06

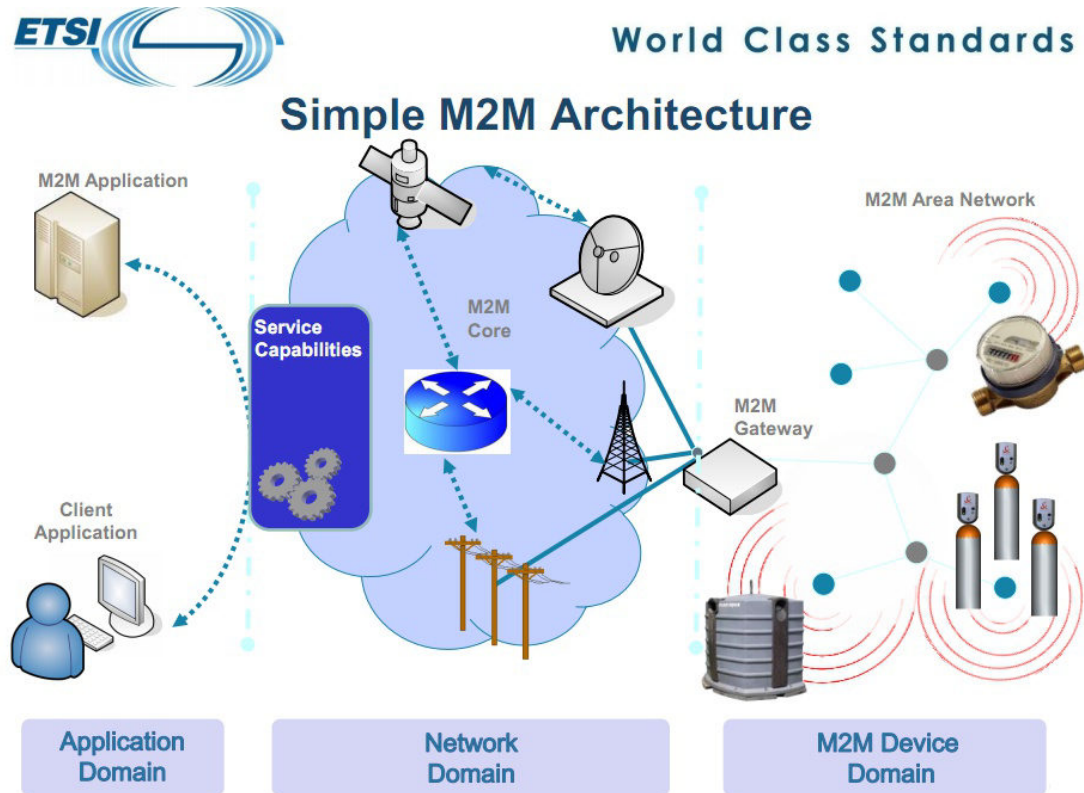# Networking

Communication: Human-to-human

Communication: Human-to-machine
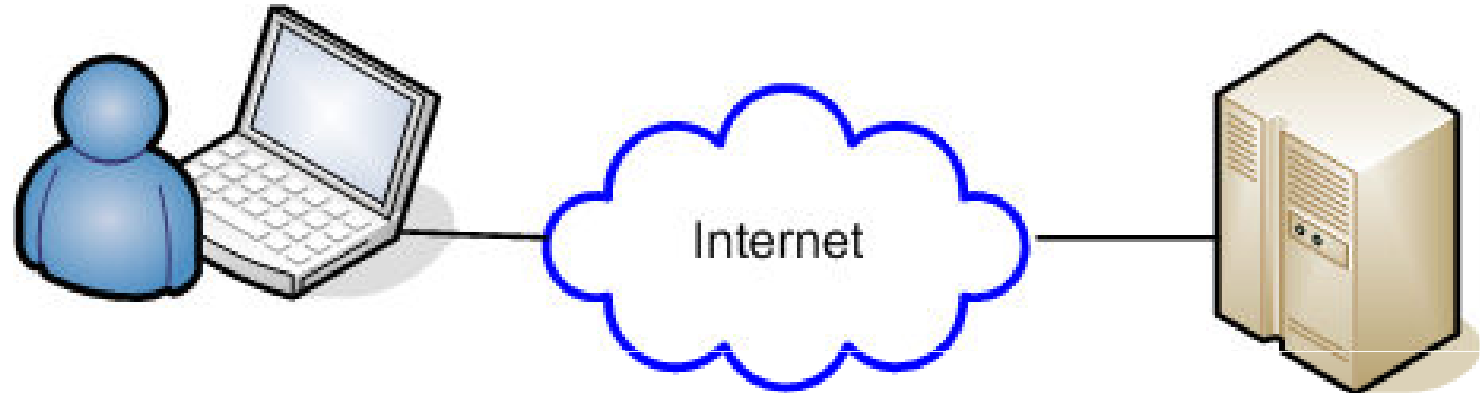
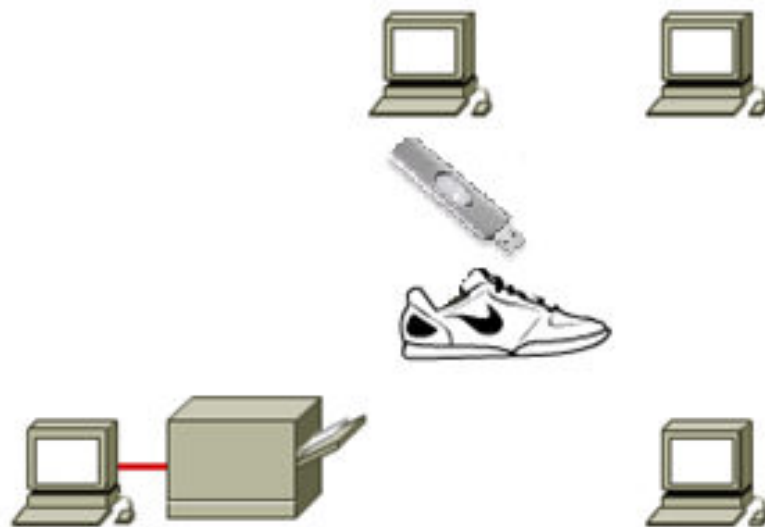# Communication: Machine-to-machine

Simple M2M Architecture (courtesy ETSI)

Machine-to-machine communications can be used to monitor traffic in real time, like at this Los Angeles traffic center.
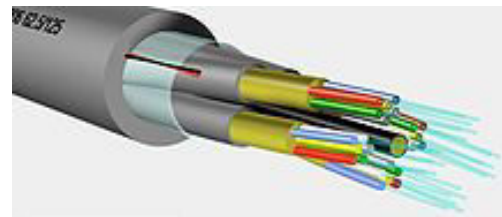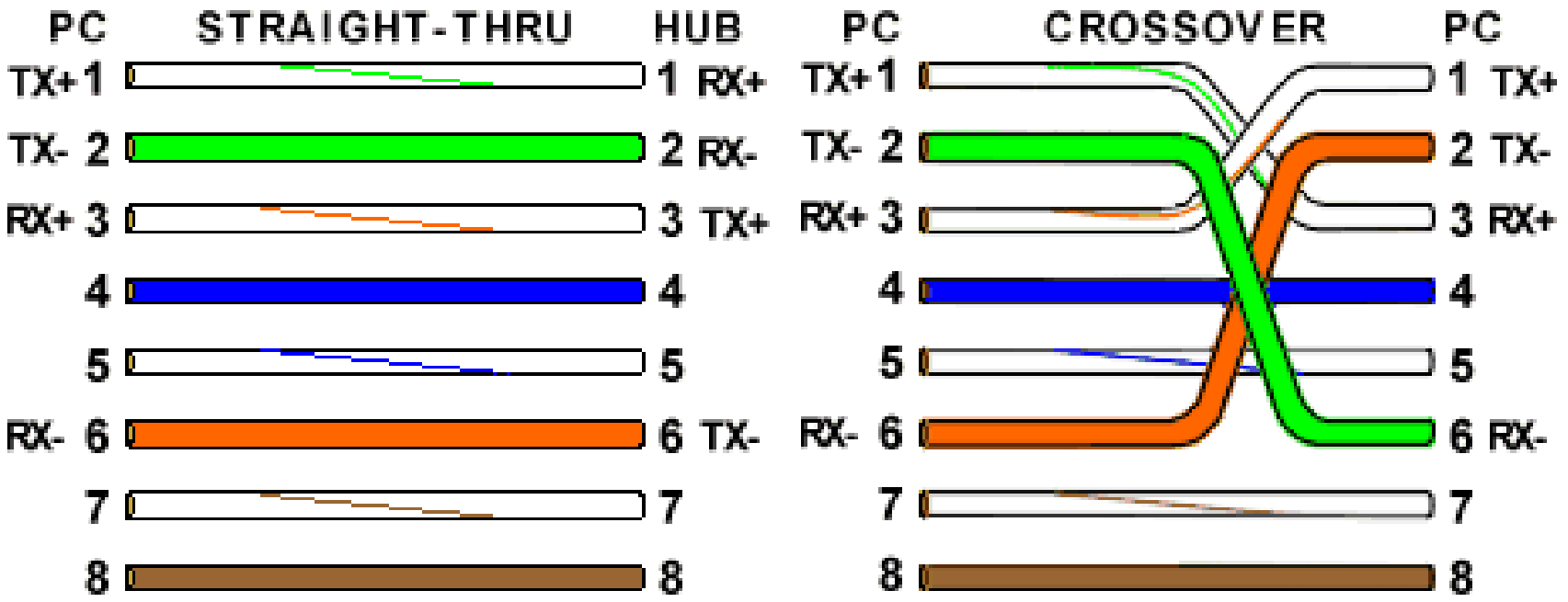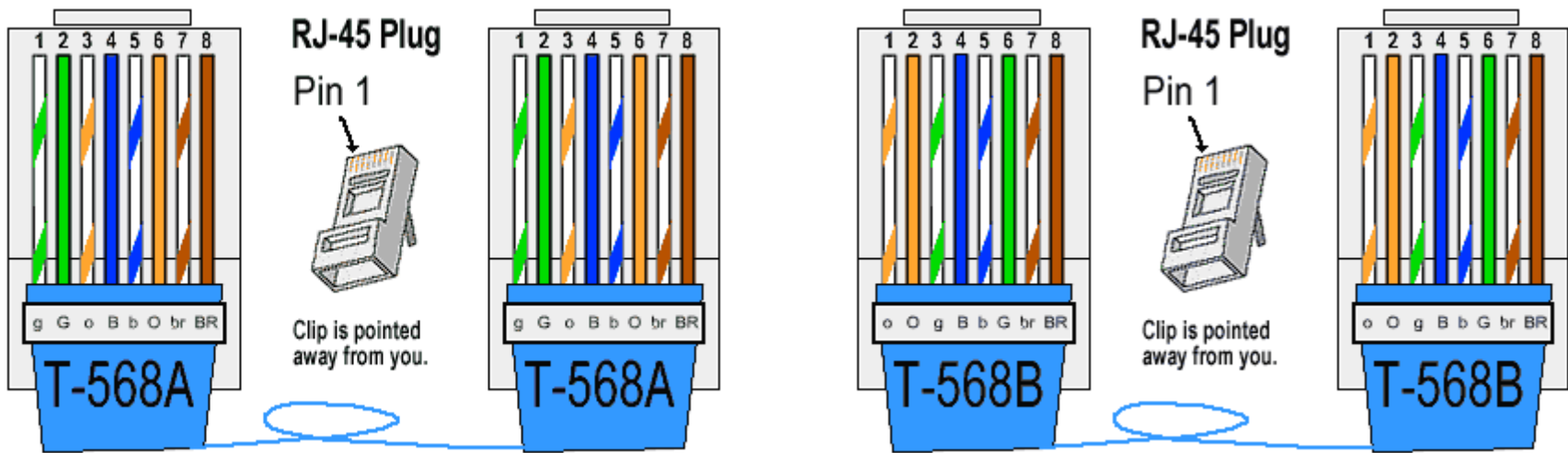© David McN ew/Getty Images

