Introduction and Internet Applications
Chapter 1 & 2

Introduction and Overview

updated: 8/26/14

Networking Seems Complex

- The networking subject seems complex, because
  - Different technologies exist and each is adopted for a particular application
    - Each technology has features that distinguish it from the others
  - Companies create commercial network products and services
    - often by using technologies in new unconventional ways
  - Different technologies must be combined and interconnected in many ways
- Computer networks can be especially confusing to a beginner because
  - No single underlying theory exists that explains the relationship among all parts
  - Multiple organizations have created computer networks standards
  - Various organizations have attempted to define conceptual models
  - The set of technologies is diverse and changes rapidly
- The lack of consistency in the field has produced another challenge for beginners:
  - Multiple groups each attempt to create their own terminology
  - Computer networking jargon contains terms that are often abbreviated, misused, or associated with products

The Five Key Aspects of Networking

1. Network Applications and Network Programming
2. Data Communications
3. Switching Networks (Packet Switching and Circuit Switching) Technologies
4. Internetworking with TCP/IP
5. Additional Networking Concepts and Technologies

These are the course objectives!

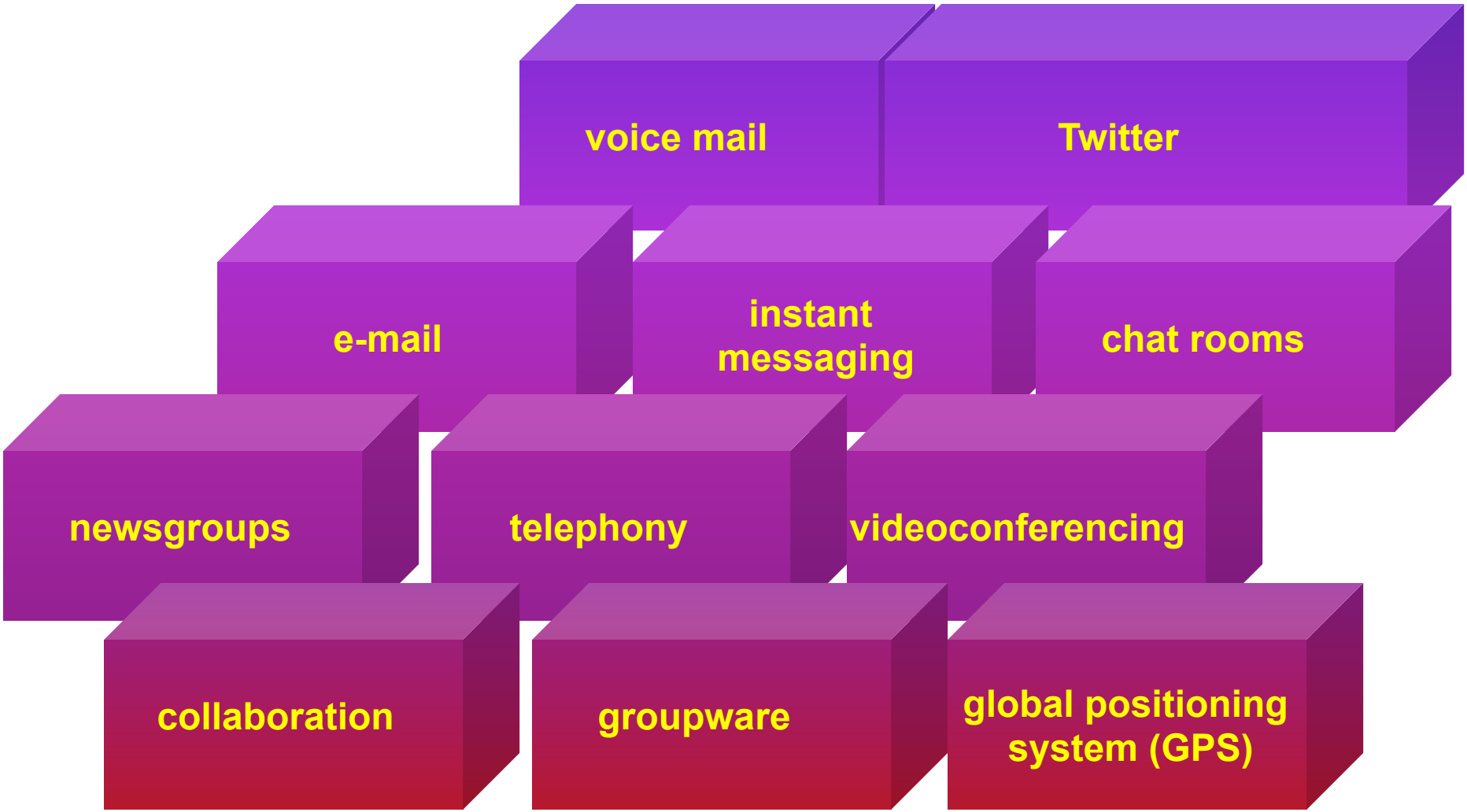
Network Applications and Network Programming

- Network services are provided by an application software
  - an application on one computer communicates across a network with an application program running on another computer
- Network applications span a wide range, such as:
  - email
  - file transfer
  - web browsing
  - voice telephone calls (VoIP)
  - distributed databases
  - audio/video teleconferencing

