COMP 204 – Principles of Computer Networks

Week 1

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Agenda

- Introductions
- Review policies, procedures, and expected outcomes
- Learning Activities
- Introduce homework problems

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Introductions

- Prof. Todd Whittaker
  - Full time faculty @ Franklin
  - IT Program Chair
  - Developer on most ITEC classes
- Industry experience in software development, systems administration, networking

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Introductions

- Now you:
  - Name
  - Major
  - Interest level and experience in networking
  - Goal for this class

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Administrivia

Principles of Computer Networks

Prerequisites: Introduction to Computer Science and Object Oriented Programming (COMP 111) OR Business Programming Concepts (ITEC 136) OR any structured programming course.

This course serves as an introduction to the function, design, administration, and implementation of computer networks. Topics include network infrastructure, architecture, protocols, applications, and the OSI networking model.

Administrivia

Course Outcomes

1. Diagram an end-to-end network communication path, describing each intermediate step.
2. Design a small-scale network configuration, including addressing, routing, and switching.
3. Describe the functions of the TCP/IP and Ethernet protocols including select fields, flags, options, headers, and trailers for both.

Administrivia

Course Outcomes (ctd)

4. Distinguish between types of data elements (segments, packets, frames, and bits).
5. Map the key elements of the TCP/IP protocol suite to the OSI model.

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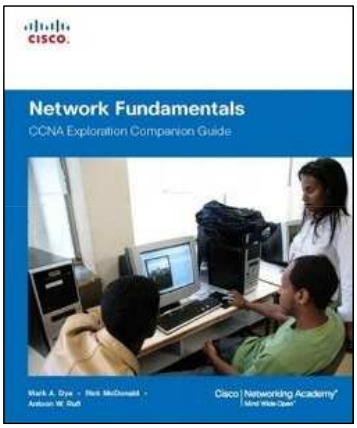
Administrivia

Text

Dye, M., McDonald, R., & Rufi, A. (2007). *Network fundamentals, CCNA exploration companion guide*. (2nd ed.). Indianapolis, IN: Cisco Press. ISBN: 9781587132087.



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Administrivia

- Academic integrity
  - Items on the Web can serve as "inspiration" for your solutions *if:*
    - You understand the solution as if you had written it yourself.
    - You cite your source of inspiration
  - *Not citing your source can get you charged with cheating/plagiarism.*

Administrivia

- Academic in
  - Items on th
    your soluti
    - You unde
      yourself.
    - You cite your ce of inspiration
  - *Not citing your source can get you charged with cheating/plagiarism.*

Note: if a homework problem says "research X," or "investigate Y," then I'm **expecting** a citation! Technically, you should cite your textbook on almost every HW assignment.

Administrivia

- Academic integrity
  - Other students cannot serve as a source for your "inspiration!"
    - The closer you move toward sharing answers with or soliciting answers from another person (student or not), the more likely it is that you are cheating.

Administrivia

- Academic integrity
  - If you have a vague feeling that you wouldn't want your instructor to know about what you're doing… don't do it.
  - When in doubt, ask your instructor.

Administrivia

Points breakdown

Pct	Type	Count	Each	Total
15%	Homework	5	30	150
30%	Labs	3	30,55,55	140
45%	Exams	1	150	150
10%	Participation / Franklin*Live!*	6	10	60
				500

Daily/weekly Activities

- Daily: Check announcements and e-mail lists
- Before class
  1. Read the associated sections from the text books and key points
  2. Read and consider the weekly homework problems
- After class
  1. Complete the homework assignment
  2. Work on any scheduled lab assignments
  3. Note significant learning

This Week's Outcomes

- Identify the key components of a data network.
- Describe the characteristics of network architectures.
- Assess the value of a layered approach to networking.
- Compare the layers of the OSI and TCP/IP network models.

Motivation

- Why is Computer Networks a required course?
  - Networking is fundamental to computing
  - Used in many different applications (from terminals to www)
  - Something that any technology major should be at least passably knowledgeable of
  - Needed for many certifications and exams (Network+, CISSP, MCSE, etc.)

Elements of a Network

- Protocols
- Messages
- Media
- Devices

Elements of a Network

- Protocols
- Messages
- Media
- Devices

Rules about how messages are sent, received, directed, and interpreted.

