Introduction to the Internet (II)

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Recall…

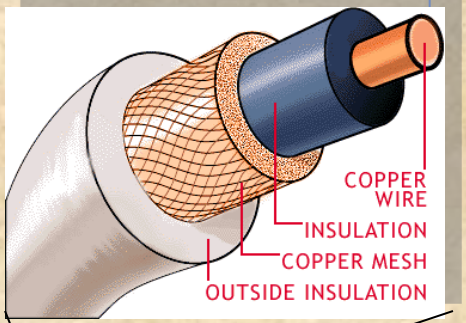
- Dos Commands
- Binary Operations
- IP + Mask: Network + Host
  - Application:
- Network Mask rule: 111…000
- Subnetting
  - Trade-off “network” & “host”

Agenda

- Transmission Media
- LAN
- Ethernet
- Extending LAN
- MAN/WAN
- Internetworking & ISO/OSI RM
- TCP/IP

Transmission Media

- Copper Wire
  - Unshielded Twisted Pair (UTP)
  - Coaxial Cable
  - Shielded Twisted Pair (STP)



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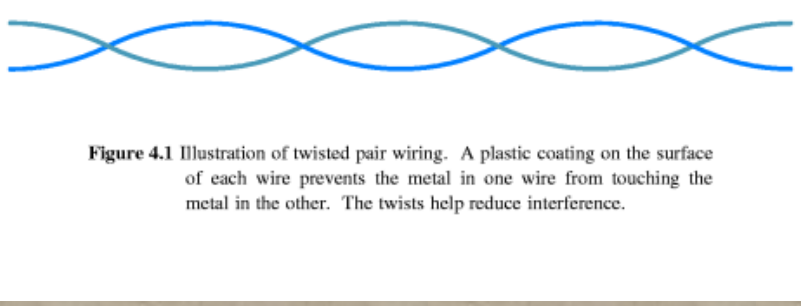


Figure 4.1 Illustration of twisted pair wiring. A plastic coating on the surface of each wire prevents the metal in one wire from touching the metal in the other. The twists help reduce interference.

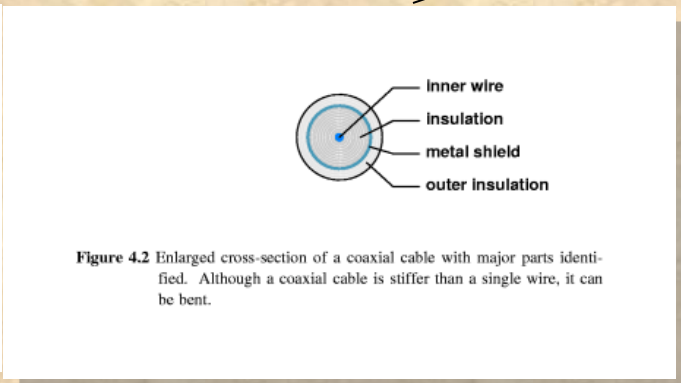


Figure 4.2 Enlarged cross-section of a coaxial cable with major parts identified. Although a coaxial cable is stiffer than a single wire, it can be bent.

Appendix

Twisted-Pair Cabling

There are different grades, or categories, of twisted-pair cabling. Category 5 is the most reliable and is highly recommended. Straight-through cables are used for connecting computers to a hub. Crossover cables are used for connecting a hub to another hub (there is an exception: some hubs have a built-in uplink port that is crossed internally, which allows you to link or connect hubs together with a straight-through cable instead).

You can buy pre-made Category 5 cabling, or cut and crimp your own. Category 5 cables can be purchased or crimped as either straight-through or crossover cables. A Category 5 cable has 8 thin, color-coded wires inside that run from one end of the cable to the other. All 8 wires are used. In a straight-through cable, wires 1, 2, 3, and 6 at one end of the cable are also wires 1, 2, 3, and 6 at the other end. In a crossover cable, the order of the wires change from one end to the other: wire 1 becomes 3, and 2 becomes 6. See the diagrams on the next page for more detailed information on straight-through and crossover cabling.

