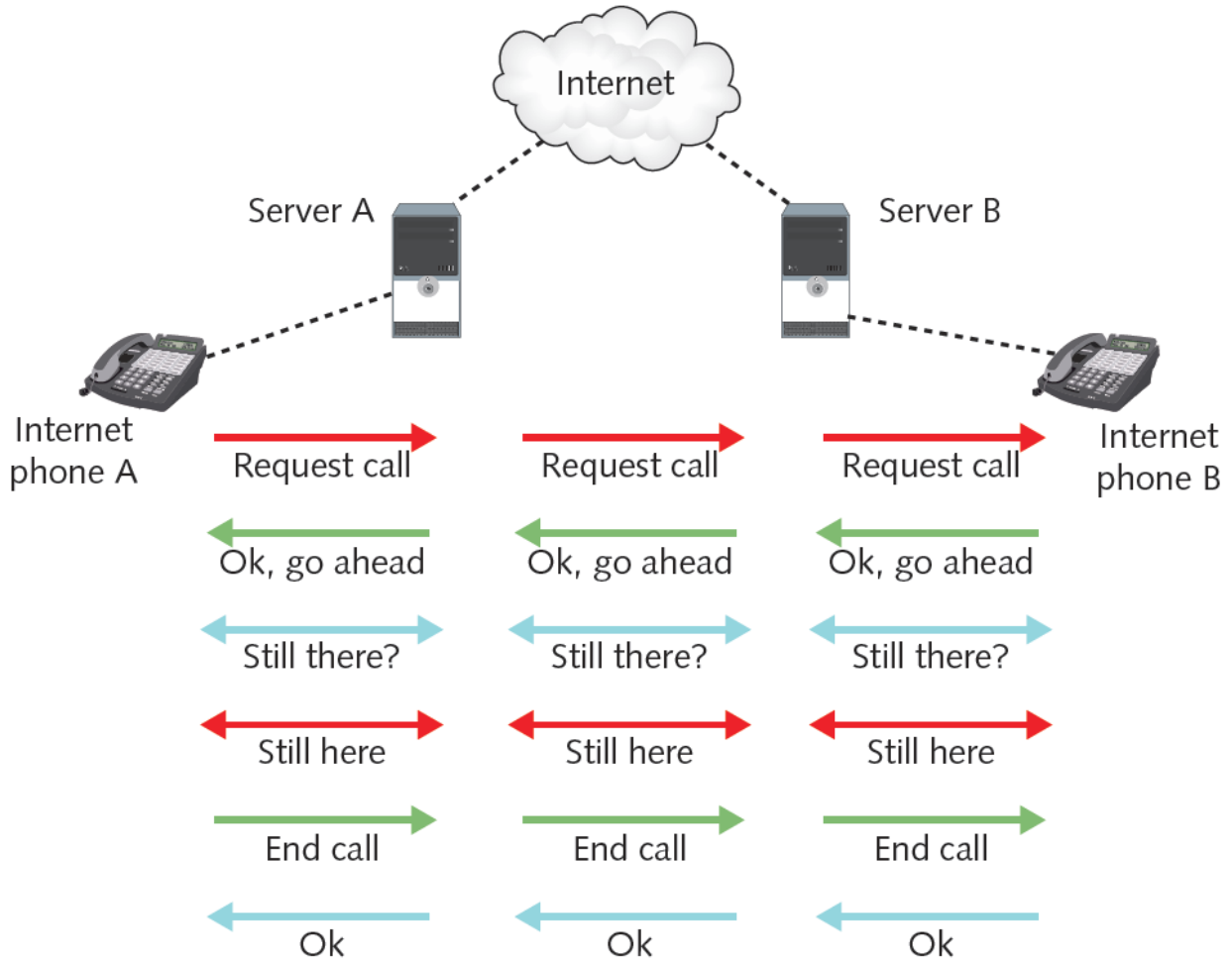


Image: Course Technology / Cengage learning

Transport Layer

- Protocol Functions
  - Accept data from Session layer
  - Manage end-to-end data delivery
  - Handle flow control
- Connection-oriented protocols
  - Establish connection before transmitting data
  - e.g. TCP three-way handshake
    - SYN (synchronization) packet
    - SYN-ACK (synchronization-acknowledgment)
    - ACK