- Like grammar in a language
- Ensures that two communicating parties understand one another.
- Ex: XMPP, HTTP, TCP

Elements of a Network

- Protocols
- Messages
- Media
- Devices

Data that is sent and received as part of communication.

- Two parts: the protocol and the data payload.
- Protocol is the "envelope" in which the data is carried.
- Ex: e-mail text in an SMTP envelope.

Elements of a Network

- Protocols
- Messages
- Media
- Devices

The material through which the messages move.

- Wired – copper (electrical) or fiber (optical).
- Wireless – atmosphere & space (radio waves).

Elements of a Network

- Protocols
- Messages
- Media
- Devices

The equipment that sends, receives, or directs the messages. Connected to the media.

- Wired – copper (electrical) or fiber (optical).
- Wireless – atmosphere & space (radio waves).
- Ex: tablet, PDA, router, server, phone.

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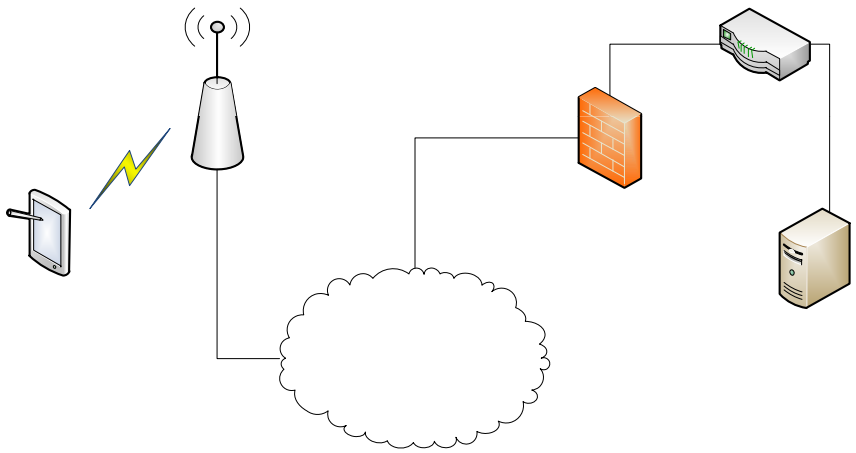
Elements of a Network

- Example – protocols, messages, media, devices



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Qualities of a Network Architecture

- Fault tolerance
- Scalability
- Quality of service
- Security

Qualities of a Network Architecture

- Fault tolerance
- Scalability
- Quality of service
- Security

A measure of the degree to which the network can still provide service despite failures. Key concept is redundancy.

- Many ways to measure it
- Ex: multiple redundant paths, fail-over hardware devices, availability, etc.

Qualities of a Network Architecture

- Fault tolerance
- Scalability
- Quality of service
- Security

A measure of the degree to which the network can add capacity at lower levels without redesigning upper levels.

- Decentralized control
- Layers
- Networks of networks

Qualities of a Network Architecture

- Fault tolerance
- Scalability
- Quality of service
- Security

Ensuring that certain time- or resource-intensive services get prioritized higher than others. Employs priority queuing.

- VoIP
- Interactive video
- Web traffic
- E-mail

Qualities of a Network Architecture

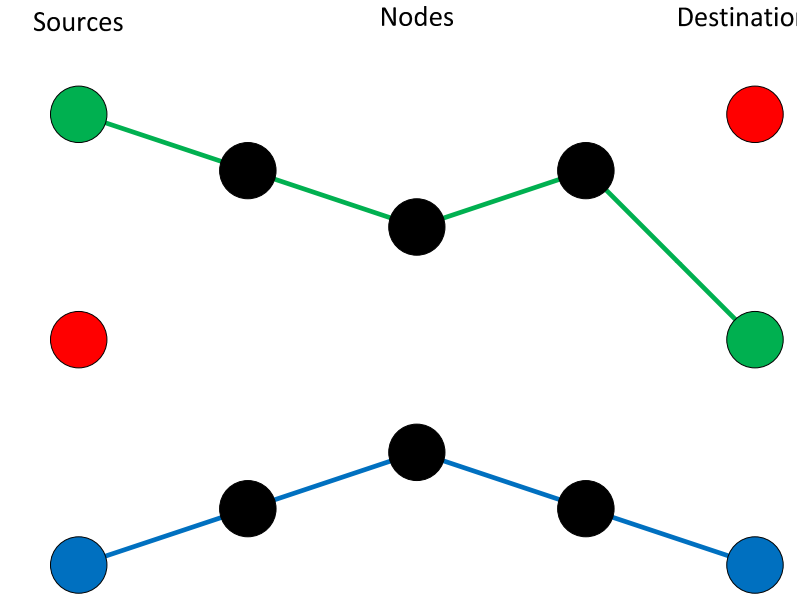
- Fault tolerance
- Scalability
- Quality of service
- Security