The need: data transfer

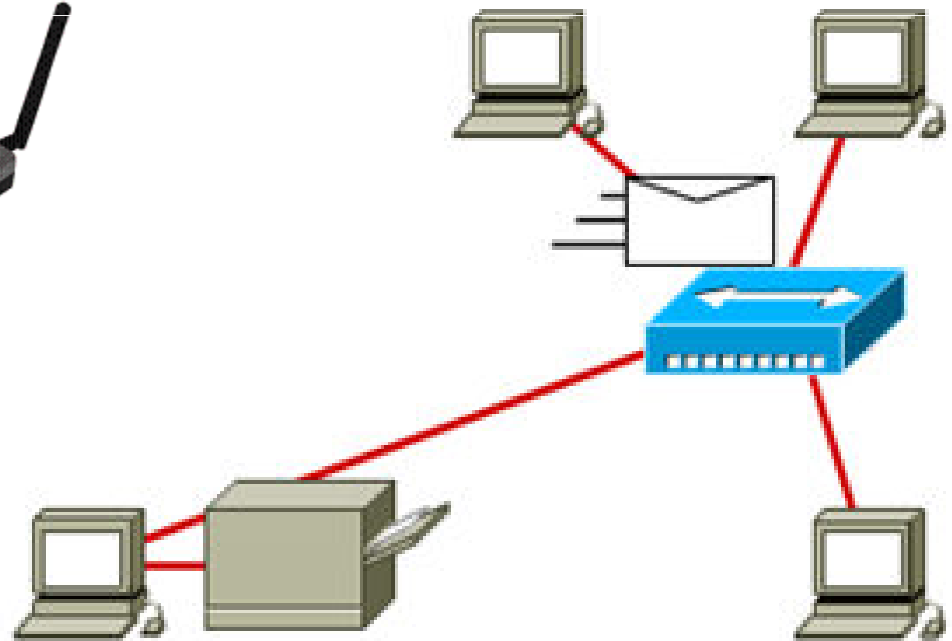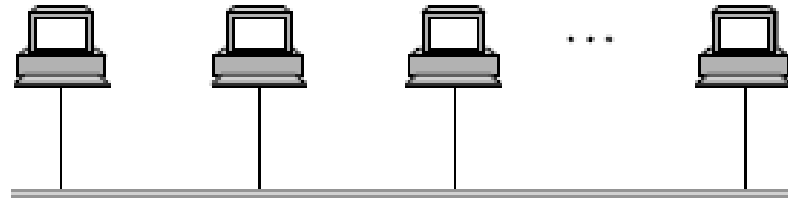- Sneaker-net

Connectivity: directly connected

- Point-to-point

Cable with
RJ45 connection

NIC Card

T-568A — T-568A

T-568B — T-568B

RJ-45 Plug

Pin 1

Clip is pointed away from you.

PC	STRAIGHT-THRU	HUB
TX+1		1 RX+
TX- 2		2 RX-
RX+ 3		3 TX+
4		4
5		5
RX- 6		6 TX-
7		7
8		8

PC	CROSSOVER	PC
TX+1		1 TX+
TX- 2		2 TX-
RX+ 3		3 RX+
4		4
5		5
RX- 6		6 RX-
7		7
8		8

Connectivity: directly connected

- Multiple access

When a link has been established…

- Software has to manage the communication over it
  - both sides **agree** as to the format of that information
  - Address; message
  - Framing
  - Packet format
  - Error handling etc.

Physical Addressing

Frame format

Ethernet

Preamble	Destination Address	Source Address	Type	DATA	FCS
8	6	6	2	46-1500	4

IEEE 802.3

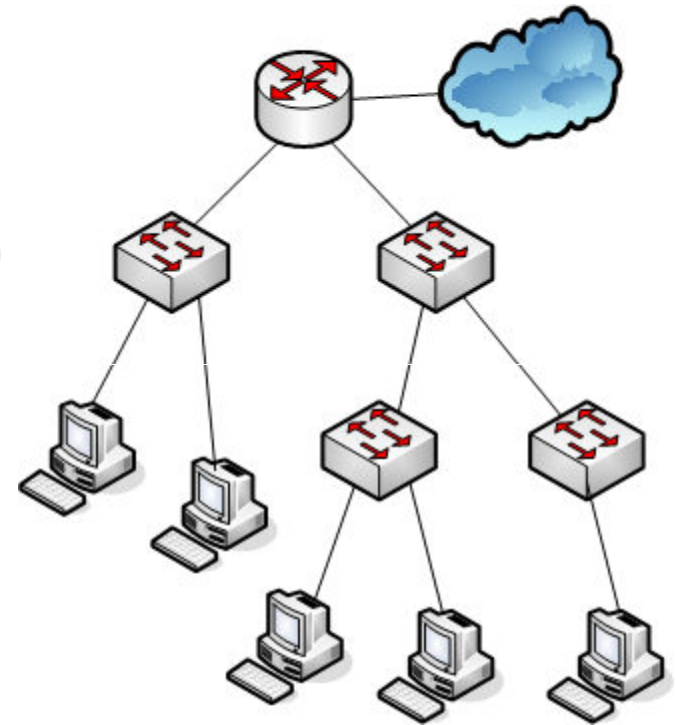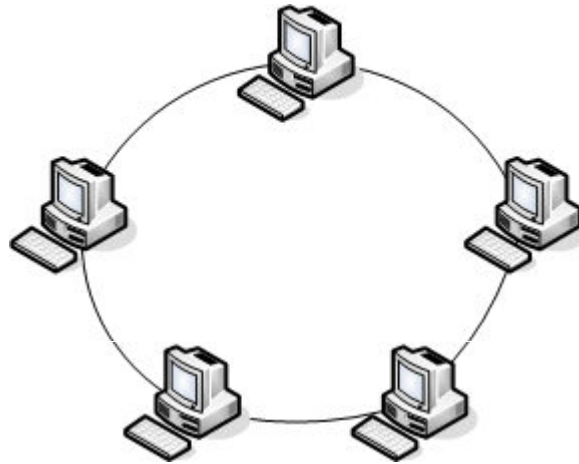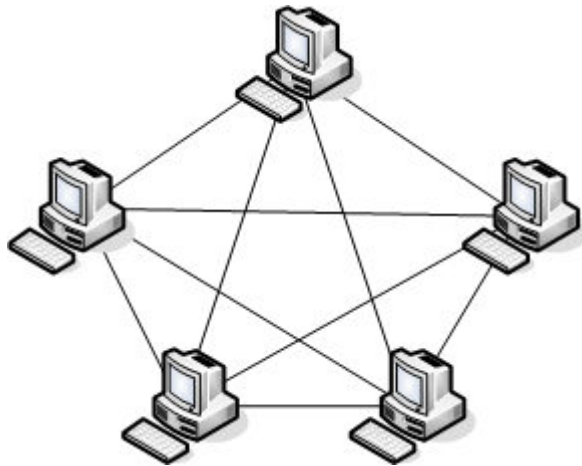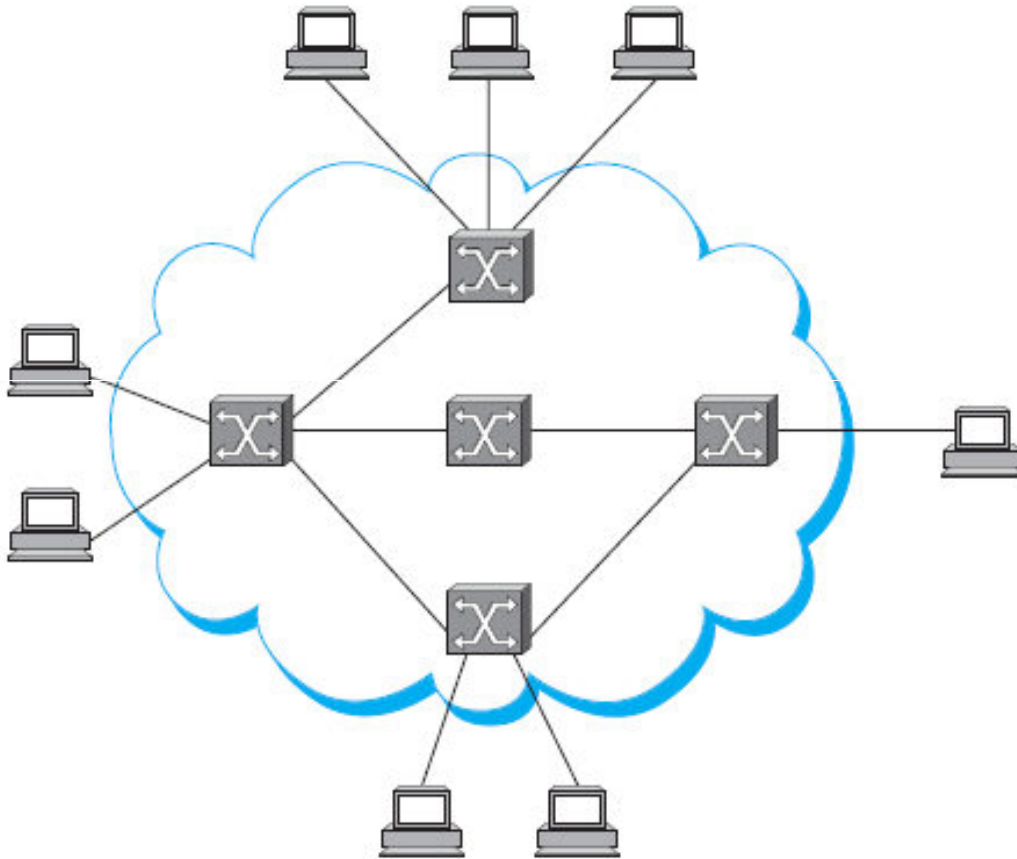| Preamble	S O F	Destination Address	Source Address	Length	802.2 Header	DATA	FCS
7	1	6	6	2		46-1500	4