Transport Layer (cont'd)

- Checksum
  - Unique character string
  - Allows receiving node to determine if arriving data matches sent data
- Connectionless protocols
  - Do not establish connection with another node before transmitting data
  - Do not check for data integrity
  - Faster than connection-oriented protocols

Transport Layer (cont'd)

- Segmentation
  - Breaking large data units received from Session layer into multiple smaller units called segments
  - Increases data transmission efficiency on certain network types
- MTU (maximum transmission unit)
  - Largest data unit network will carry
  - Ethernet default: 1500 bytes
  - Jumbo packets

Transport Layer (cont'd)

- Reassembly
  - Recombining the segmented data units
- Sequencing
  - Identifying segments belonging to the same group of subdivided data
  - Specifies order of data

Transport Layer (cont'd)

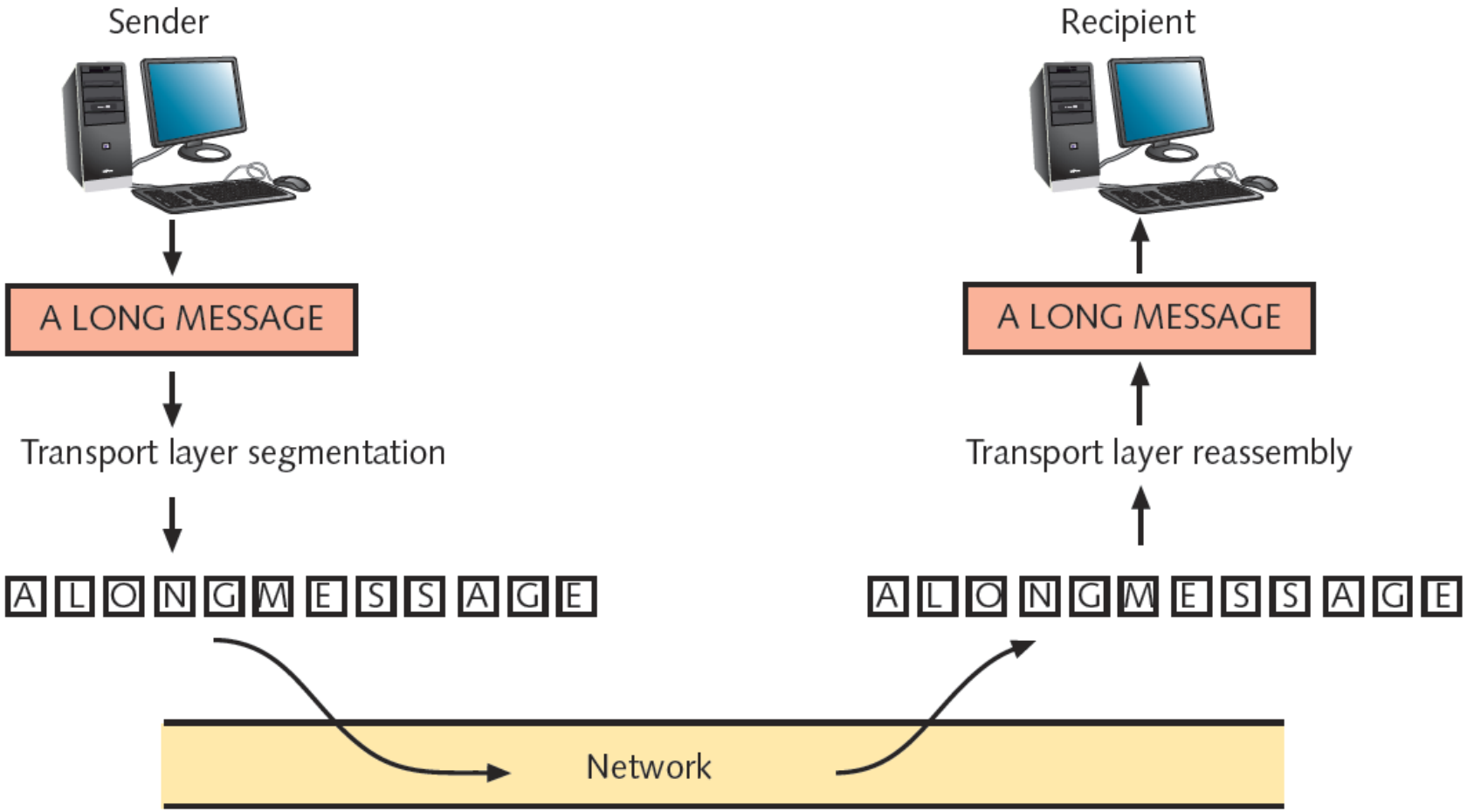


Image: Course Technology / Cengage learning

Transport Layer (cont'd)