Ensuring the confidentiality, integrity, and availability of network resources.
- Authentication
- Authorization
- Encryption
- Access

Packet vs. Circuit Switched

- Old POTS network used circuit switching
  - An "out of band" signal set up the circuit
  - Voice was delivered across that circuit
  - An interruption anywhere on the circuit dropped the call.

Packet vs. Circuit Switched

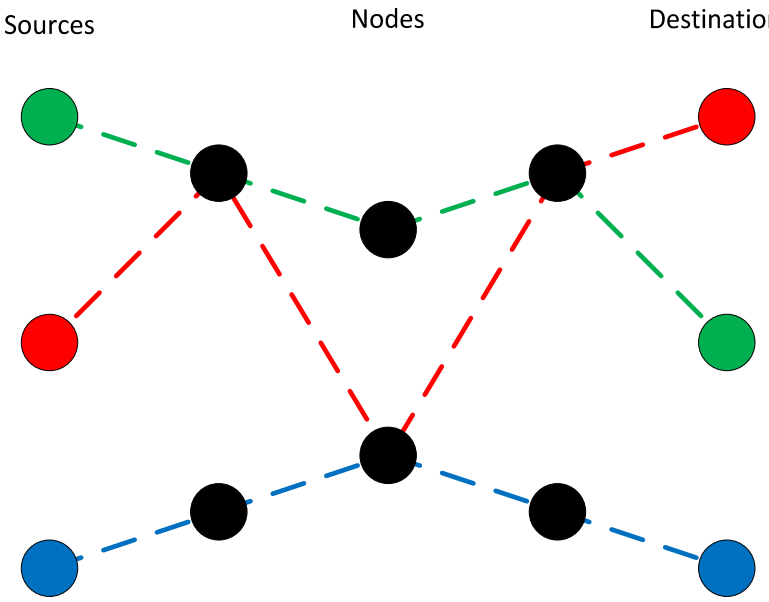


http://www.missphones.co.uk/article/packet-switching-vs-circuit-switching/

Packet vs. Circuit Switched

- Most data networks today are packet switched
  - Individual routers know about a next hop to the destination
  - Sender breaks large messages into smaller pieces and each piece is sent individually.
  - Receiver reassembles the original message.
  - Packets can move over different routes and arrive out of order.

Packet vs. Circuit Switched



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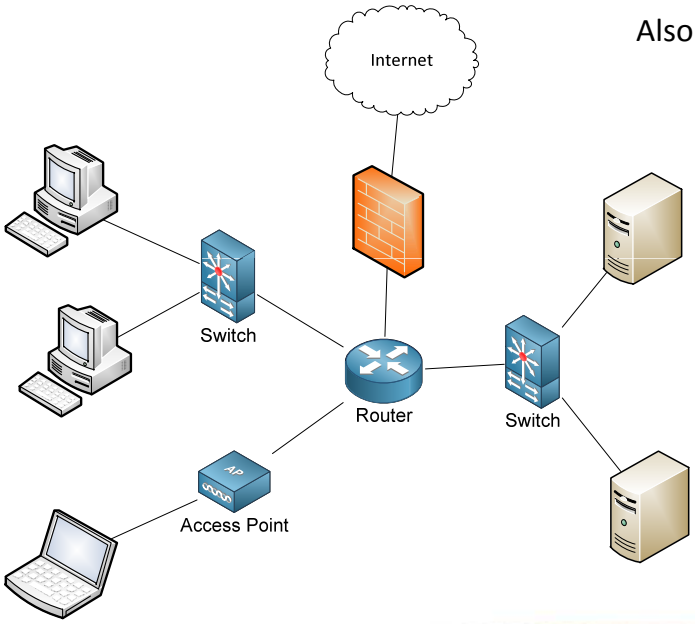
Intermediary devices

- Network access devices: wireless access points, switches, hubs
- Internetwork devices: routers
- Security devices: firewalls, RADIUS servers

Icons

Also on p. 44



Protocols

- Application, transport, internetwork, network access
  - Application: HTTP (hypertext transfer protocol), NNTP, POP, DHCP, etc.
  - Transport: TCP (transmission control protocol), UDP (user datagram protocol), etc.
  - Internetwork: IP (internet protocol), ICMP, IPsec, IPv6
  - Network access: MAC (media access control), PPP, OSPF, etc.)