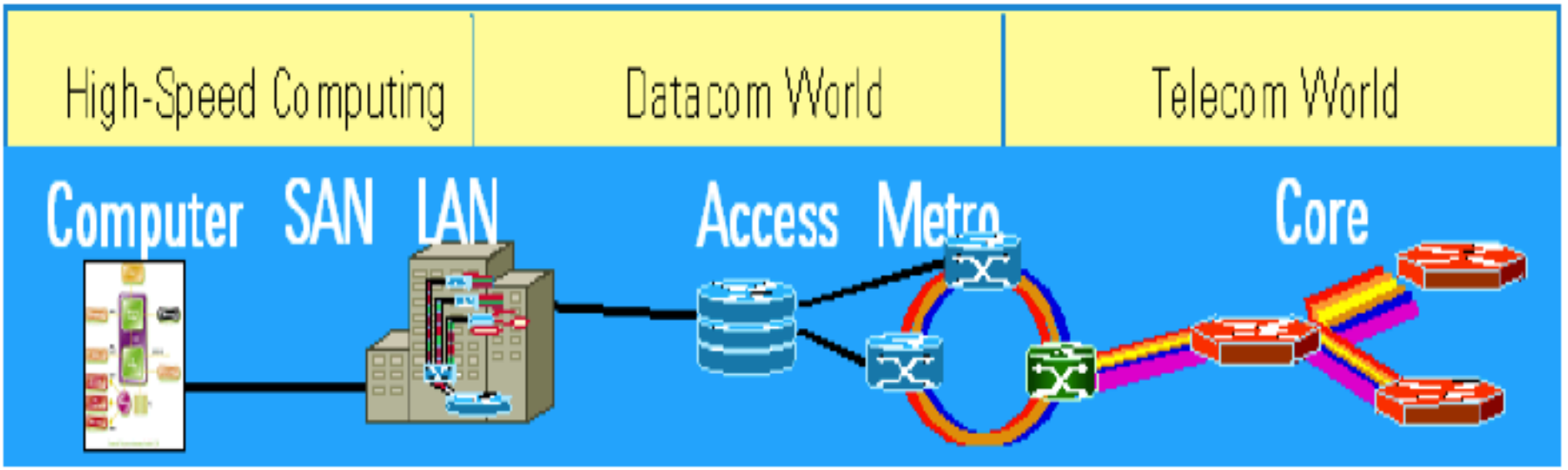
Network HW and Software are Separate from One another!

- Each application offers a specific service to the user using a specific user interface
  - But all applications can communicate over a single, shared network
- To write the application software one must learn about one interface to network

Examples of Network Services



Computing, Datacom, Telecom



Representative Technologies

Fibre Channel
FC Edge: 8GFC, 16GFC, 32xFC
FC ISL: 10G, 20G FC
FCoE: 10G FCoE

40G SONET /SDH

40G DWDM

USB
PCI Express
SATA/SAS
HDMI, Display Port
Thunderbolt

40G/100G Ethernet
IEEE 802.3ba

PON
IEEE EPON, 10G-PON
ITU/FSAN GPON

40G/100G Complex Modulation
RZ-DPSK, RZ-DQPSK, DP-QPSK (OIF)

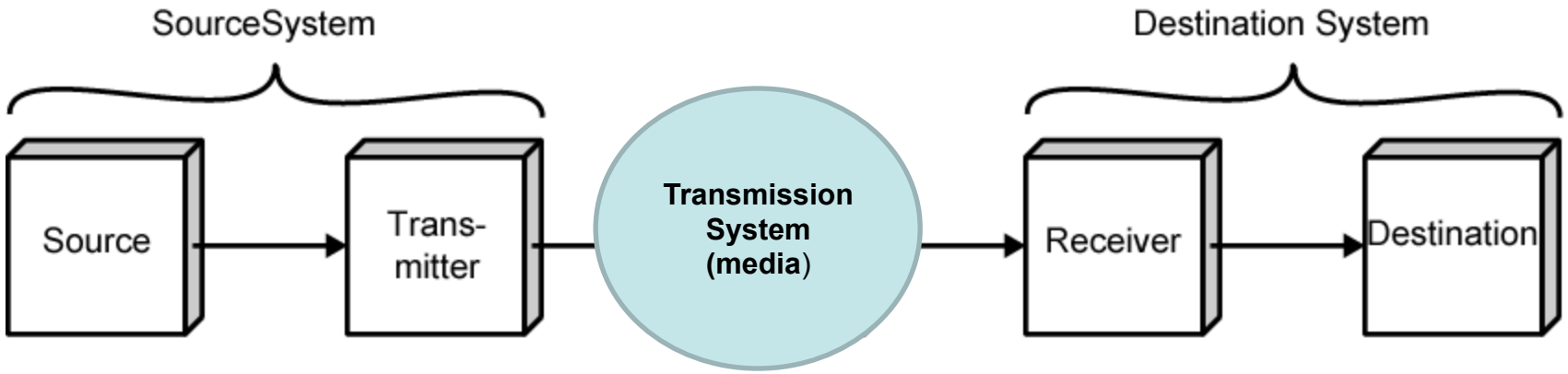
Active Optical Cabling (AOC)

Active Ethernet

Ref: Agilent Technologies

Data Communications:

- Refers to the study of low-level mechanisms and technologies used to send information across a physical communication medium
- Provides a foundation of concepts on which the rest of networking is built
- Focuses on ways to use physical phenomena to transfer information
  - impacts the design of many protocol layers



Data Communication System Model

Packet Switching and Networking Technologies

- In 1960s, the packet switching concept revolutionized data communications
- Early communication networks had evolved from telegraph and telephone systems
  - A physical pair of wires between two parties to form a dedicated circuit
- Packet switching changed networking in a fundamental way
  - Packet switching divides data into small blocks, called packets
    - It includes an identification of the intended recipient in each packet
    - Devices throughout the network each have information about how to reach each possible destination
  - Packet switching allows multiple users to share a network
  - It provided the basis for the modern Internet

Packet Switching and Networking Technologies

- Basic Characteristics

- Many designs for packet switching are possible
  - Depending on speed, distance, and economic cost
- But there is a need for answers to basic questions:
  - How should a destination be identified?
  - How can a sender find the identification of a destination?
  - How large should a packet be?
  - How can a network recognize the end and beginning of one packet?
  - If a network is shared, then how can they coordinate to insure that each receives a fair opportunity to send?
  - How can network technologies be designed to meet various requirements for speed, distance, and economic cost?
  - How can packet switching be interfaced to other networks (e.g., wireless)?