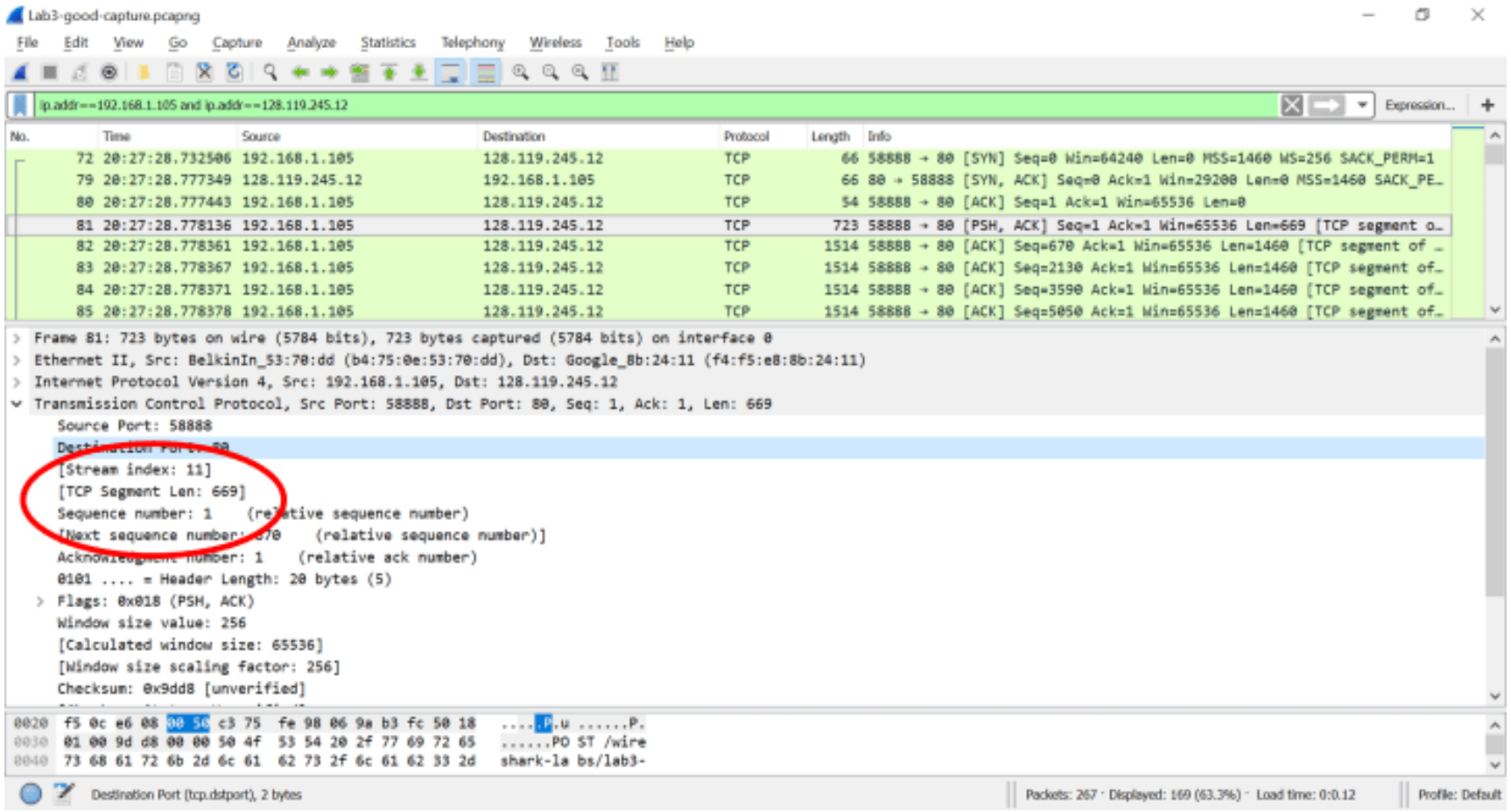


Image: MadPackets *(https://madpackets.com/2018/04/25/tcp-sequence-and-acknowledgement-numbers-explained/)*