Protocols

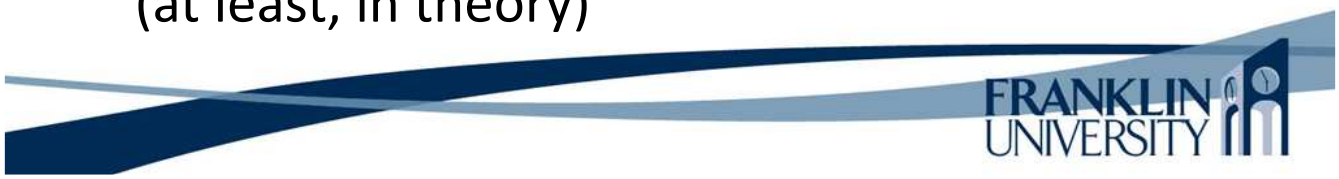
- Protocols are STANDARDS, not TECHNOLOGY
  - Controlled by standards bodies (e.g. IEEE) and RFCs (request for comments).
  - Can, for instance, run IP over carrier pigeons. See RFC 1149: http://www.faqs.org/rfcs/rfc1149.html

OSI Model

- Open Systems Interconnection Reference Model, developed by International Organization for Standardization (ISO)
- Serves as a model for implementing network functions/protocol stacks
- Does not specify concrete protocols, instead specifies the functions that concrete protocols will have to implement at each layer.

TCP/IP Protocol Suite

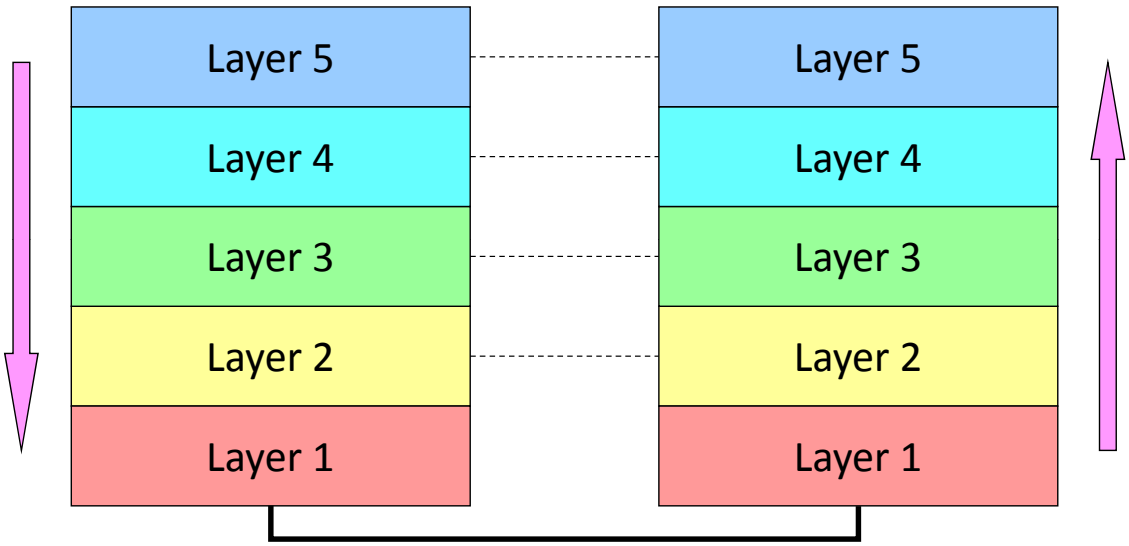
- TCP/IP is a set of protocol standards
- It is NOT:
  - single protocol
  - name of the company
  - software name/title/brand
- Each company implements it differently
- The result of implementation is still the same (at least, in theory)



Need for Multiple Protocols

- Protocols address different problems (like programming languages)
  - Hardware Failure
  - Network Congestion
  - Packet Delay or Loss
  - Data Corruption
  - Data Duplication or Sequence Errors
- You can put it all in one protocol, but what would happen a year from today?