The field length are in bytes

Network Topologies
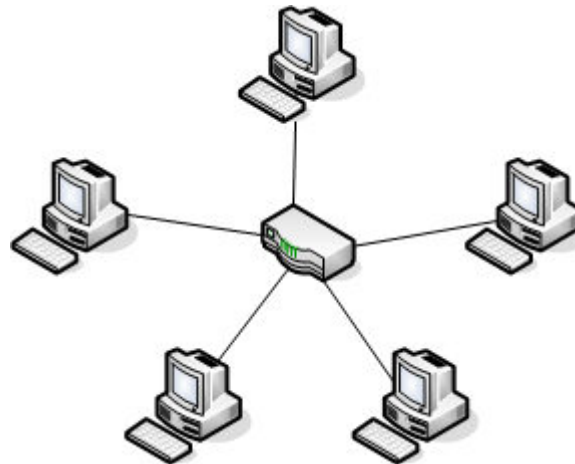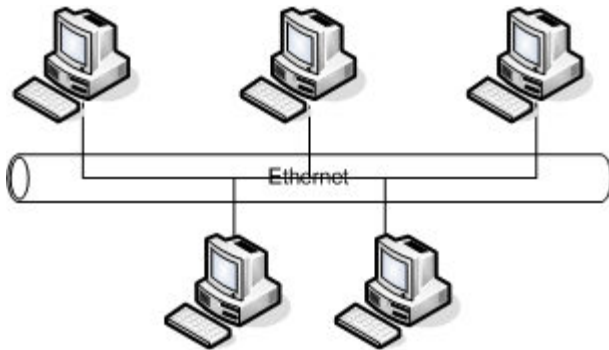
Indirect connectivity: Switched network


- Nodes:
  - Host: support users and run application programs
  - Switch: implement the network; to store and forward packets
- Cloud:
  - denote any type of network, whether it is a single point-to-point link, a multiple-access link, or a switched network
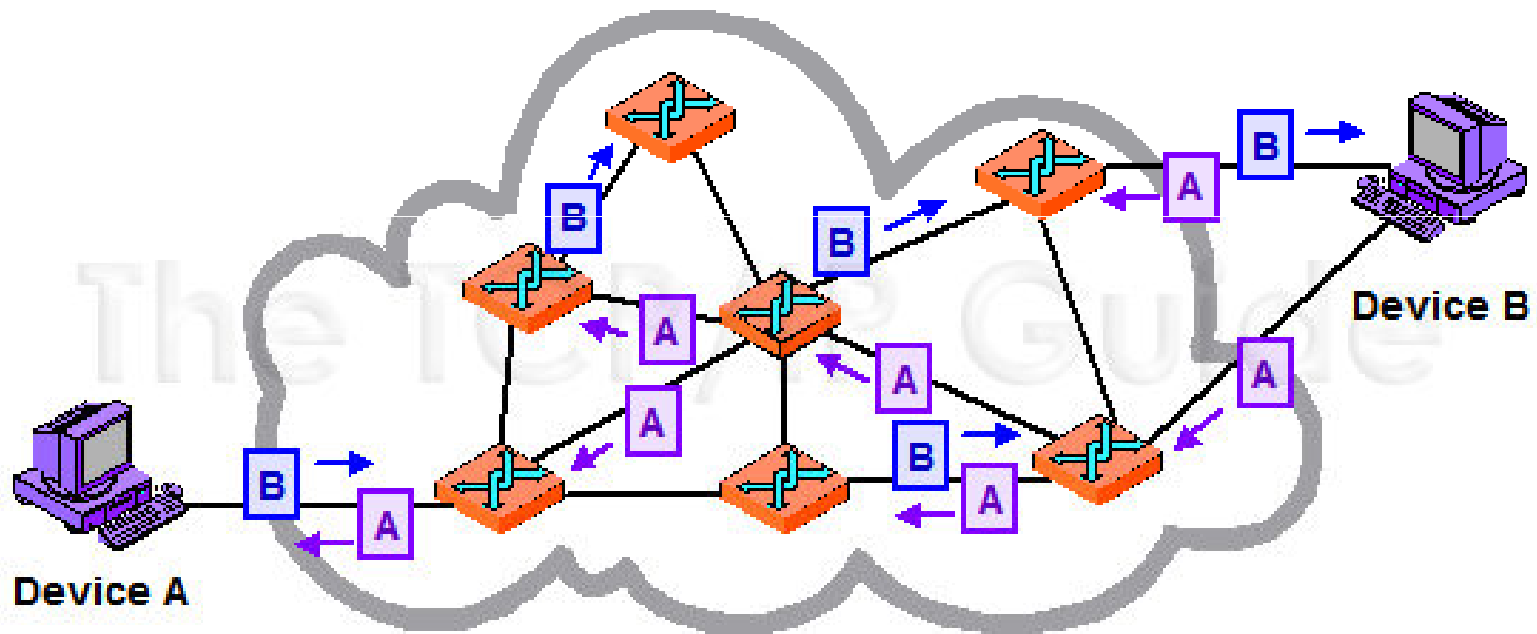
Circuit vs packet switched

- In the circuit switching, source and destination need to make connection establishment
  - Example: telephone network