Network Layer

- Protocol functions
  - Translate network addresses into physical counterparts
  - Decide how to route data from sender to receiver
- Addressing
  - System for assigning unique identification numbers to network devices
- Types of addresses
  - Network addresses (logical or virtual addresses)
  - Physical addresses

Network Layer

- Network address example: 192.168.1.4
- Physical address example: A6-2B-B5-AE-00-FB (48 bits)
- Factors used to determine path routing
  - Delivery priority
  - Network congestion
  - Quality of service
  - Cost of alternative routes
- Routers belong in the network layer

Network Layer (cont'd)

- Common Network Layer Protocol
  - IP (Internet Protocol)
- Fragmentation
  - Subdividing Transport layer segments
  - Performed at the Network layer
- Segmentation preferred over fragmentation for greater network efficiency

Network Layer (cont'd)


```
⊞ Frame 7: 134 bytes on wire (1072 bits), 134 bytes captured (1072 bits) on interface 0
⊞ Ethernet II, Src: c2:01:0f:2c:00:00 (c2:01:0f:2c:00:00), Dst: c2:02:0c:0c:00:00 (c2:02:0c:0c:00:00)
⊟ Internet Protocol Version 4, Src: 10.0.12.1 (10.0.12.1), Dst: 10.0.12.2 (10.0.12.2)
    Version: 4
    Header Length: 20 bytes
  ⊞ Differentiated Services Field: 0x00 (DSCP 0x00: Default; ECN: 0x00: Not-ECT (Not ECN-Capable Transport))
    Total Length: 120
    Identification: 0x000b (11)
  ⊞ Flags: 0x00
    Fragment offset: 8880
    Time to live: 255
    Protocol: ICMP (1)
  ⊞ Header checksum: 0x8b21 [validation disabled]
    Source: 10.0.12.1 (10.0.12.1)
    Destination: 10.0.12.2 (10.0.12.2)
    [Source GeoIP: Unknown]
    [Destination GeoIP: Unknown]
  ⊟ [7 IPv4 Fragments (8980 bytes): #1(1480), #2(1480), #3(1480), #4(1480), #5(1480), #6(1480), #7(100)]
      [Frame: 1, payload: 0-1479 (1480 bytes)]
      [Frame: 2, payload: 1480-2959 (1480 bytes)]
      [Frame: 3, payload: 2960-4439 (1480 bytes)]
      [Frame: 4, payload: 4440-5919 (1480 bytes)]
      [Frame: 5, payload: 5920-7399 (1480 bytes)]
      [Frame: 6, payload: 7400-8879 (1480 bytes)]
      [Frame: 7, payload: 8880-8979 (100 bytes)]
      [Fragment count: 7]
      [Reassembled IPv4 length: 8980]
      [Reassembled IPv4 data: 080025f10003000000000000000001eb30abcdabcdabcdabcd...]
⊞ Internet Control Message Protocol
```

Data Link Layer

- Protocol functions
  - Divide data received into distinct frames for transmission in Physical layer
- Frame
  - Structured package for moving data
  - Includes raw data (payload), sender's and receiver's network addresses, error checking and control information
- Communications Issues
  - Not all information received
  - Corrected by error checking

Data Link Layer (cont'd)

- Error checking methods
  - Frame check sequence
  - CRC (cyclic redundancy check)
- Frame
  - Structured package for moving data
  - Includes raw data (payload), sender's and receiver's network addresses, error checking and control information

Data Link Layer (cont'd)

- Two Data Link layer sublayers
  - LLC (Logical Link Control) sublayer
  - MAC (Media Access Control) sublayer
- MAC sublayer
  - Manages access to the physical medium
  - Appends physical address of destination computer onto data frame
- Physical Address
  - Fixed number associated with each device's network interface