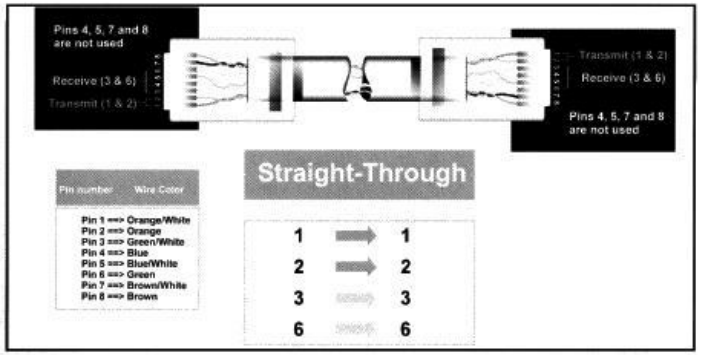
RJ-45 Color Chart

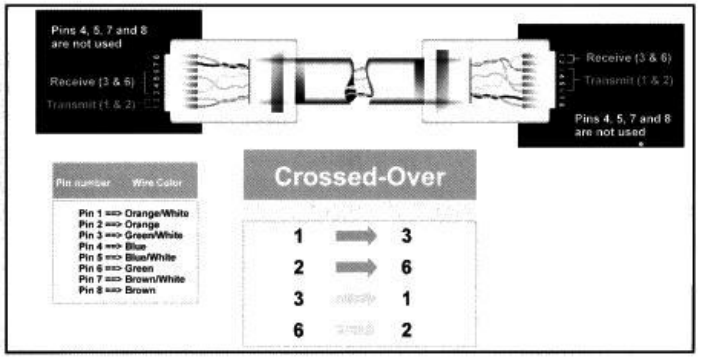
Wire 1	White with an Orange Stripe
Wire 2	Orange
Wire 3	White with a Green Stripe
Wire 4	Blue
Wire 5	White with a Blue Stripe
Wire 6	Green
Wire 7	White with a Brown Stripe
Wire 8	Brown

straight-through cable		crossed cable	
Wire	Becomes	Wire	Becomes
1	1	1	3
2	2	2	6
3	3	3	1
6	6	6	2

To determine which wire is wire number 1, hold the cable so that the end of the plastic RJ-45 tip (the part that goes into a wall jack first) is facing away from you. Face the clip down so that the copper side faces up (the springy clip will now be parallel to the floor).When looking down on the copper side, wire 1 will be on the far left.

Crimping Your Own Network Cables





Transmission Media (Cont.)

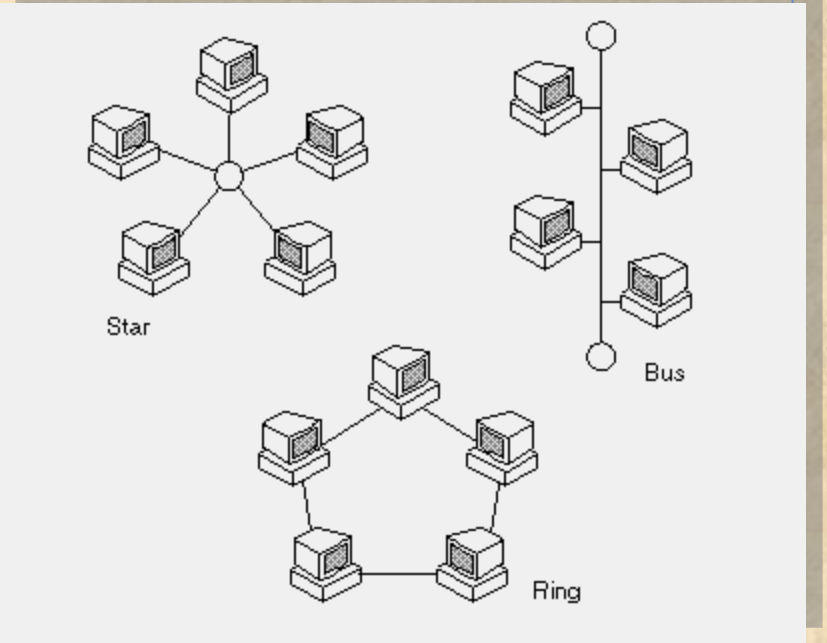
- Optical Fiber
  - Advantages
    - Cause no electrical interference in other cables
    - Carry a pulse of light much farther than a copper can carry a signal
    - Carry more information than a wire
    - Unlike electricity, light can travel from one computer to another over a single fiber
  - Disadvantages:
    - Special equipments are needed to allow light to pass through
    - If a fiber breaks, finding the location is hard
- Satellites, Geosynchronous Satellites
- Microwave, Infrared

Local Area Networks (LAN)