- In the packet switching method the nodes in such a network send discrete blocks of data to each other.
  - Example: the Internet
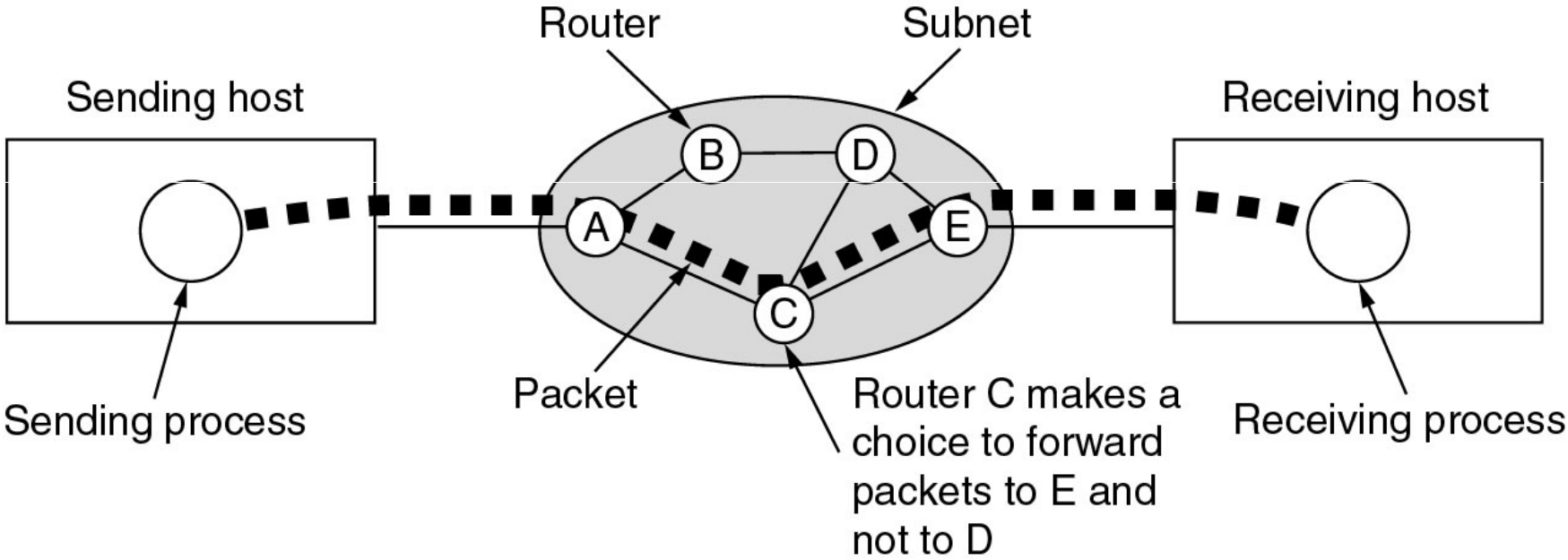 - Analogy: postal network
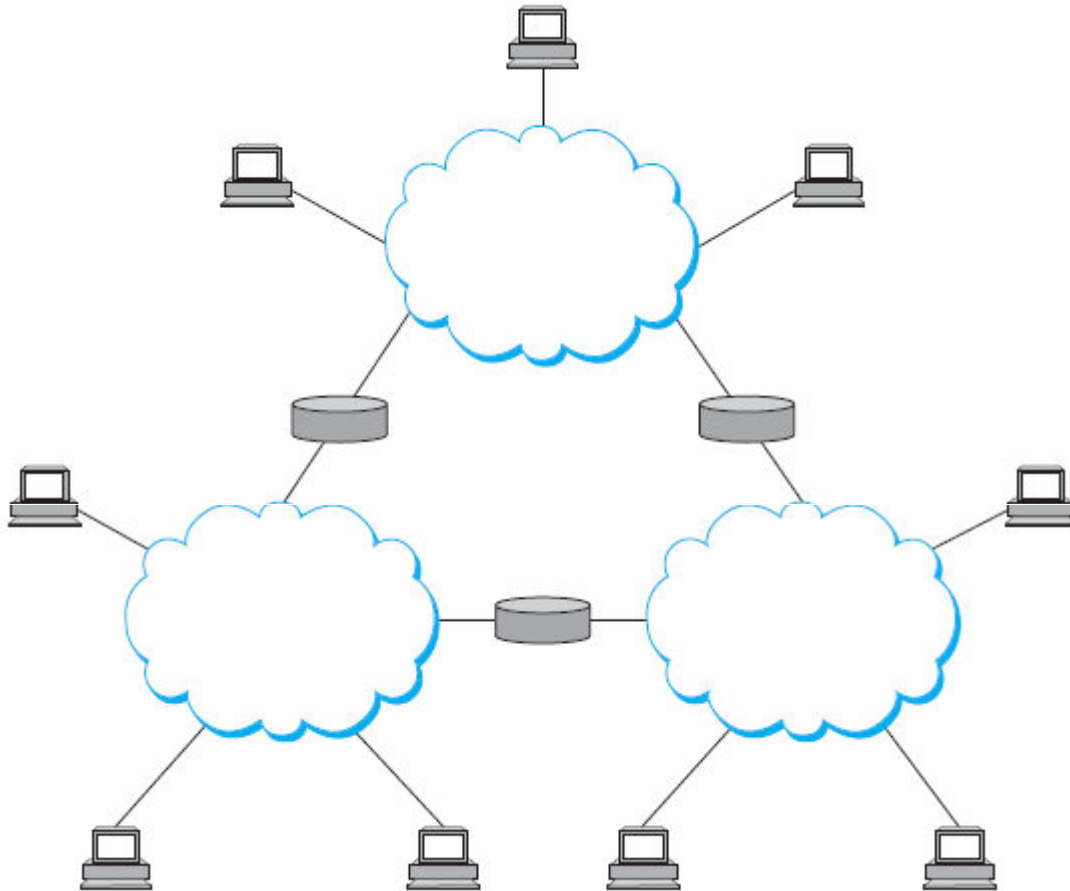
Circuit switching
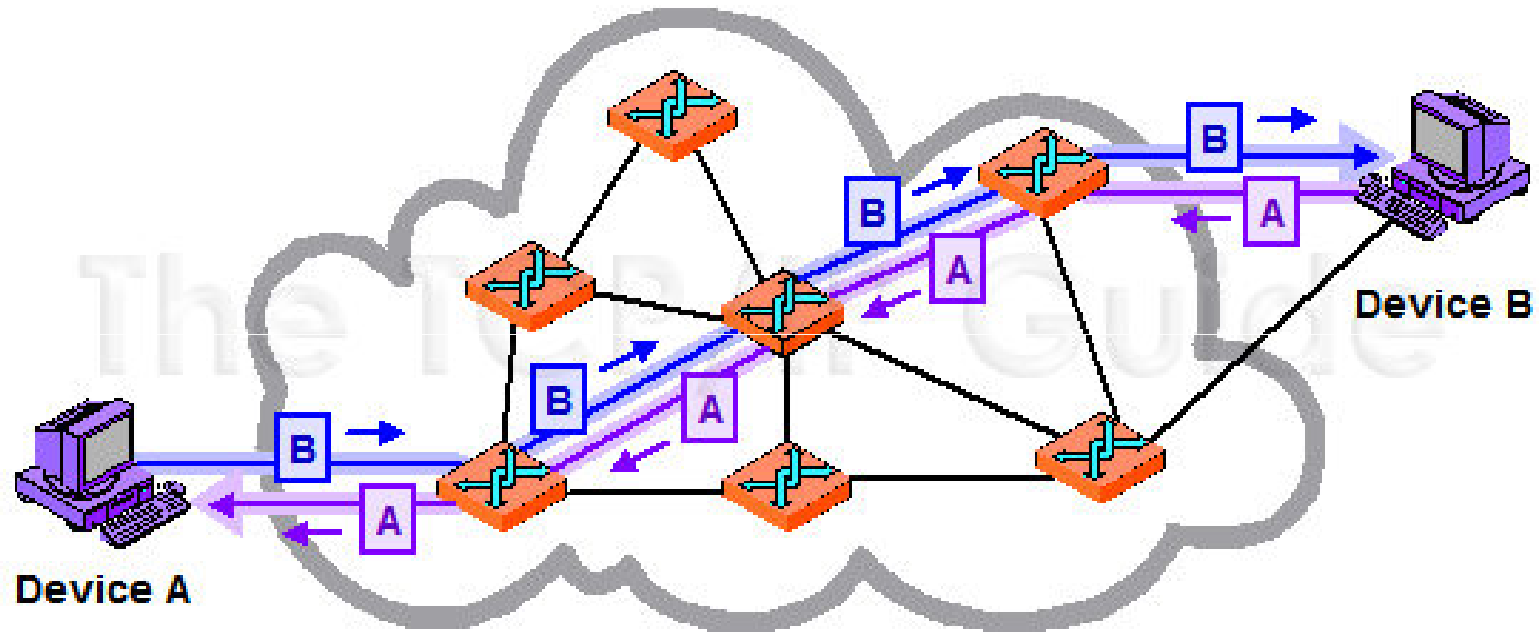
Packet switching

- Store-and-forward strategy

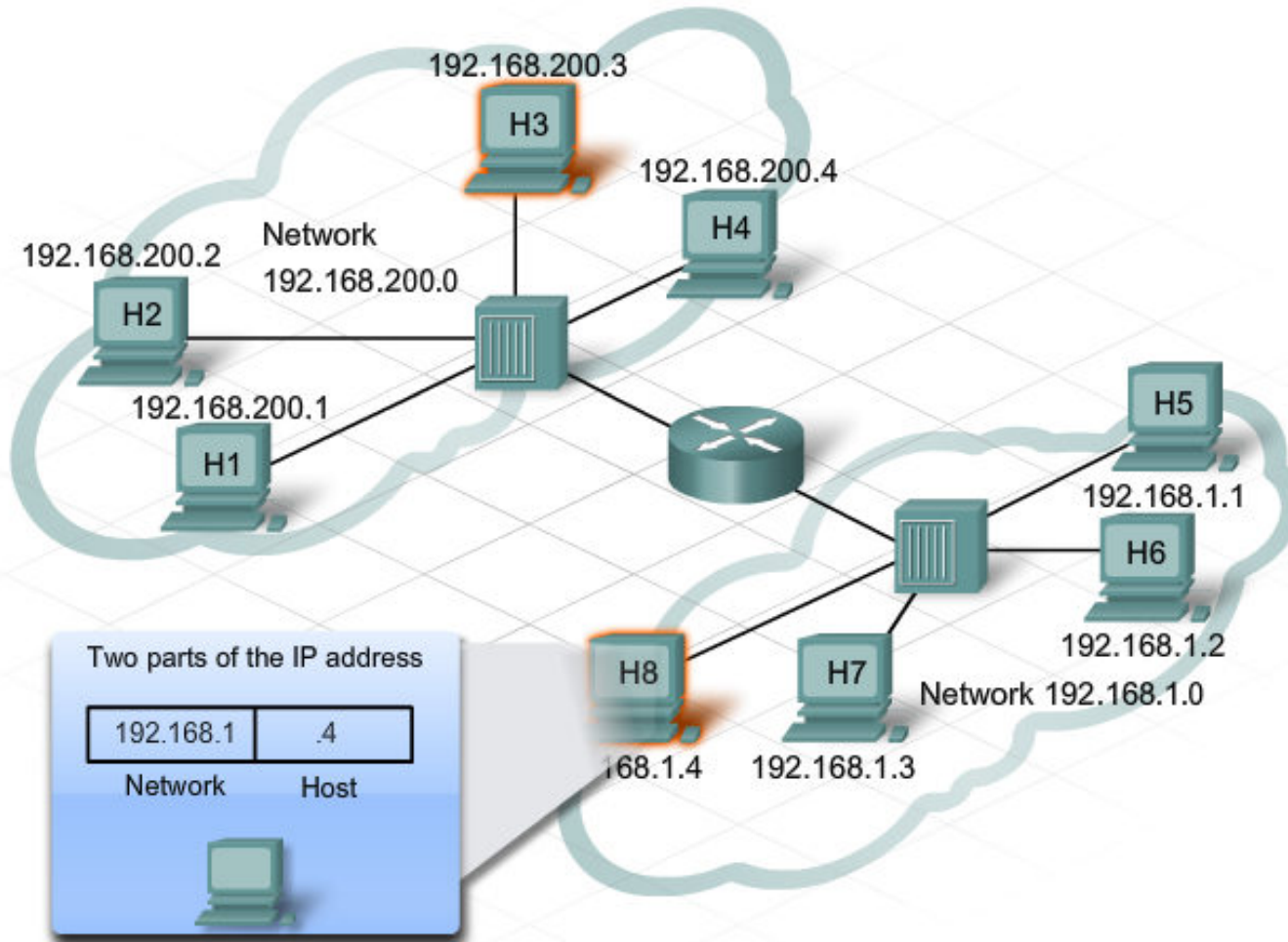# Routing & Forwarding

Indirect connectivity: internetwork

▶ Router / gateway:
  ◦ A node that is connected to two or more networks
  ◦ Forwards messages from one network to another