Data Link Layer (cont'd)

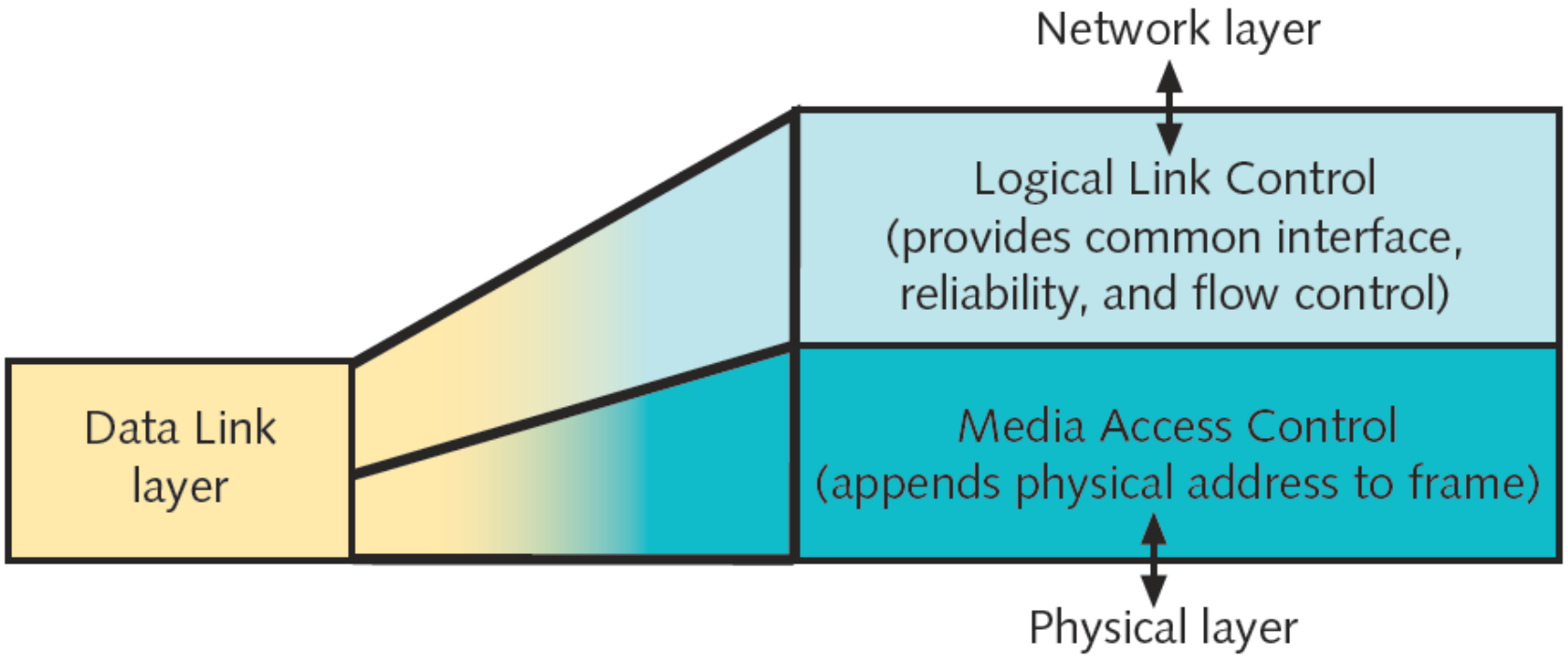


Image: Course Technology / Cengage learning

Data Link Layer (cont'd)

Physical Layer

- Protocol functions
  - Accept frames from Data Link layer
  - Generate signals as changes in voltage at the NIC
- Copper transmission medium
  - Signals issued as voltage
- Fiber-optic cable transmission medium
  - Signals issued as light pulses
- Wireless transmission medium
  - Signals issued as electromagnetic waves

Physical Layer (cont'd)

- Responsibilities when receiving data
  - Detect and accept signals
  - Pass on to Data Link layer
  - Set data transmission rate
  - Monitor data error rates
  - No error checking
- Example devices
  - Hubs and repeaters
- NICs operate at both Physical layer and Data Link layers