Internetworking with TCP/IP

- In the 1970s, another revolution in computer networks arose: Internet
  - connecting multiple networks together
- In 1973, Vinton Cerf and Robert Kahn
  - Proposed that a single packet switching technology cannot meets everyone's needs
  - They explored interconnecting many packet switching technologies into a functioning whole
  - They proposed a set of standards to be developed for such an interconnection
  - The resulting standards became known as the TCP/IP Internet Protocol Suite (usually abbreviated TCP/IP)
- TCP / IP takes a virtualization approach
  - Defining a network-independent *packet* and *identification* scheme

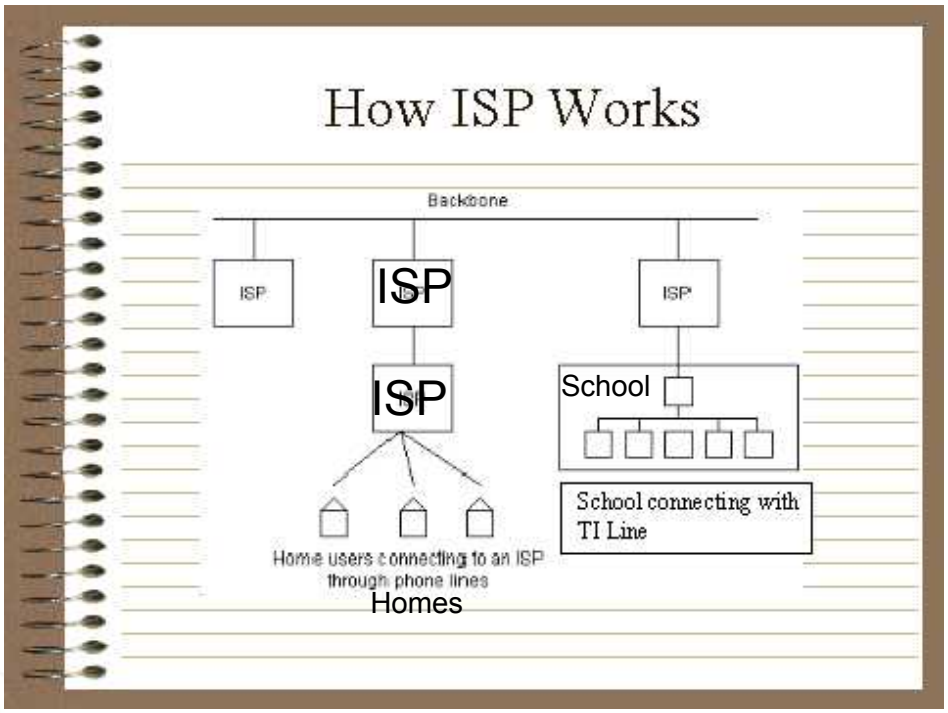
The success of TCP/IP lies in its tolerance of heterogeneity

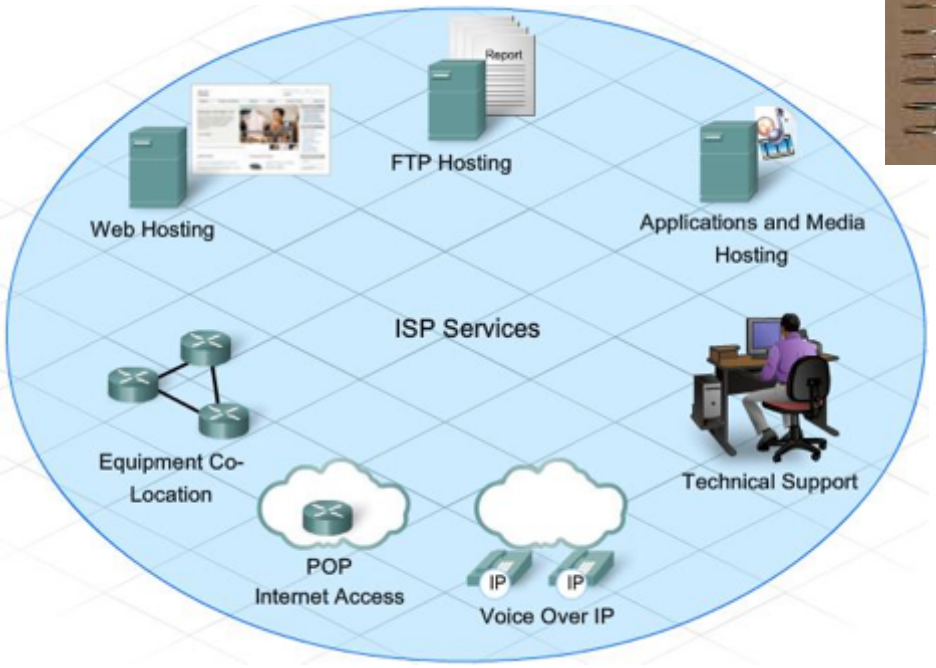
Public and Private Parts of the Internet

- From ownership point of view, we can categorize networks
  - Public Networks
  - Private Networks
- A public network is run as a service that is available to subscribers (Toll ways!)
  - Any individual or corporation who pays the subscription fee can use
  - A company that offers service is known as a service provider (ISP)
  - Public refers to the general availability of service, not to the data being transferred
- A private network is controlled by one particular group
  - network use is restricted to one group
  - a private network can include circuits leased from a provider

Read about Net Neutrality!