Protocol Layering



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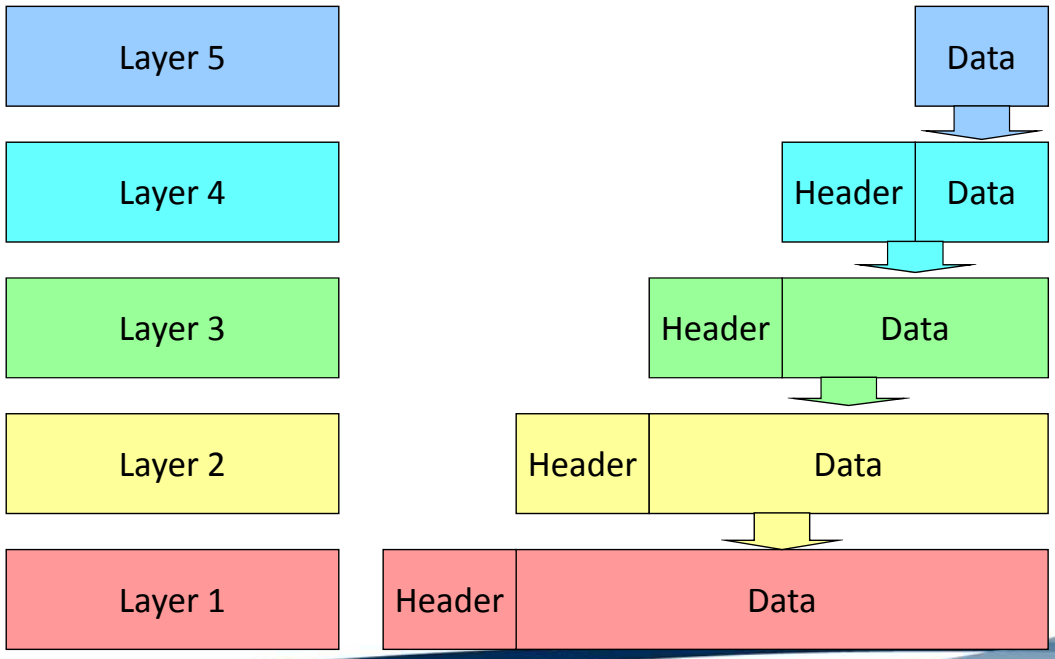
Protocol Layering



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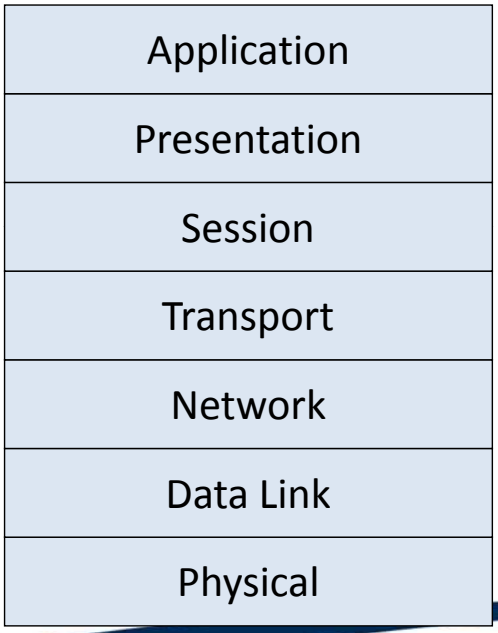
OSI Reference Model



- All People Seem To Need Data Processing (they really do – for exam purposes)
- Each layer provides a different level of abstraction
- Each layer has a well-defined function
- Layer boundaries are chosen to minimize the information flow between layer boundaries
- The number of layers is kept small enough to be feasible