OSI Model - Summary

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OSI model layer	Function
Application (Layer 7)	Provides interface between software applications and a 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

Image: Course Technology / Cengage learning

OSI Model - Communication

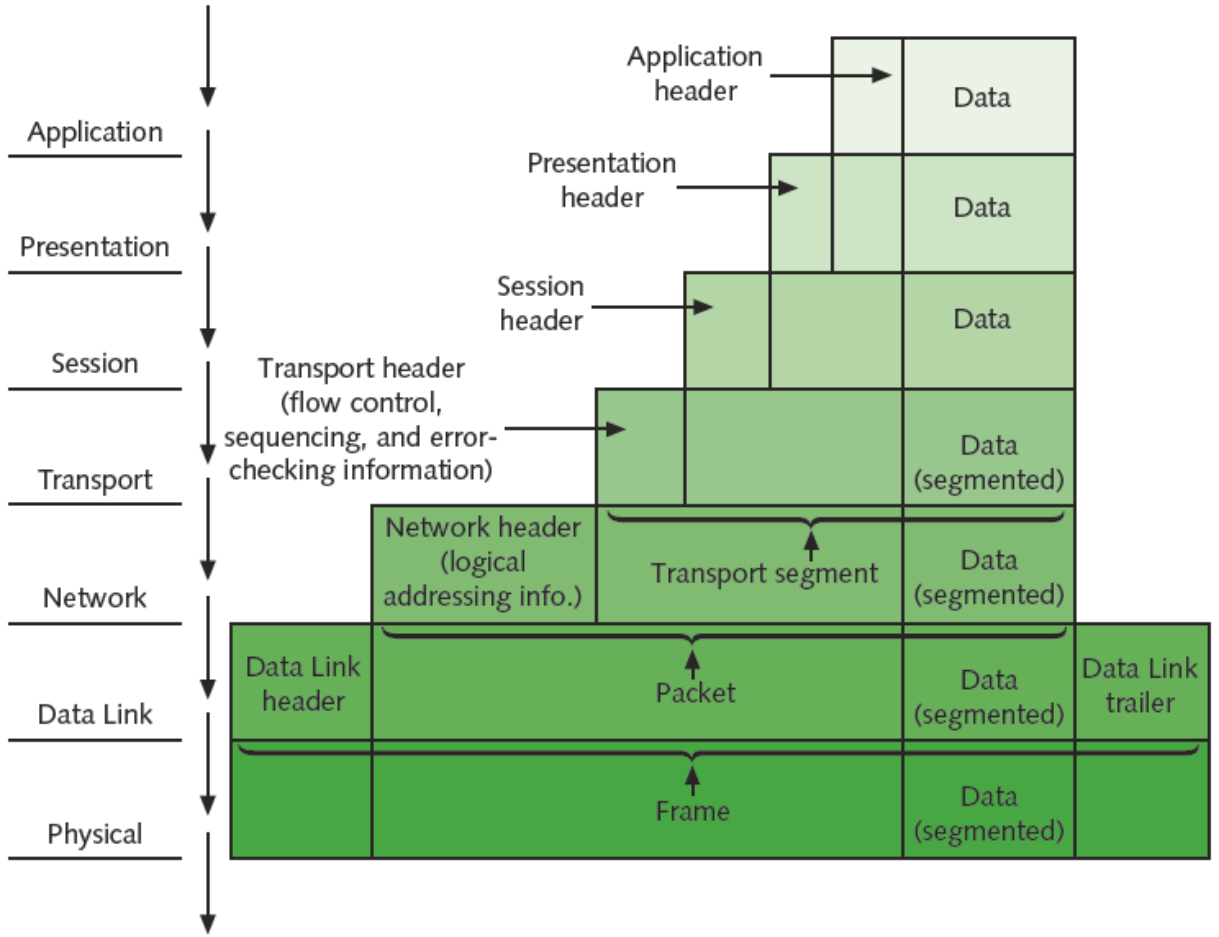

Image: Course Technology / Cengage learning

Summary

- Standards are needed to ensure interoperability between software and hardware from different manufacturers internationally
- ISO's OSI model
  - Represents communication between two networked computers
  - Includes seven layers
  - Useful at a theoretical level