- LAN technologies have become the most popular form of computer networks which connect more computers than any other type of network
- LAN
  - **topology** : The geometric arrangement of devices on the network. For example, devices can be arranged in a ring or in a straight line.
  - **protocols** : The rules and encoding specifications for sending data. The protocols also determine whether the network uses a peer-to-peer or client/server architecture.
  - **media** : Devices can be connected by twisted-pair wire, coaxial cables, fiber optic cables, or wireless

LAN topologies

- **Bus topology**
  - All devices are connected to a central cable, called the bus or backbone.
- **Ring topology**
  - All devices are connected to one another in the shape of a closed loop, so that each device is connected directly to two other devices, one on either side of it.
- **Star topology**
  - All devices are connected to a central hub
- **Tree topology**
  - A tree topology combines characteristics of linear bus and star topologies



Ethernet

- Ethernet is the most widely-installed local area network
- Specified in a standard, IEEE 802.3, Ethernet was originally developed by Xerox from an earlier specification called Alohanet
- Devices are connected to the cable and compete for access using a Carrier Sense Multiple Access with Collision Detection (**CSMA/CD**) protocol.

Ethernet (Cont.)

- CSMA/CD Send/Receive
- CSMA/CD Animation

WLAN

- A mobile user can connect to a local area network (LAN) through a wireless (radio) connection
- A standard, IEEE 802.11, specifies the technologies for wireless LANs

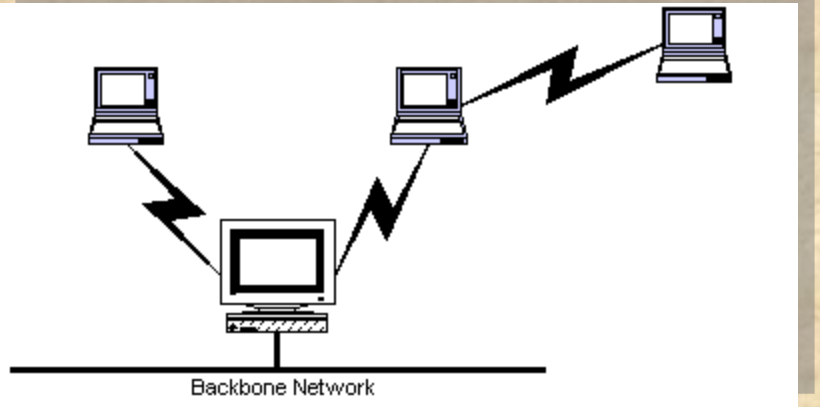


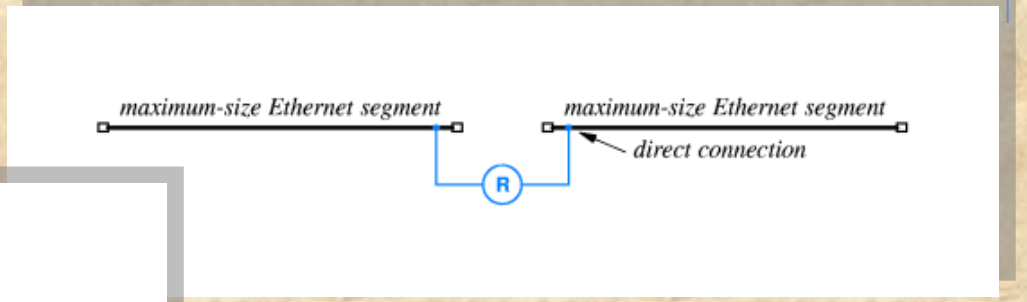
Figure from http://www.cse.wustl.edu/~jain/cis788-99/ftp/wireless_lans/index.html