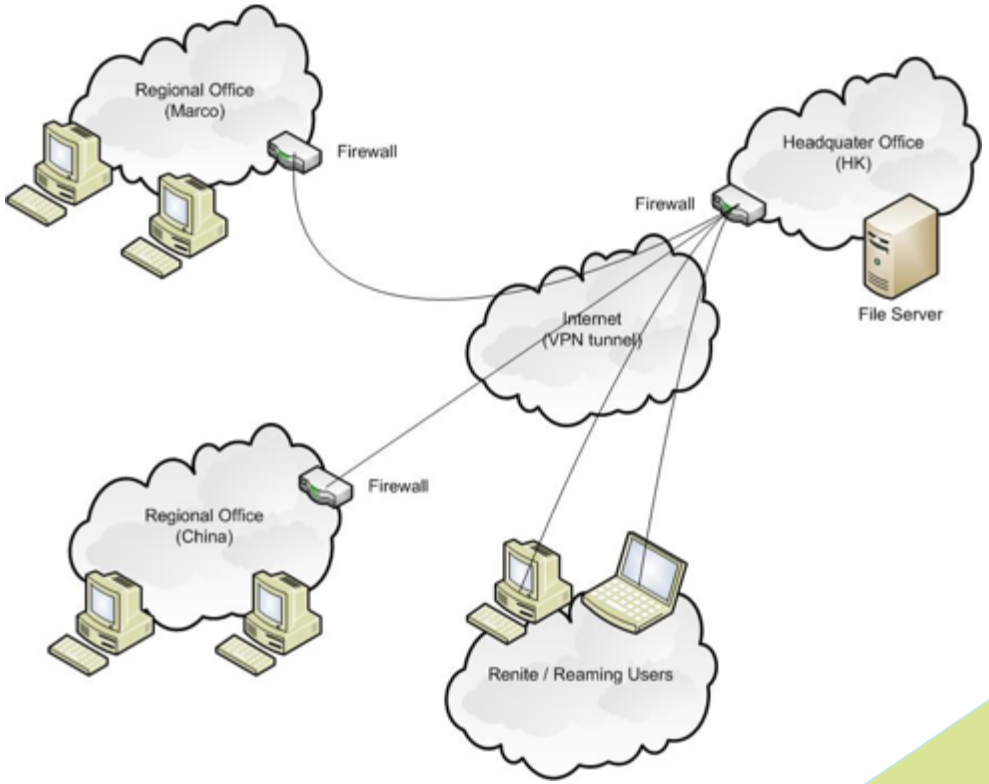
ISP and its Services





Private Network

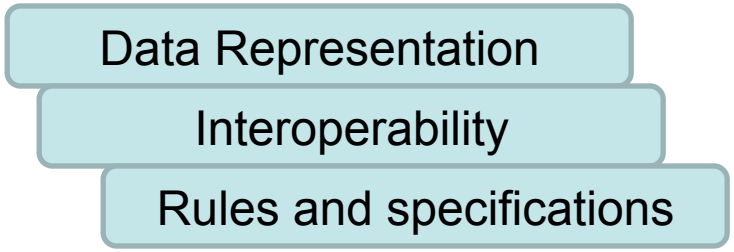
- Network vendors generally divide private networks into four categories based on the size:
  - Consumer
  - Small Office / Home Office (SOHO)
  - Small-to-Medium Business (SMB)
  - **Large Enterprise**



Project Topic

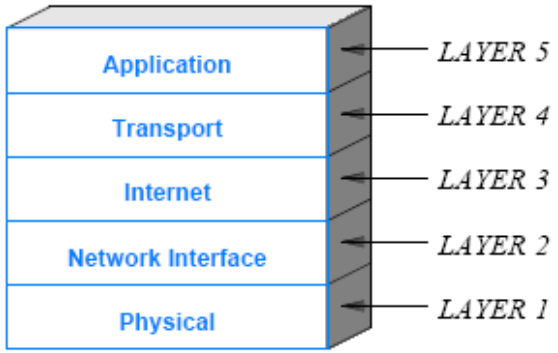
Networks, Interoperability, and Standards

- All entities (e.g., TX & RX) in a network must agree on how information will be represented and communicated
  - Signal, hand shaking, format, etc.
- An important issue is interoperability
  - it refers to the ability of two entities to communicate
- All communicating parties must agree on details and follow the same set of rules, an exact set of specifications
- Communication protocol, network protocol, or simply protocol to refer to a specification for network communication



Protocol Suites and Layering Models

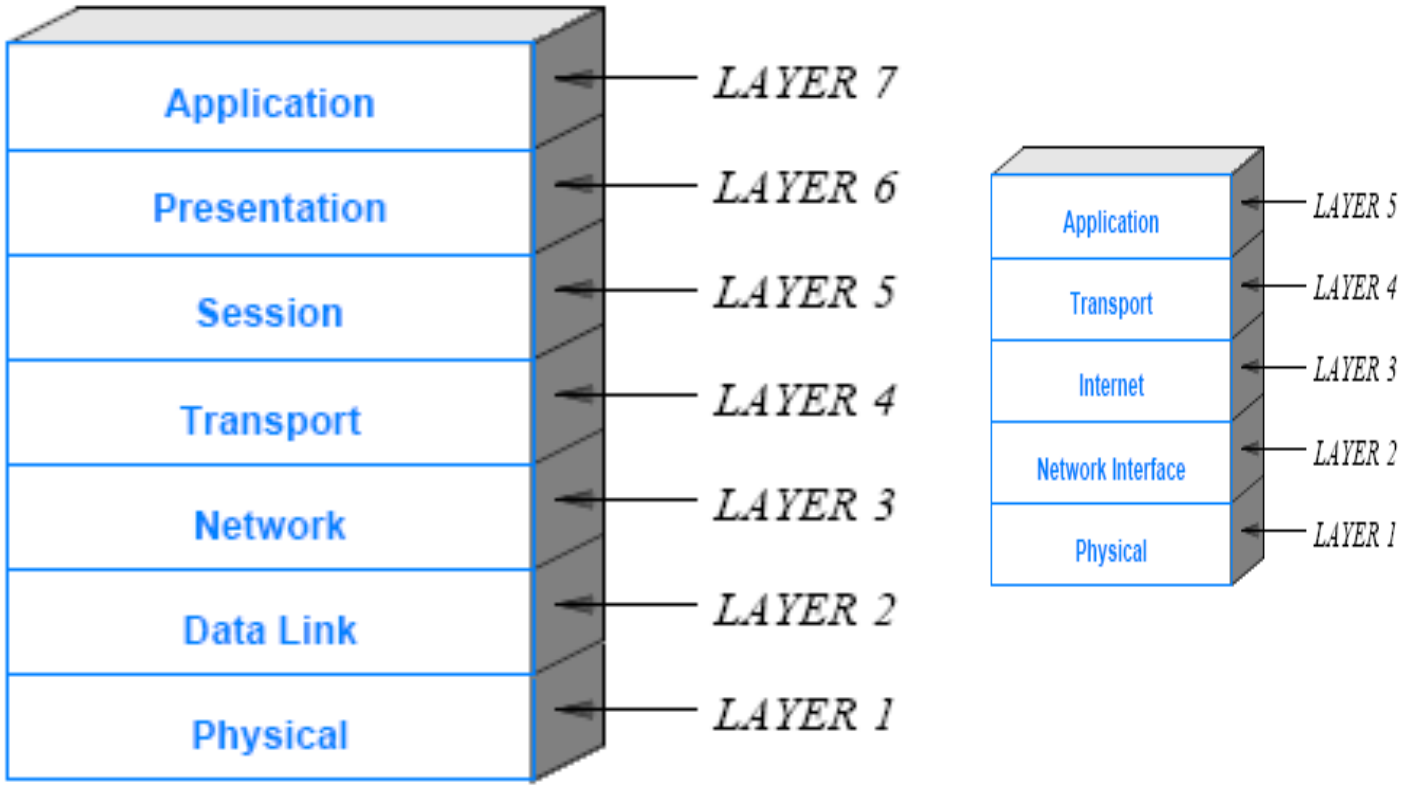
- A set of protocols must be constructed
- Each protocol should handle a part of communication not handled by other protocols
  - protocols are designed in complete, cooperative sets called suites or families
  - Each protocol in a suite handles one aspect of networking
- The fundamental abstraction used to collect protocols into a unified whole is known as a layering model