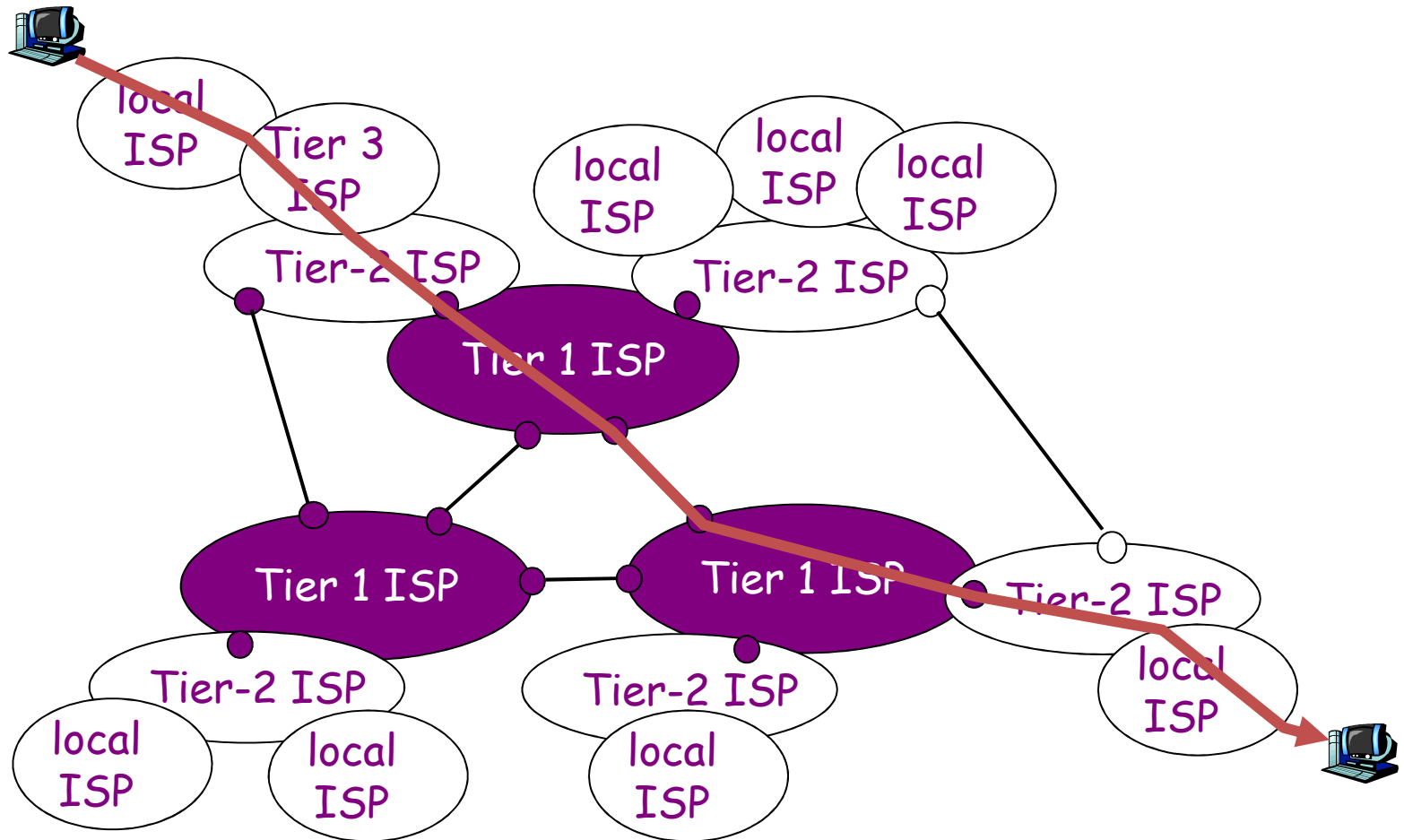▶ We can recursively build arbitrarily large networks
  ◦ Internet = interconnection of internets; network of networks

# Logical Addressing

Internet structure: network of networks

- a packet passes through many networks!

Protocols

- **a set of rules** which is used by computers to communicate with each other across a network.

- a convention or **standard** that controls or enables the connection, communication, and data transfer between computing endpoints.

- In its simplest form, a protocol can be defined as the rules governing the **syntax**, **semantics**, and **synchronization** of communication.
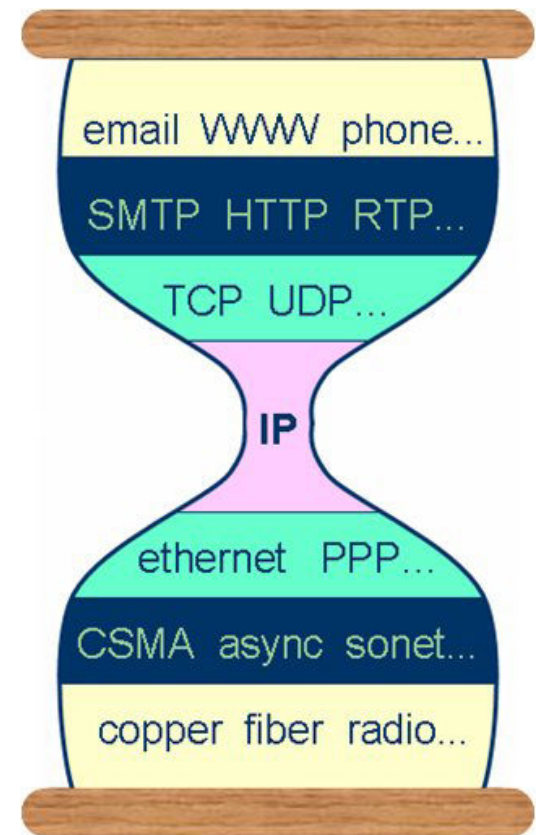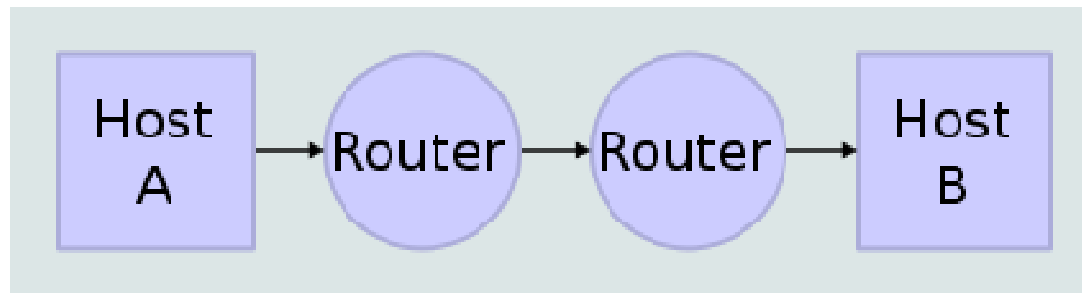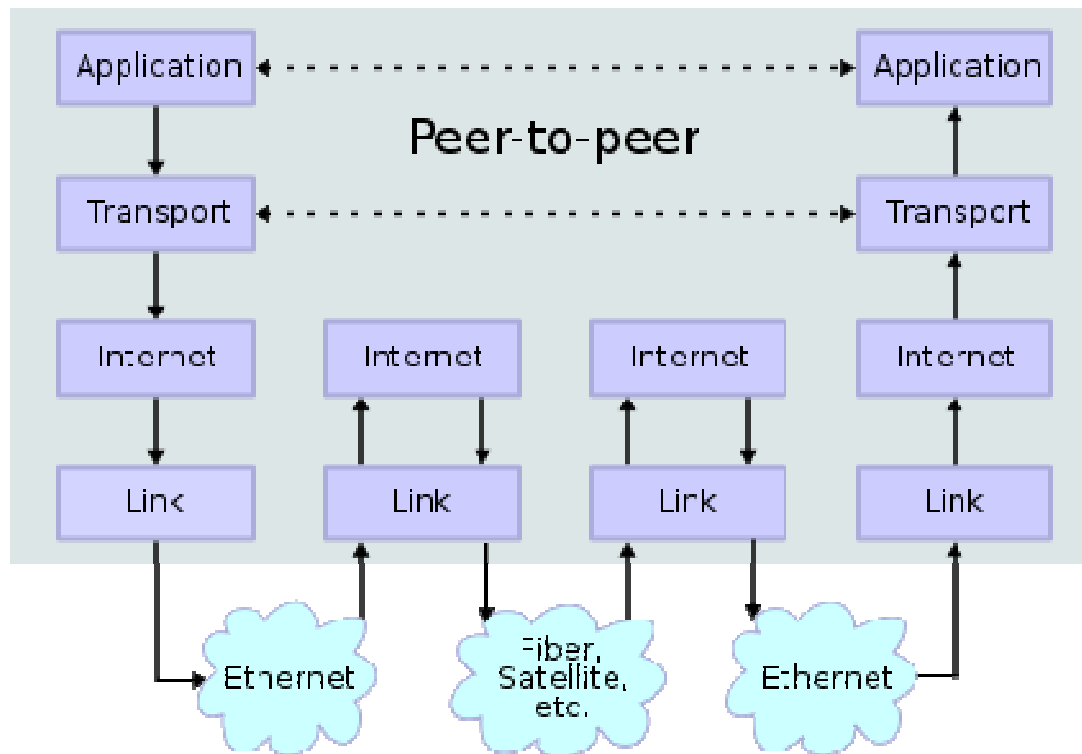
Protocol Suites
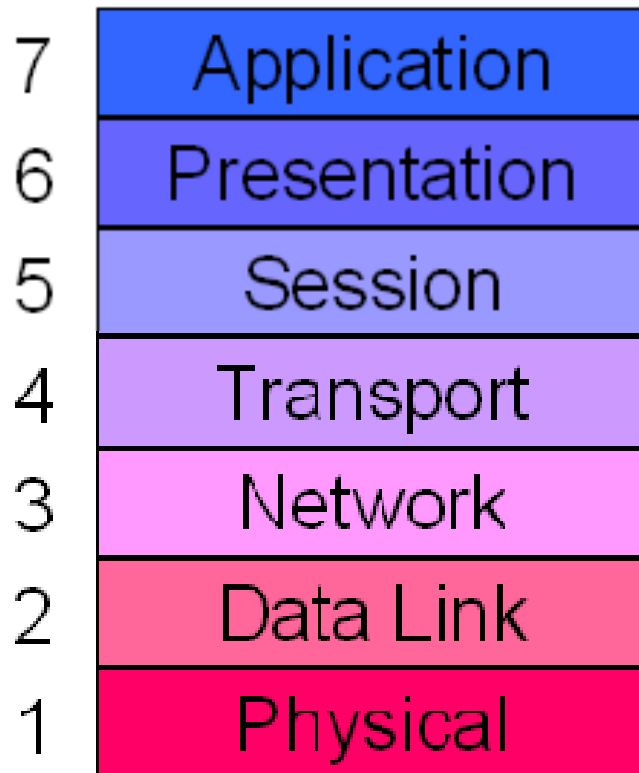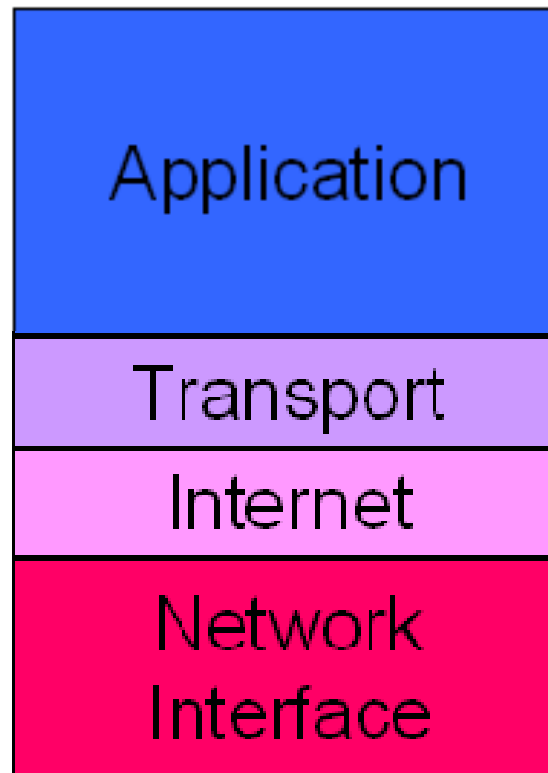
Network Connections
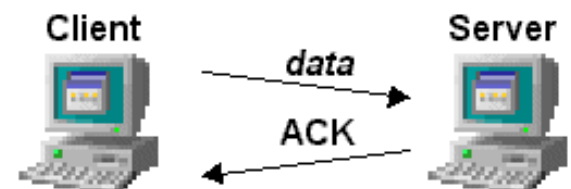