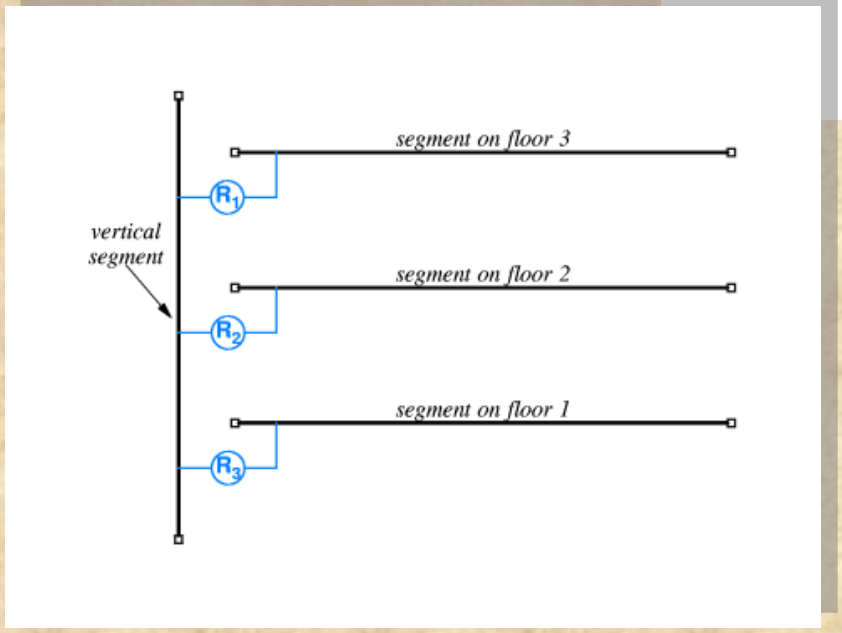
Extending LAN

- Repeaters
- Hubs
- Switches
- Bridges

Extending LAN (Cont.)

- Repeaters

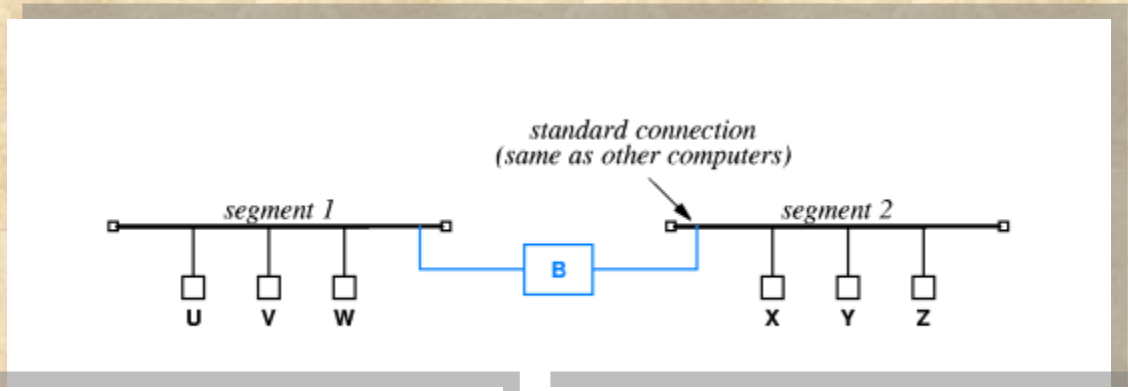


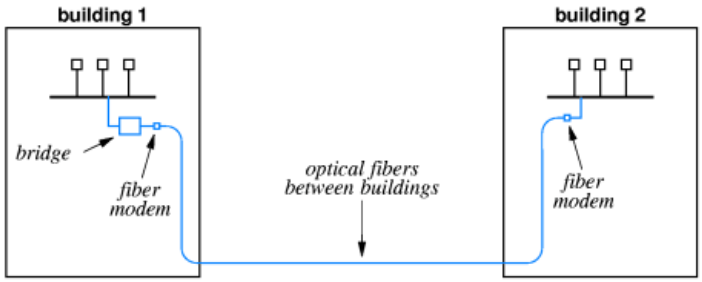


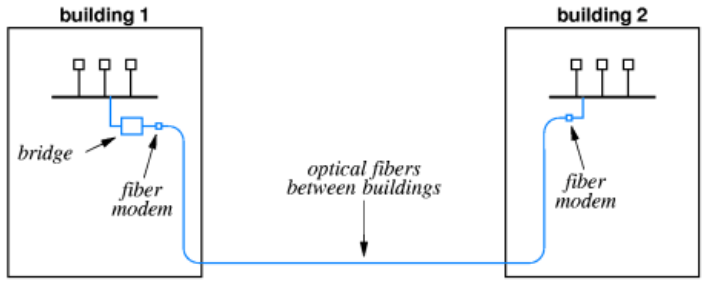
Source: http://penguin.dcs.bbk.ac.uk/academic/networks/data-link-layer/extending-lans/index.php

Extending LAN (Cont.)