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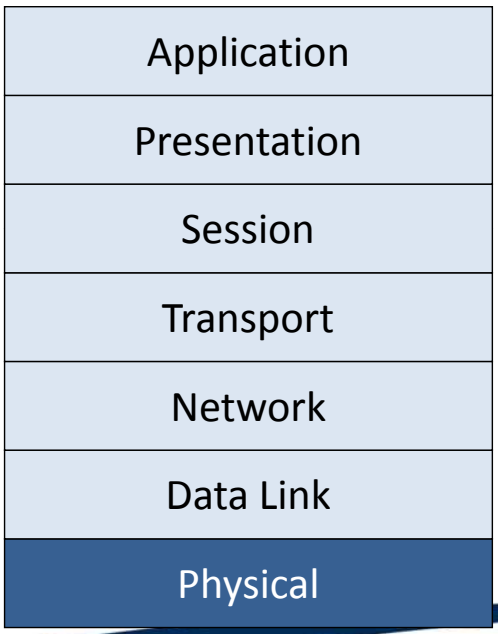
OSI – Physical Layer



- Transmits bits over communication channel
- Bits can be encoded in digital form (“0” or “1”) or analog (varied voltage) (did you buy your TV converter?)
- Does not have any knowledge of data that it transmits
- Examples of media:
  - twisted-pair cable
  - coaxial cable
  - fiber optics
  - wireless

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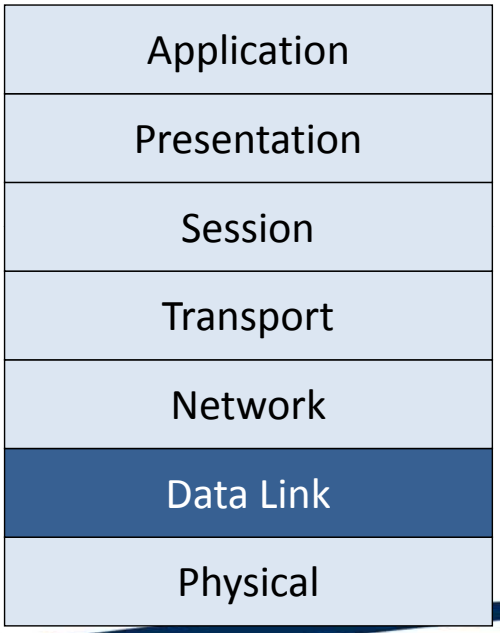
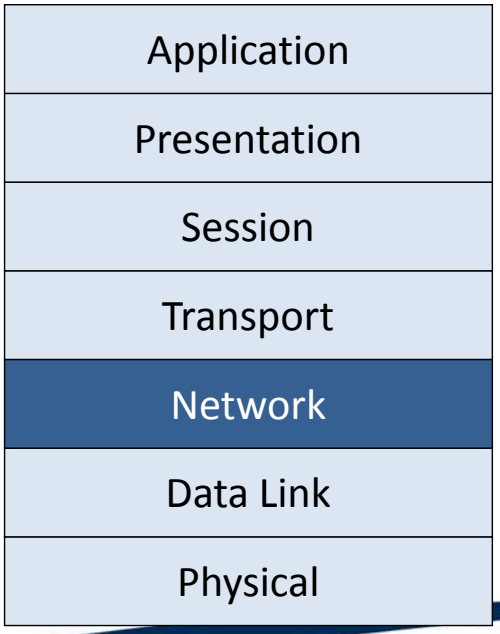
OSI – Data Link Layer



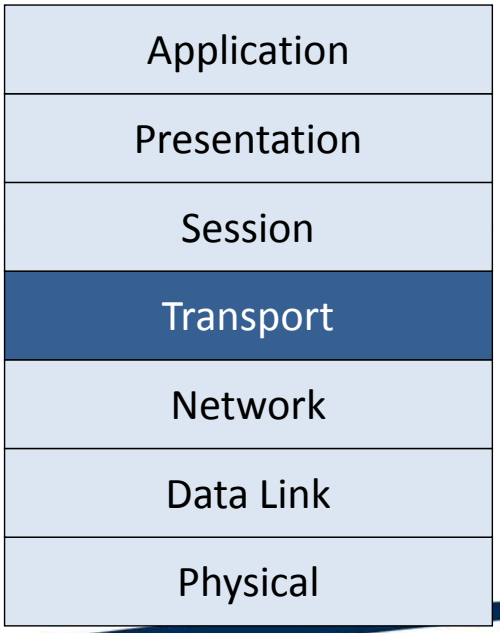
- The bits that are send or received in the Physical Layer are grouped in logical units called ***frames***
- The beginning and end of each frame is usually marked by special characters
- Examples:
  - Ethernet
  - Token Ring
  - FDDI
  - ISDN

OSI – Network Layer



- Makes it possible to send units of information (packets) across different network (routing)
- Uniform addressing scheme
- Helps eliminate network congestion
- Regulate flow of data
- Examples:
  - IP
  - IPX (Novell anyone?)