Stack Connections
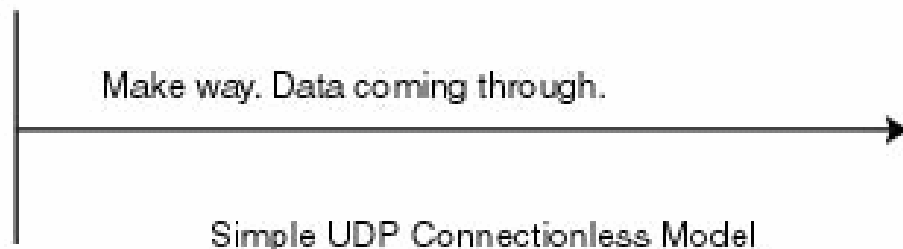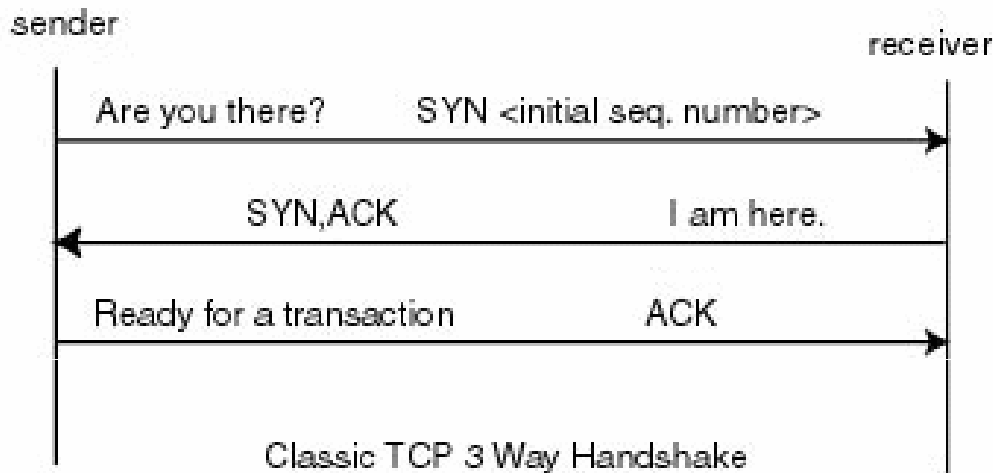
Process-to-process communication

http://userdatagramprotocol.com/process-to-process-communication/
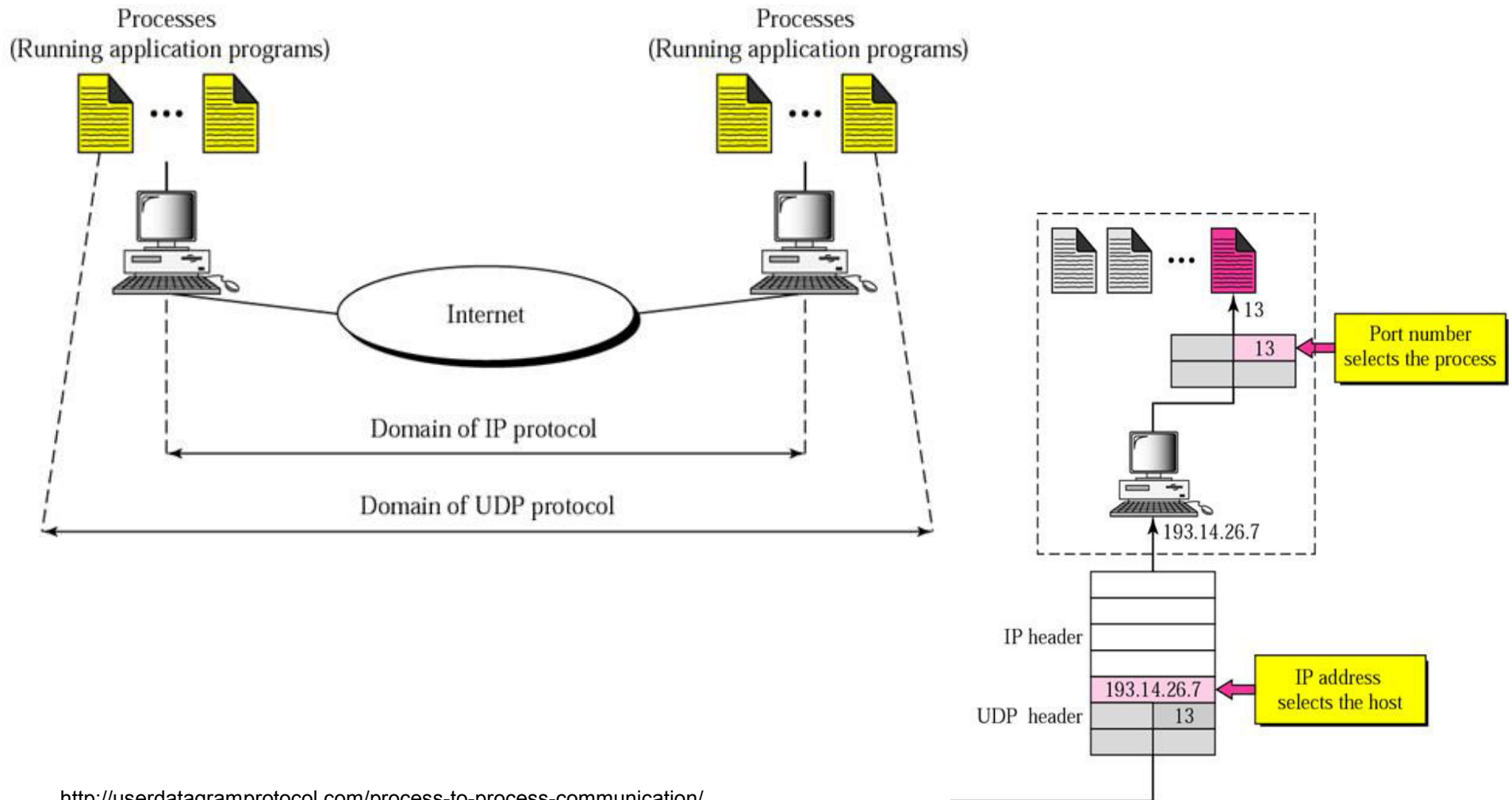
Types of communication:
Connection-oriented & Connectionless
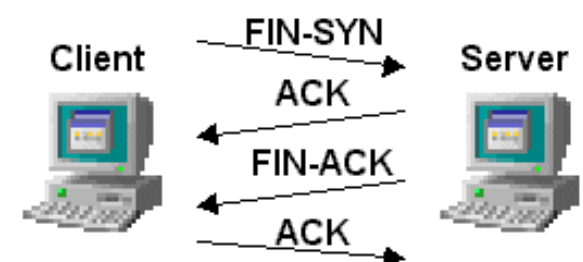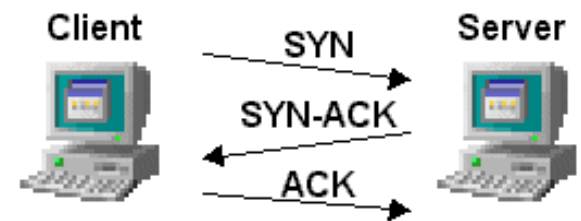
Packet Delivery Process (1)
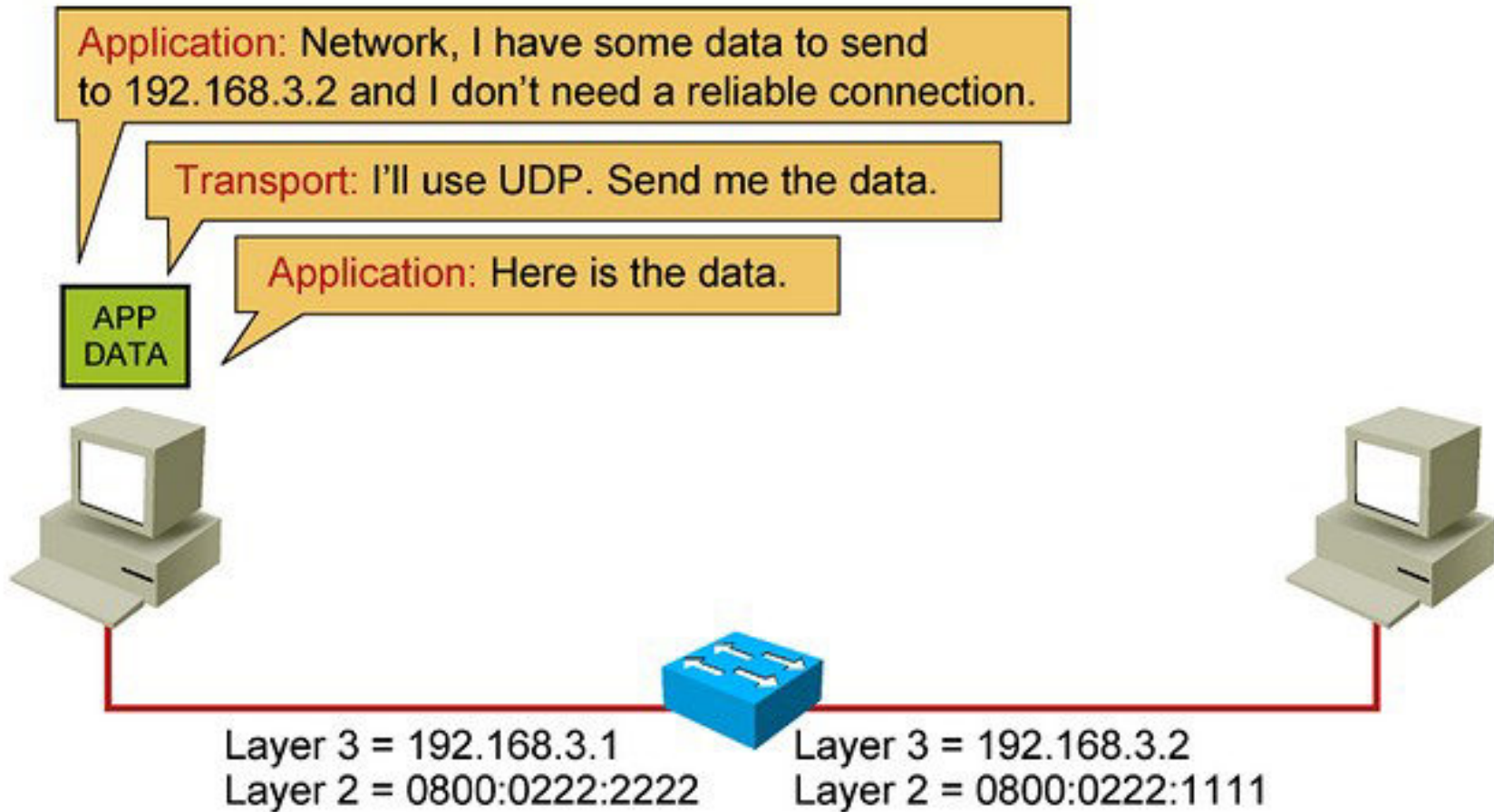
Packet Delivery Process (2)
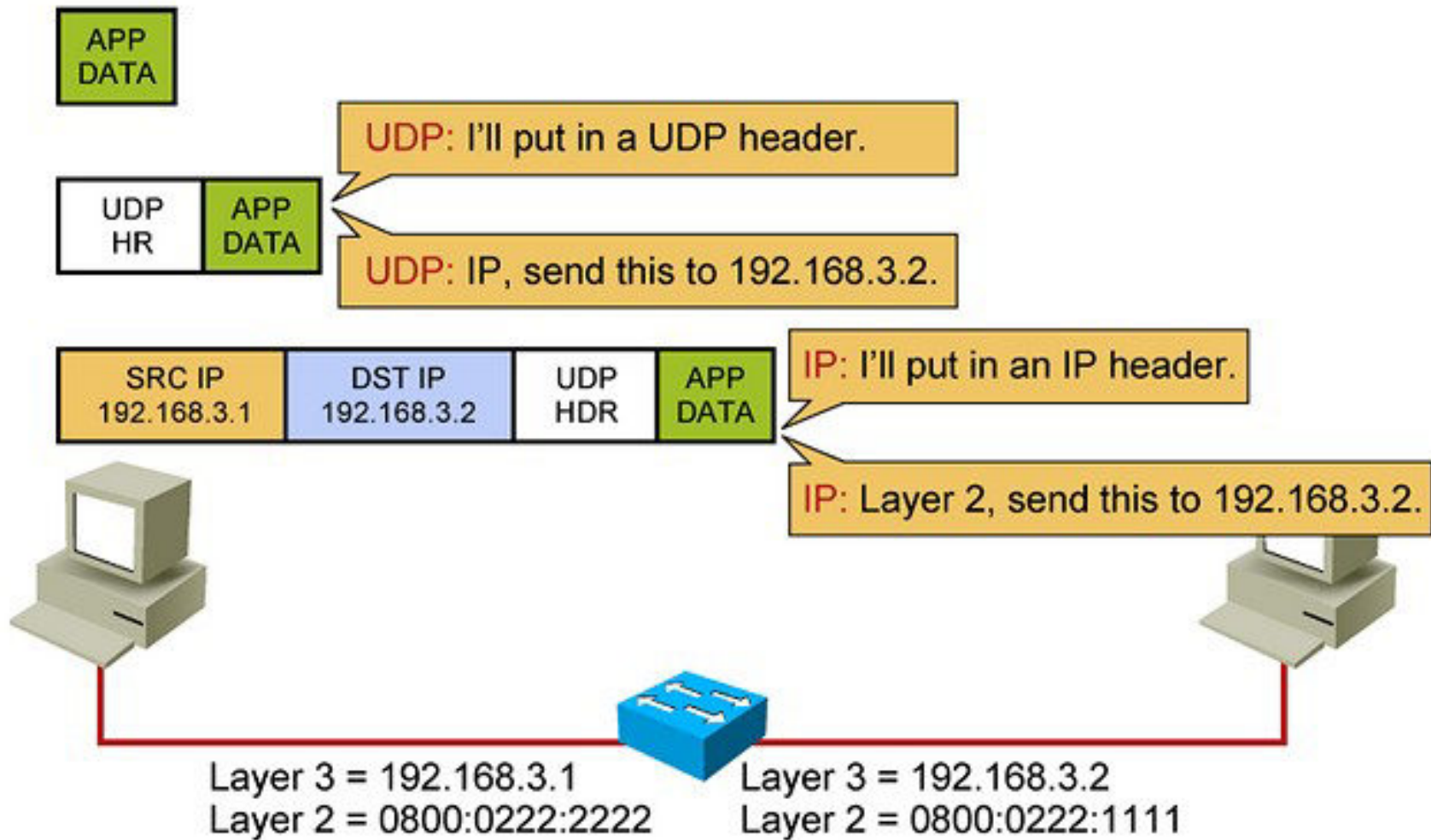
Packet Delivery Process (3)