- Bridged LAN segments
  - Optical bridge
  - Satellite bridge

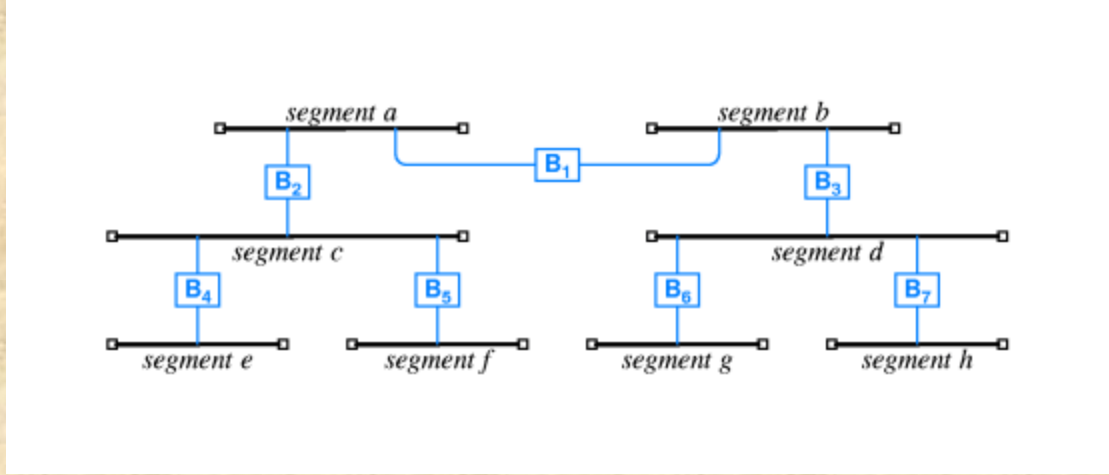






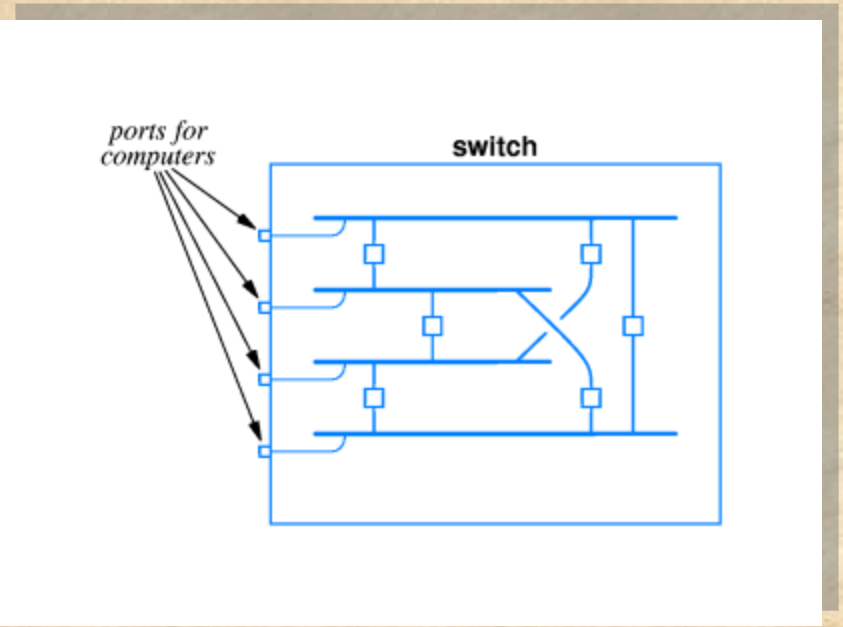
Extending LAN (Cont.)

- Spanning bridges



Extending LAN (Cont.)

- Switches
  - **Switched LAN**



MAN, WAN

- Metropolitan Area Network (MAN)
- Wide Area network (WAN)
  - Forming a WAN
    - ARPANET
    - X.25
    - Frame Relay
    - ATM

Internetworking

- Motivation
- Concept of Universal Service
- A Virtual Network

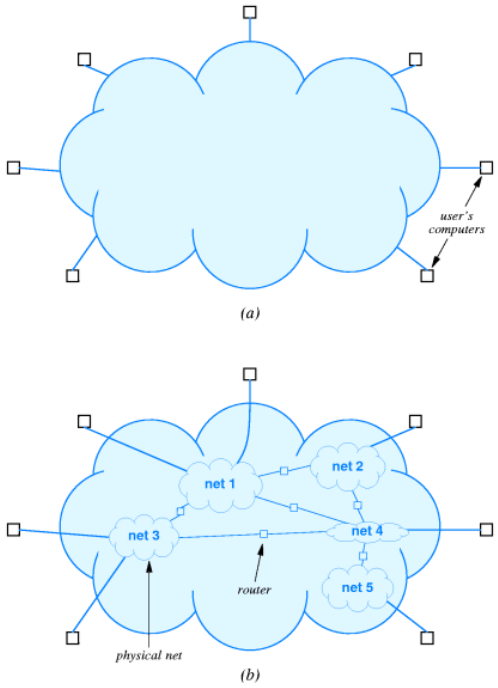


Figure 17.3 The internet concept. (a) The illusion of a single network that TCP/IP software provides to users and applications, and (b) the underlying physical structure in which a computer attaches to one physical network, and routers interconnect the networks.