The layering Model for the IP

NOTE:
- Network Interface or Data Link Layer
- Internet or Networking

Open Systems Interconnection (OSI) Seven-Layer Reference Model



Eventually, it became clear that TCP/IP technology was technically superior to OSI

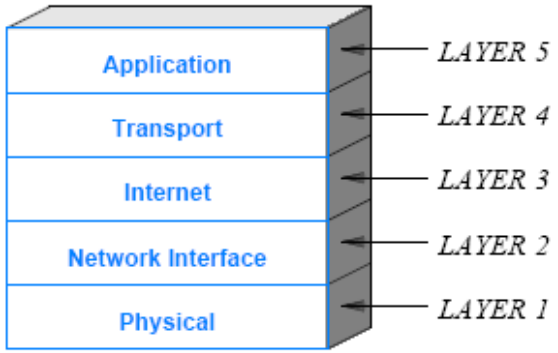
(Please Do Not Throw Sausage & Pizza Away!)

Alternative Naming

Open Systems Interconnection (OSI) Seven-Layer Reference Model

Application	4	Application	data	FTP, HTTP, POP3, IMAP, telnet, SMTP, DNS, TFTP
Presentation			data	
Session			data	
Transport	3	Transport	segments	TCP, UDP
Network	2	Internet	packets	IP
Data Link	1	Data Link	frames	
Physical		Physical	bits	

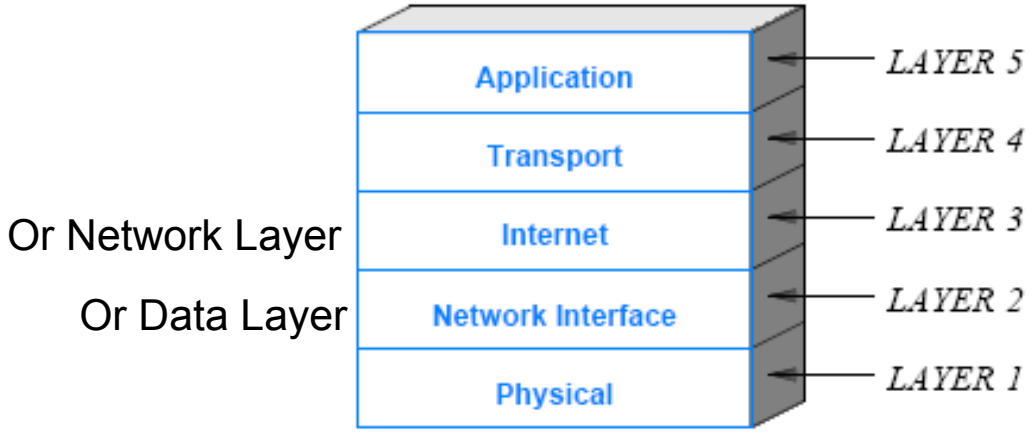
These two layers are also known as Network Access



The layering Model for the IP

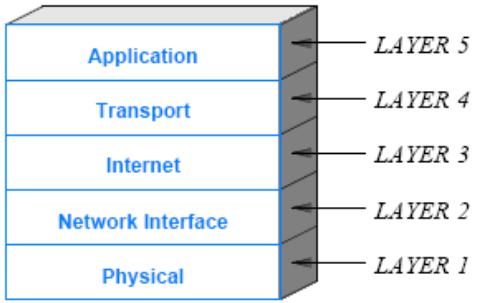
Protocol Suites and Layering Models

- Physical Layer (Layer 1)
  - specify details about the underlying transmission medium and hardware
  - all specifications related to electrical properties, radio frequencies, and signals belong in layer 1
- Network Interface (or Data Link) Layer (Layer 2)
  - Network (physical) addresses
  - maximum packet size that a network can support
  - protocols used to access the underlying medium



Protocol Suites and Layering Models

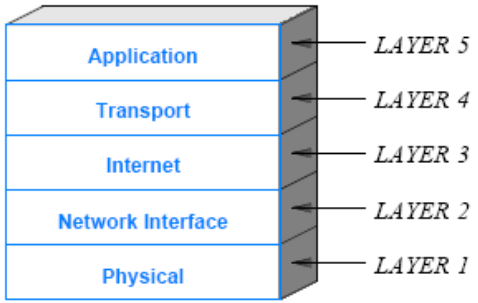
- Internet Layer (Layer 3)
  - protocols specifying communication across the Internet & routing specifications (spanning multiple interconnected networks)
  - Logical addressing and path determination
- Transport Layer (Layer 4)
  - Includes specifications on
    - controlling the maximum rate a receiver can accept data (flow control)
    - mechanisms to avoid network congestion
    - techniques to insure that all data is received in the correct order