OSI – Transport Layer



- Ensures reliable delivery of packets
- Error recovery
- Multiplexing the network connection (the use of the network by multiple applications simultaneously)
- Examples:
  - TCP
  - UDP
  - SPX (yeah, that Novell thing)

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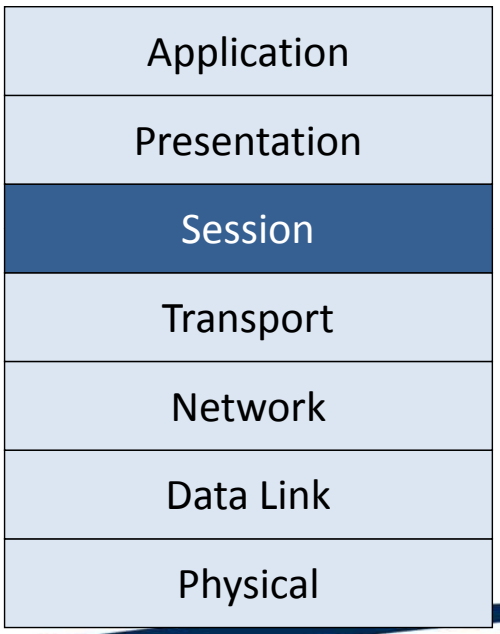
OSI – Session Layer



- Provides enhanced session services
- Examples:
  - Telnet session
  - FTP session
  - rlogin session
  - Cookies (web)

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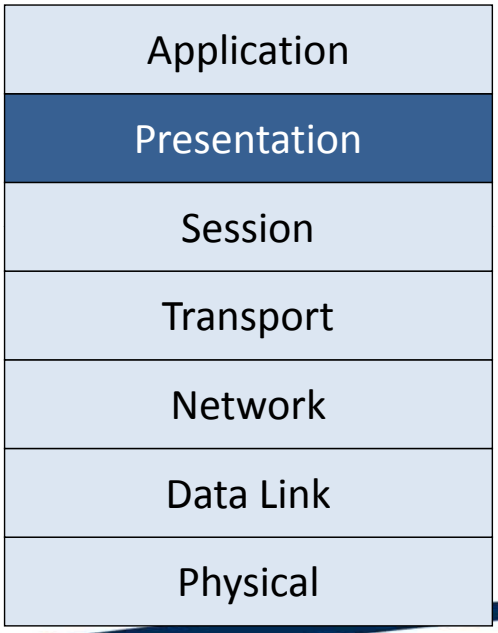
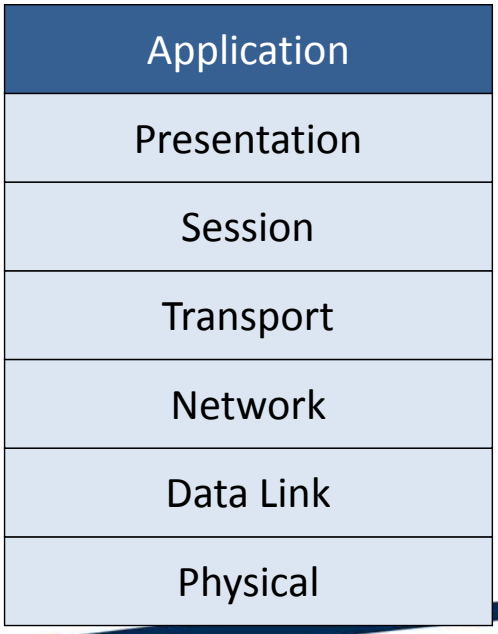
OSI – Presentation Layer