Internetworking

- ISO/OSI Reference Model
  - ISO: International Systems Organisation
  - OSI: Open Systems Interconnection
- TCP/IP RM
  - TCP/IP stands for **T**ransmission **C**ontrol **P**rotocol / **I**nternet **P**rotocol

ISO/OSI RM

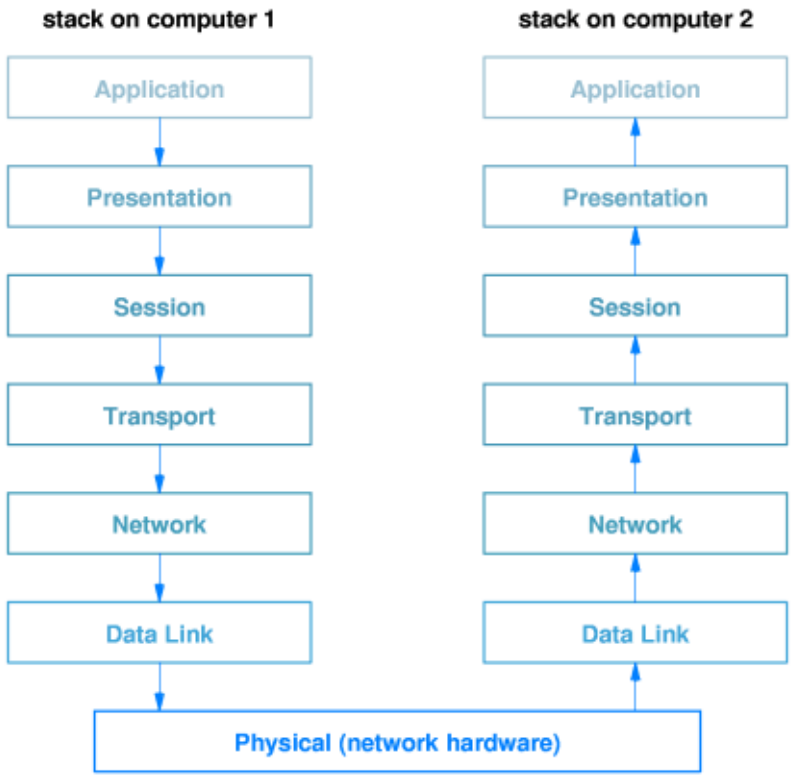


Figure 16.2 The conceptual path of data as it travels from an application on computer 1 across a network to an application on computer 2.

ISO International Systems Organisation
OSI Open Systems Interconnection

ISO/OSI RM (Cont.)

- AL
  - Specified one particular application
- PL
  - How to present data
- SL
  - Specify how to establish a communication session
- TL
  - How to handle details of reliable transfer
- NL
  - How addresses are assigned and how packets are forwarded
- DL
  - How to organize data into frames
- PHL
  - Correspond to basic network hardware

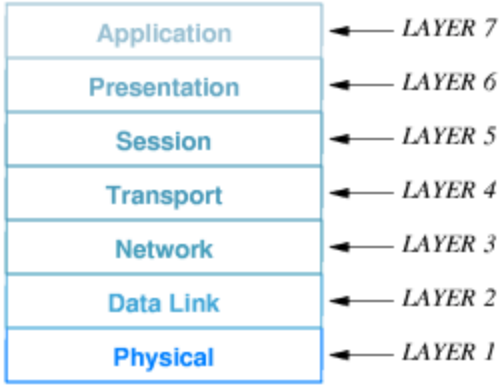


Figure 16.1 The historic ISO 7-Layer Reference Model. A layering model is a tool to help protocol designers construct a suite of protocols that solves all communication problems.