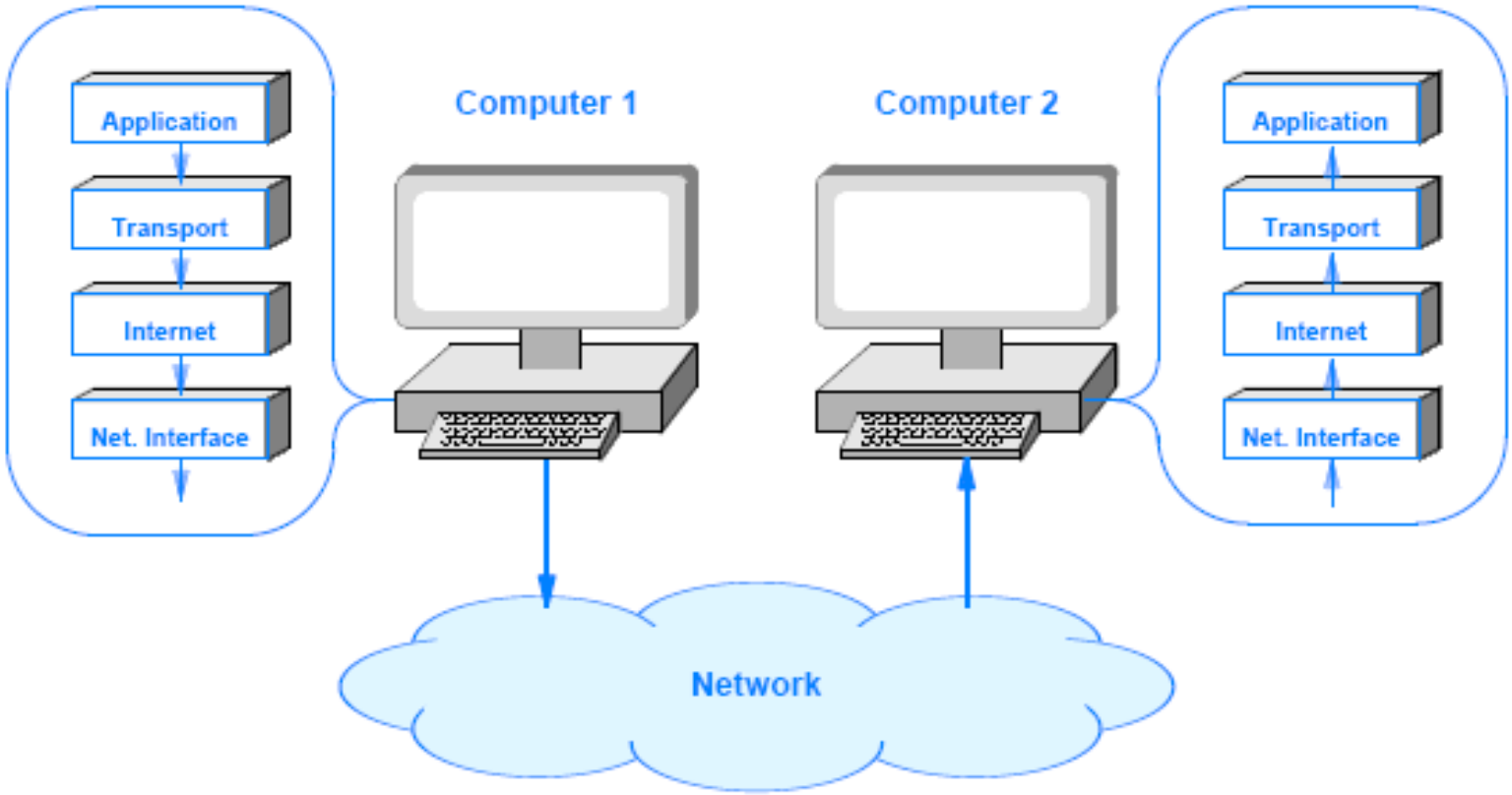
Remember: Each layer contains its own specifications & protocols!

Protocol Suites and Layering Models

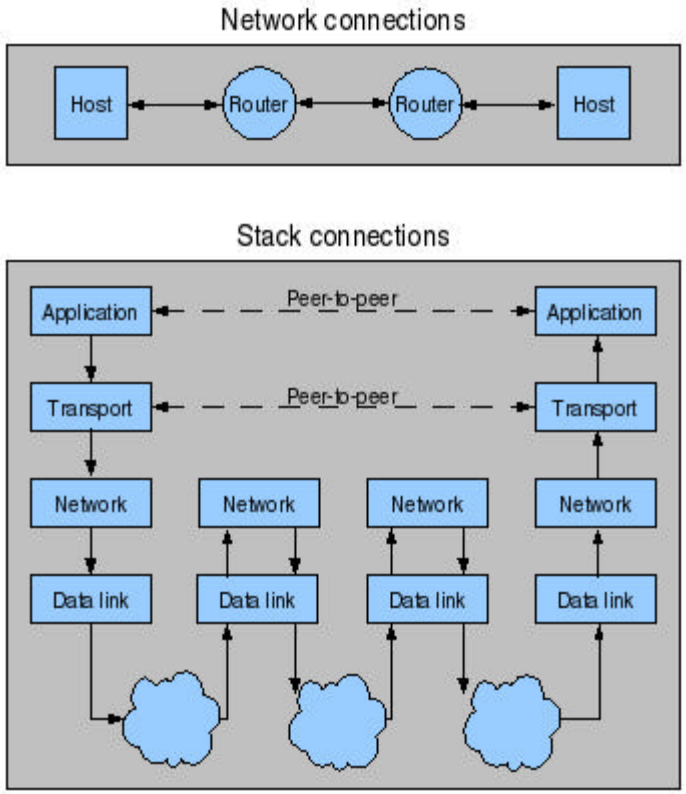
- Application Layer (Layer 5)
  - specify how a pair of applications interact when they communicate
  - specify details about
    - the meaning of messages that applications can exchange
    - the procedures to be followed to execute the application
  - Some examples of network applications in layer 5
    - email exchange
    - file transfer
    - web browsing
    - telephone services
    - and video teleconferencing