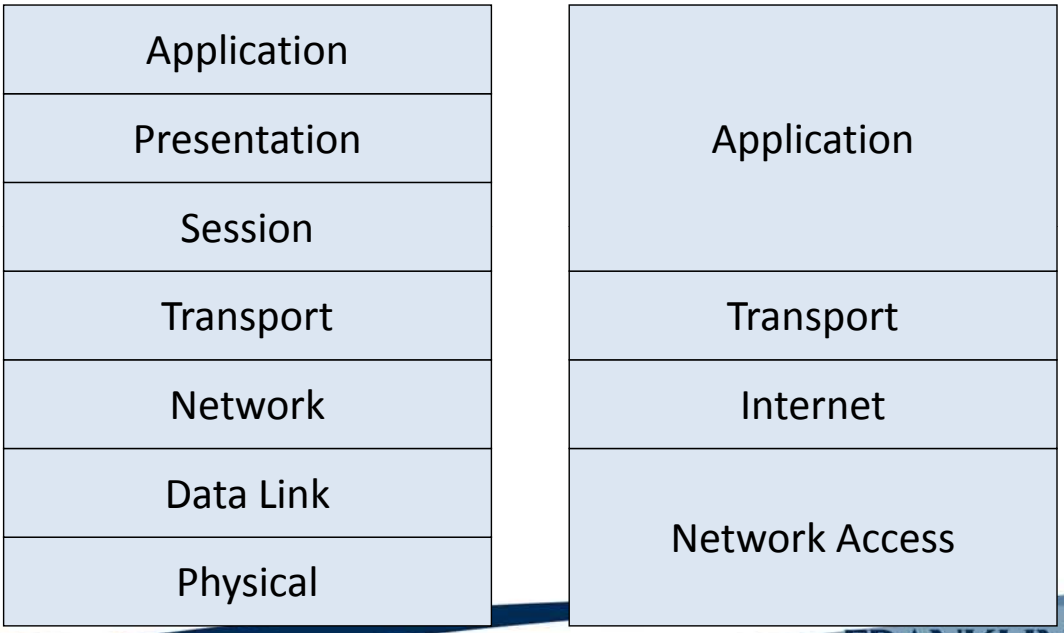
- Manages the way data is represented:
  - Encryption
  - Encoding
- Examples:
  - ASCII
  - EBCDIC
  - HTML
  - XML

OSI – Application Layer



- Provides a protocol for a certain application
- Examples:
  - DNS
  - HTTP
  - FTP
  - SMTP
  - TELNET
  - SNMP

OSI versus TCP/IP



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TCP/IP Model Boundaries

Application	
Transport	Application address (port) for TCP and UDP
Internet	IP address (host)
Network Access	MAC address (NIC)

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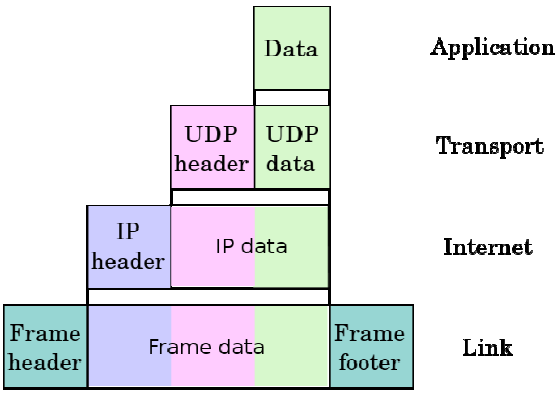
TCP/IP Boundaries

- Operating System Boundary
  - Transport and Internet layers are usually considered part of the operating system
  - Network access is typically considered “hardware” or a “driver” in the OS.

Protocol Data Unit (PDU)

- Contains information about the source and destination of a message. In the header.



http://en.wikipedia.org/wiki/TCP/IP_model

This Week's Outcomes

- Identify the key components of a data network. 
- Describe the characteristics of network architectures. 
- Assess the value of a layered approach to networking. 
- Compare the layers of the OSI and TCP/IP network models. 

Self Quiz

- When should you cite a source in your assignments?
- Should you read the book before class or after the presentation?
- What are the four elements of a network? What do they do?
- What are the four qualities of a good network architecture? Describe each.

Self Quiz

- Compare and contrast circuit and packet switched networks. What problem does packet switching solve?
- What is a protocol? Give an example of protocol in the real world.
- Why do we apply layering to protocols and networks?
- Name and describe the 7 layers of the OSI model.

Self Quiz

- How do OSI and TCP/IP map onto one another?

Due this week

- Software installation (no points)

Next week

- Chapters 3 and 4
- Application layer protocols (layer 7)
- Transport layer protocols (layer 4)
- TCP and UDP

Q & A

- Questions, comments, concerns?