TCP/IP RM

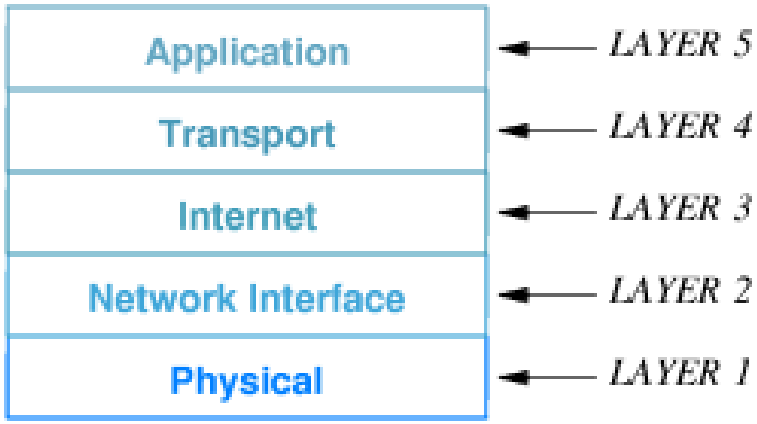
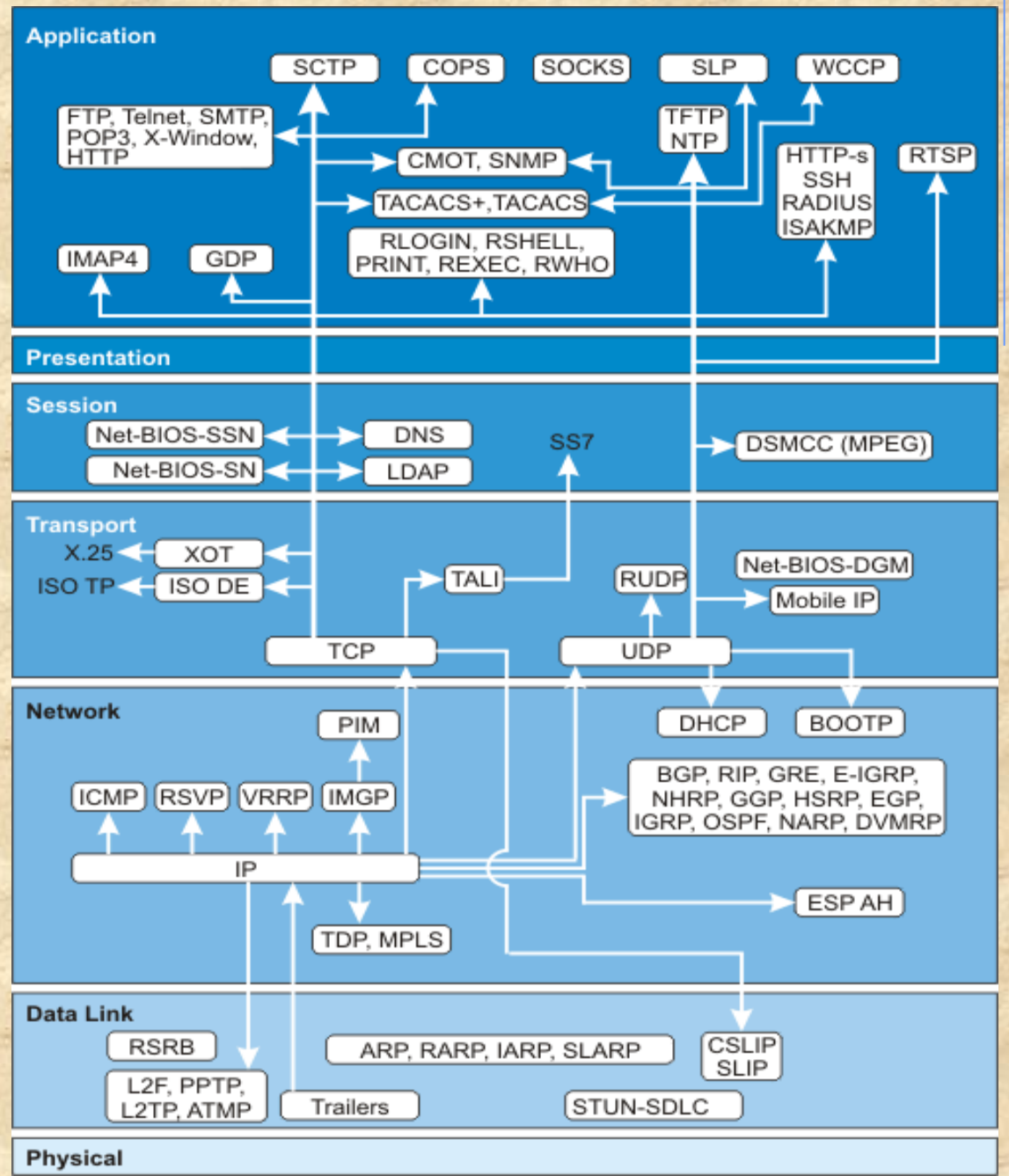


Figure 17.4 The five layers of the TCP/IP reference model.