How Data Passes Through Layers

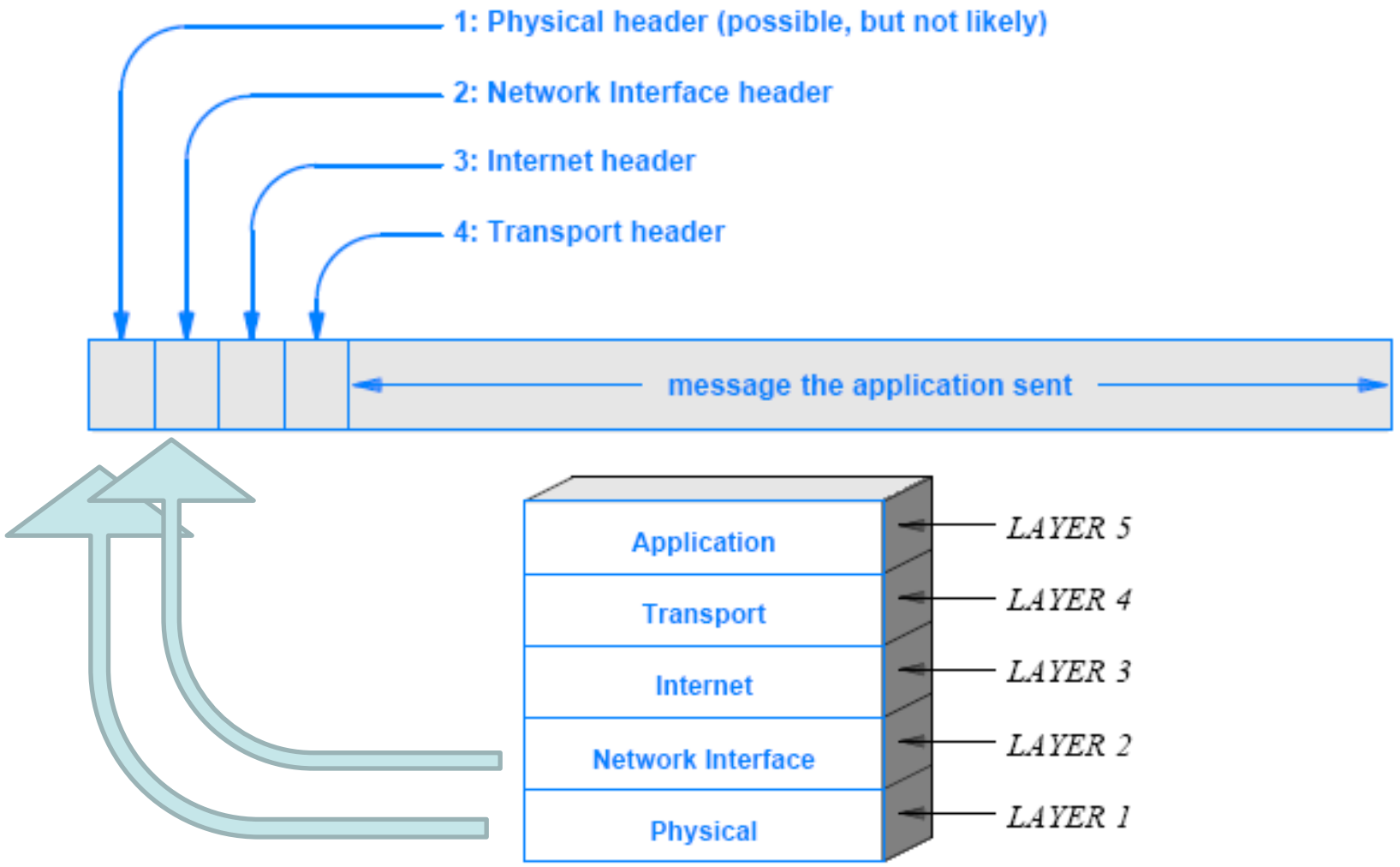


Each computer has a layered protocols



More complex routing!

Headers and Layers



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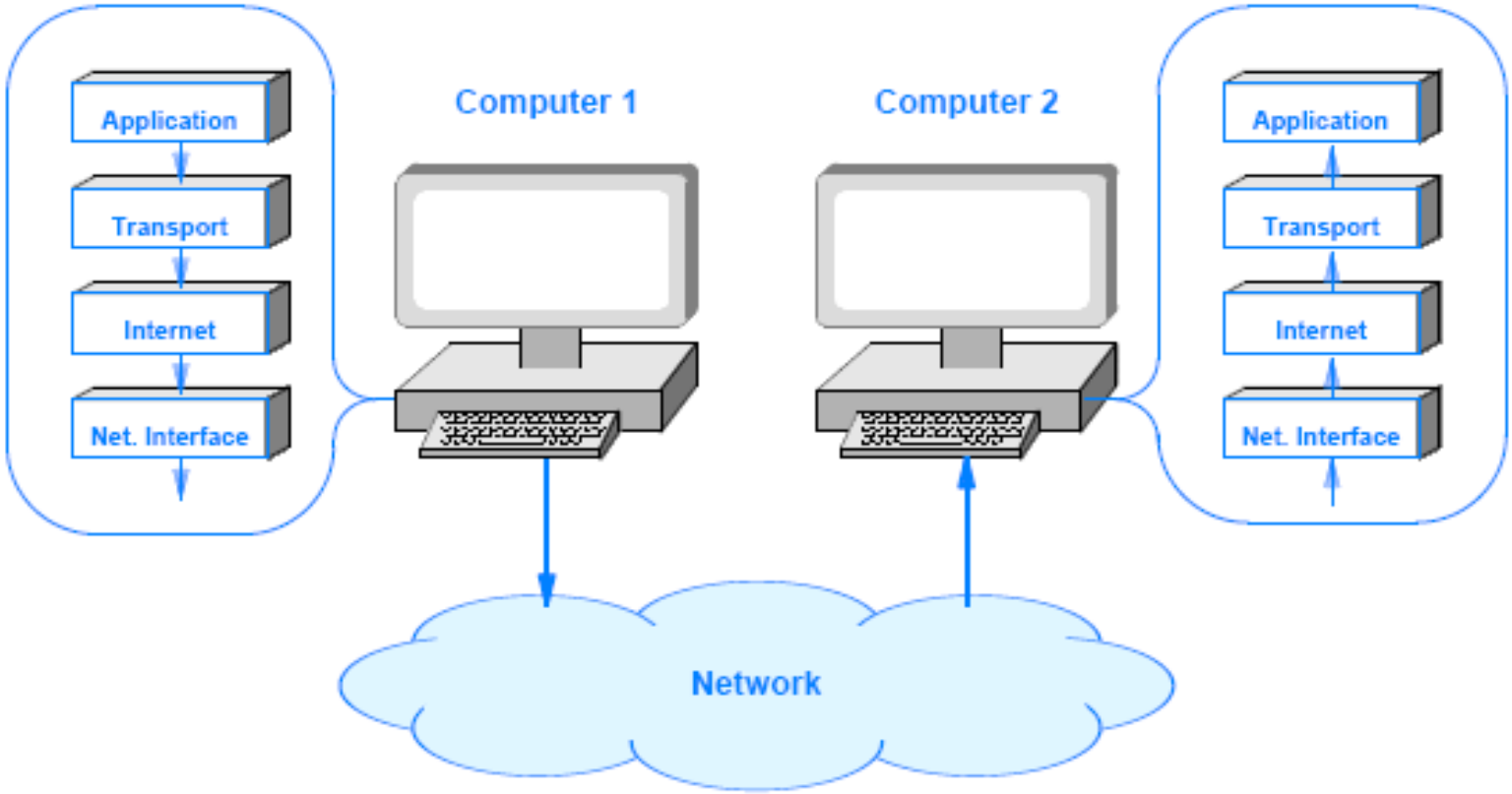