Protocols Suites



TCP Header

16								32 bits
Source port								**Destination port**
Sequence number								
Acknowledgement number								
Offset	Resrvd	U	A	P	R	S	F	Window
Checksum								Urgent pointer
Option + Padding								
Data								

TCP header structure

IP Header

- IP is defined by IETF RFC791

4	8	16	32 bits
Ver.	IHL	Type of service	Total length
Identification		Flags	Fragment offset
Time to live	Protocol	Header checksum	
Source address			
Destination address			
Option + Padding			
Data			

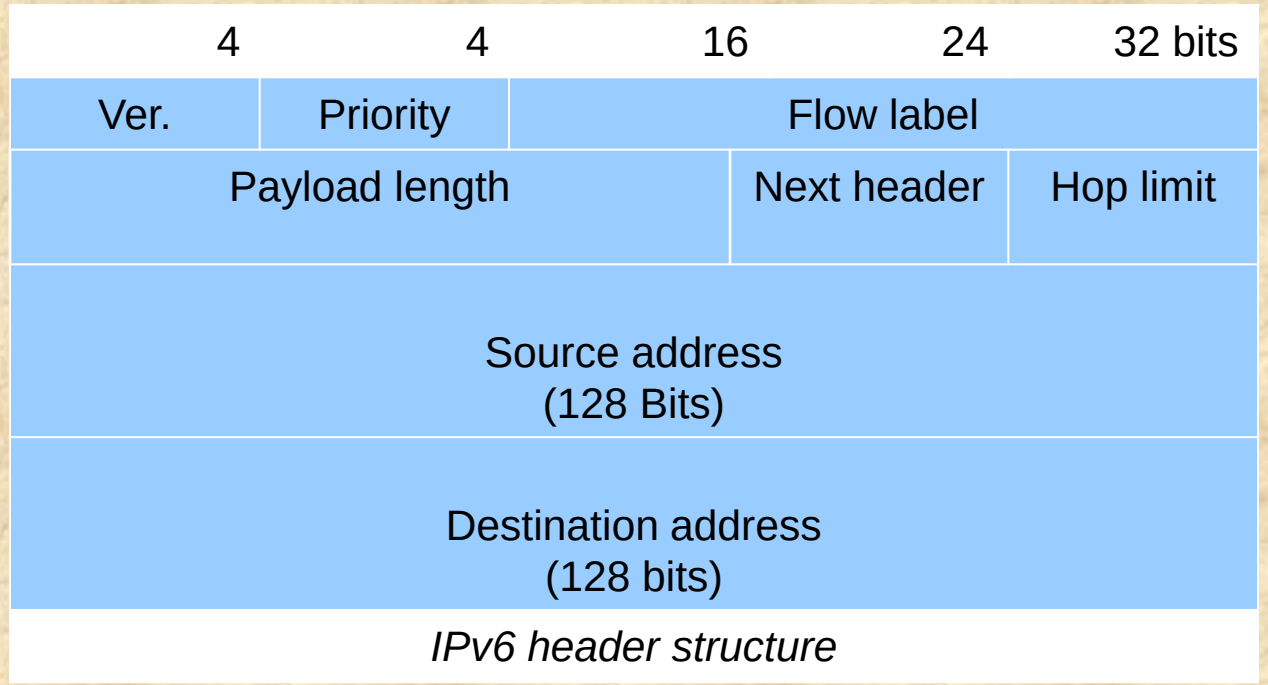
IP header structure

UDP Header

16	32 bits
Source port	Destination port
Length	Checksum
Data	

UDP header structure

IPv6



IPv6 header structure

References

1. http://www.auggy.mlnet.com/ibm/3376fm.html
2. DNS: http://www2.rad.com/networks/1998/dns/main.html#whatisdns
3. IPV6: http://www.ipv6.org/
4. Douglas E. Comer, *Computers Networks and Internets with Internet Applications*, 4e, Person Prentice Hall, 2004
5. *Yuhai Tu,* How robust is the Internet? *Nature*, Vol 406, July 2000
6. searchnetworking.techtarget.com
7. compnetworking.about.com