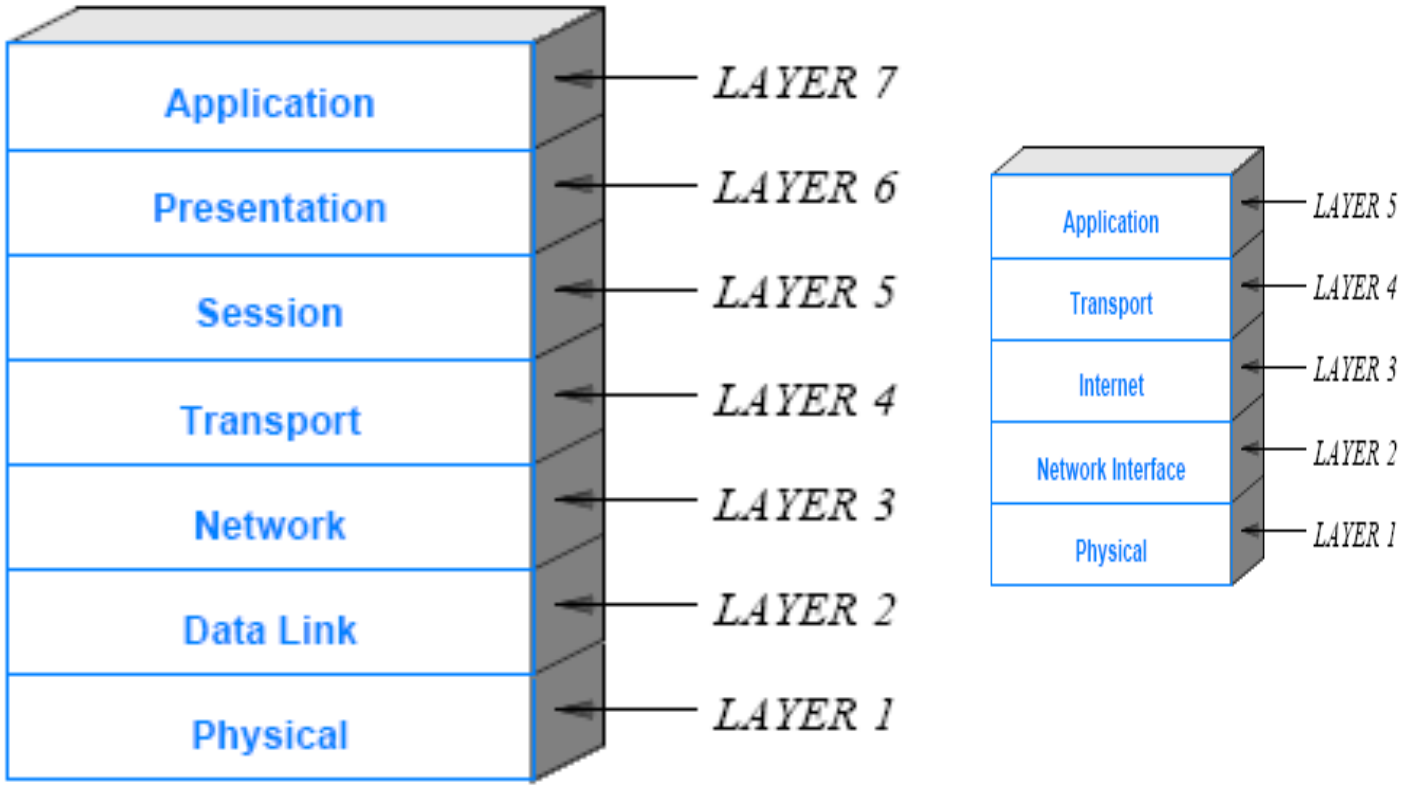
Demo

https://www.youtube.com/watch?v=Kb4hVvICx40

ISO and the OSI Seven-Layer Reference Model

- At the same time the Internet protocols were being developed, two large standards bodies jointly formed an alternative reference model
  - They also created a set of internetworking protocols
- These organizations are:
  - International Standardization Organization (ISO)
  - International Telecommunications Union, Telecommunication (ITU-T)
    - The ITU was known as the Consultative Committee for International Telephone and Telegraph (CCITT)
- The ISO layering model is known as the Open Systems Interconnection (OSI) Seven-Layer Reference Model

Open Systems Interconnection (OSI) Seven-Layer Reference Model



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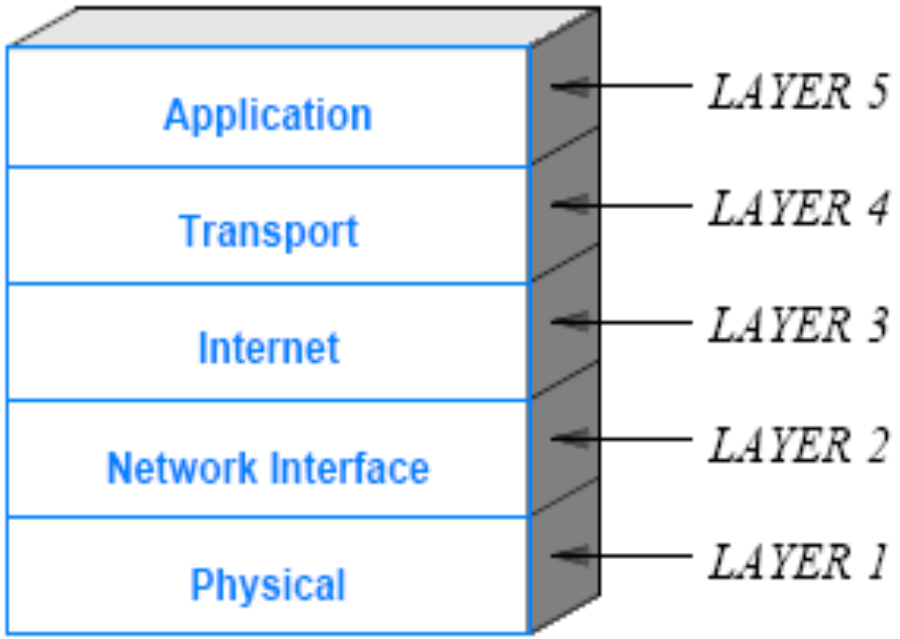
What is the plan?



Top-bottom / bottom-up approaches

References

Video

- Understanding the OSI Reference Model - https://www.youtube.com/watch?v=sVDwG2RdJho
- OSI Model (and TCP): https://www.youtube.com/watch?v=CXVINBruzhY
- Animation: https://www.youtube.com/watch?v=Kb4hVvlCx40

General

- https://www.youtube.com/user/soundtraining
- http://www.soundtraining.net/