Packet Delivery Process (4)

Packet Delivery Process (5)

Packet Delivery Process (6)

Parking Lot

Packet

ARP Request

DST MAC Broadcast	SRC MAC 0800:0222:2222	ARP Request

Layer 3 = 192.168.3.1
Layer 2 = 0800:0222:2222

Layer 3 = 192.168.3.2
Layer 2 = 0800:0222:1111

Packet Delivery Process (7)

Packet Delivery Process (8)

Packet Delivery Process (9)

Packet Delivery Process (10)

Standards

- *Standard is an agreed-upon definition of a protocol*
- Many organizations are involved in setting standards for networking. Examples:
  - **American National Standards Institute (ANSI)**: The official standards organization in the United States.
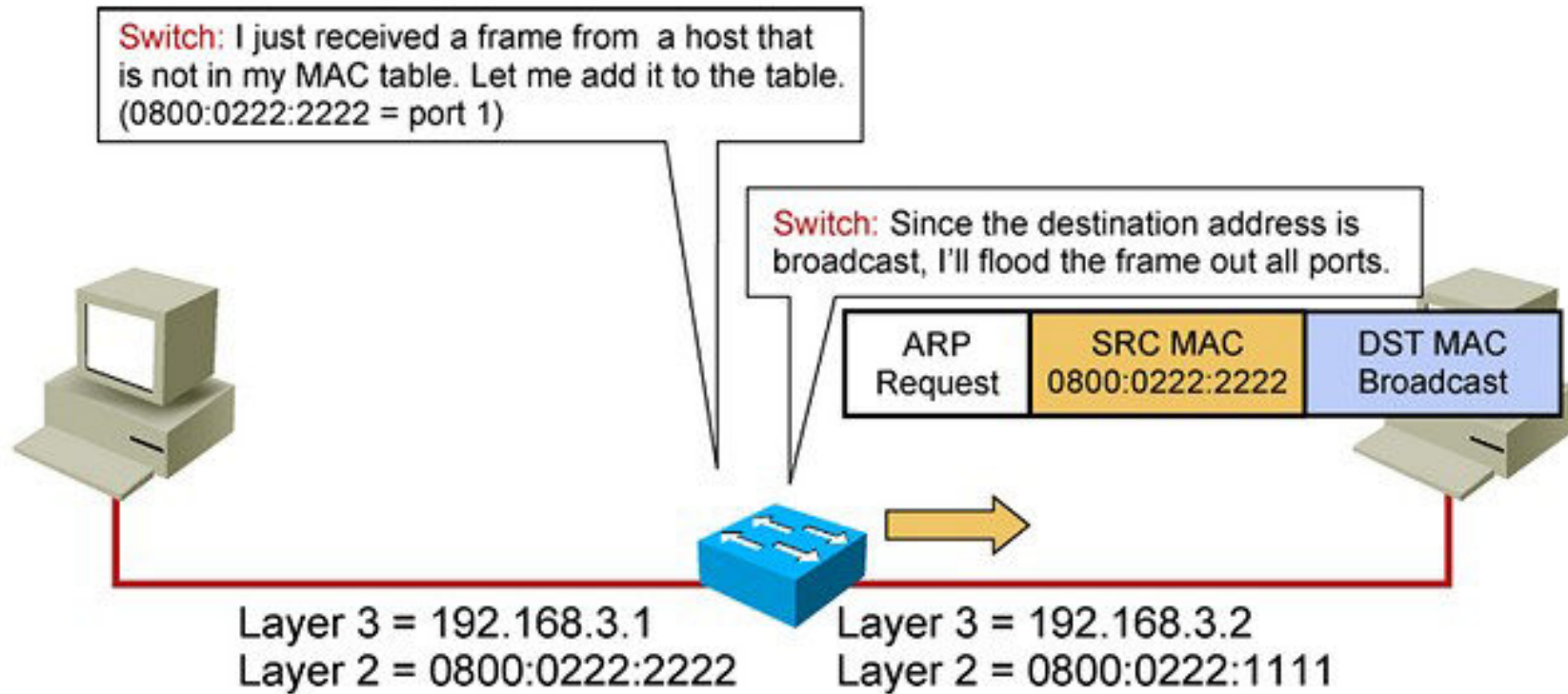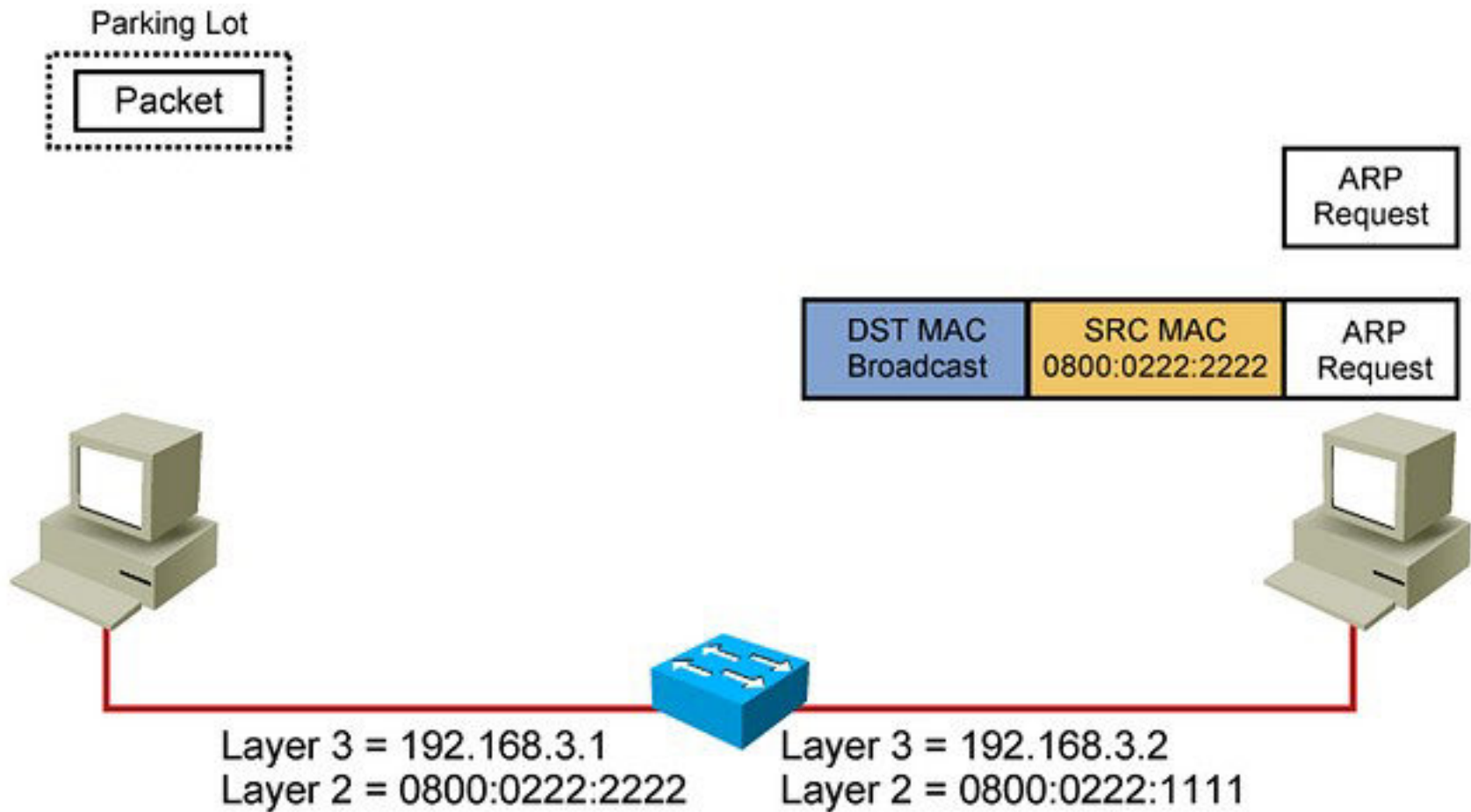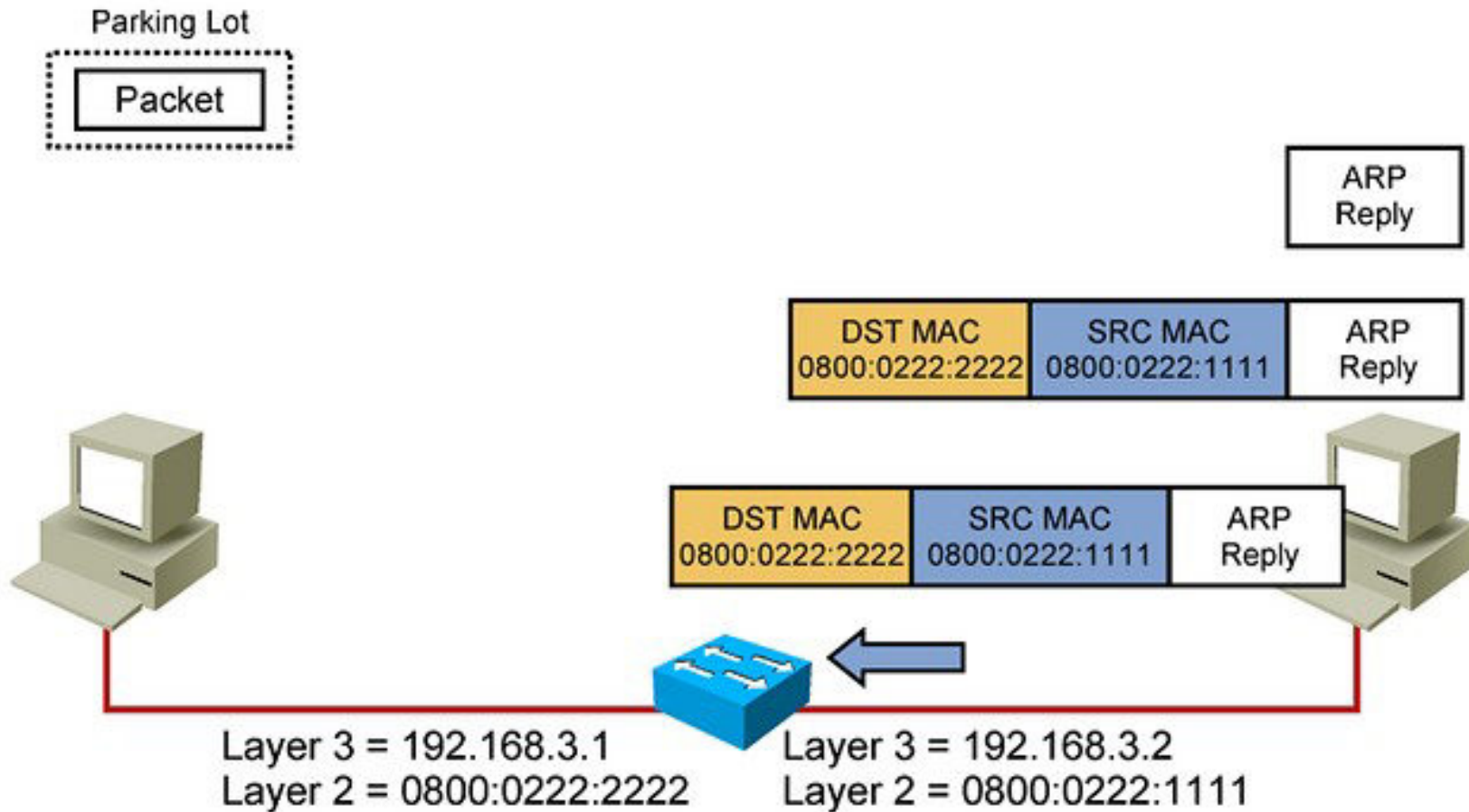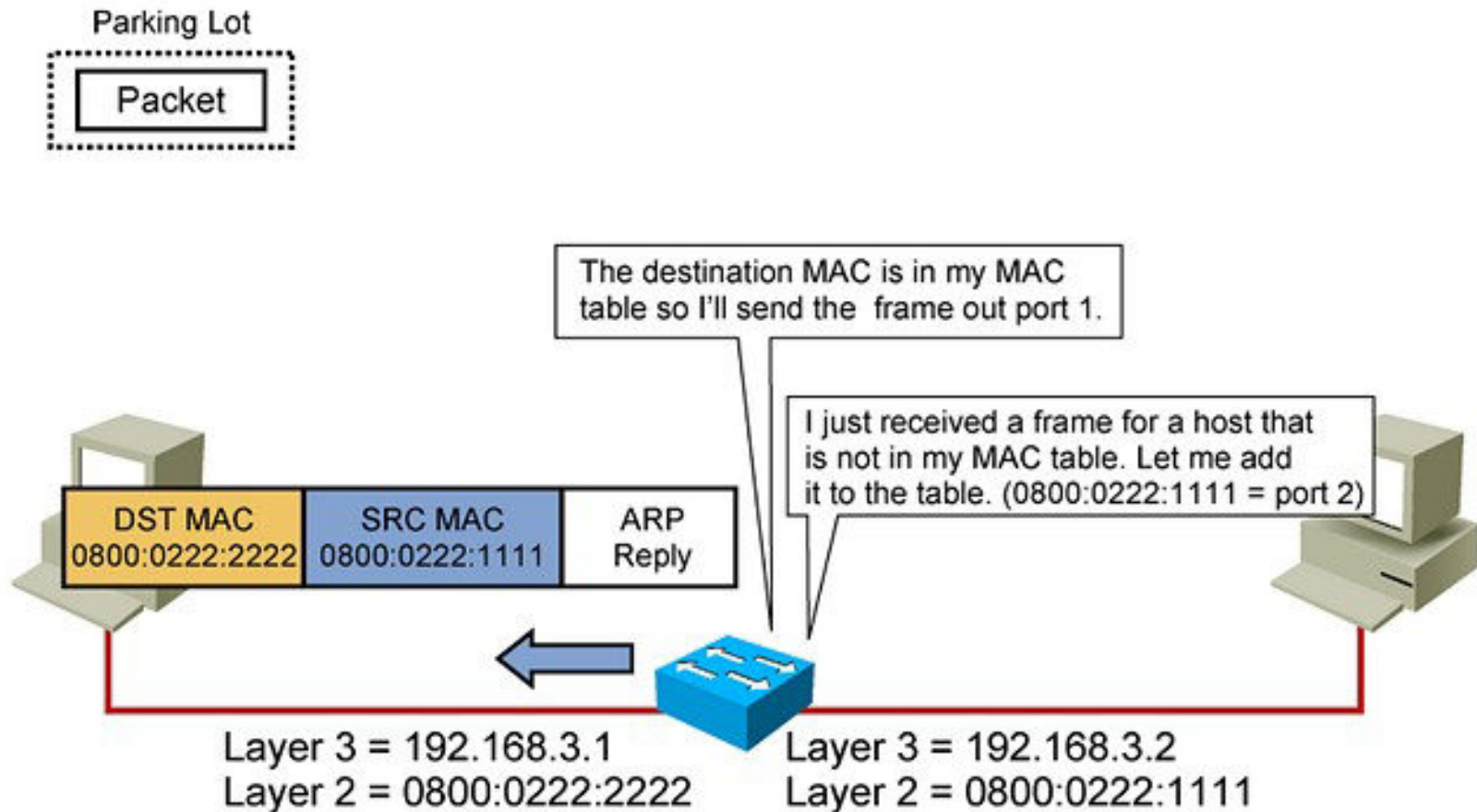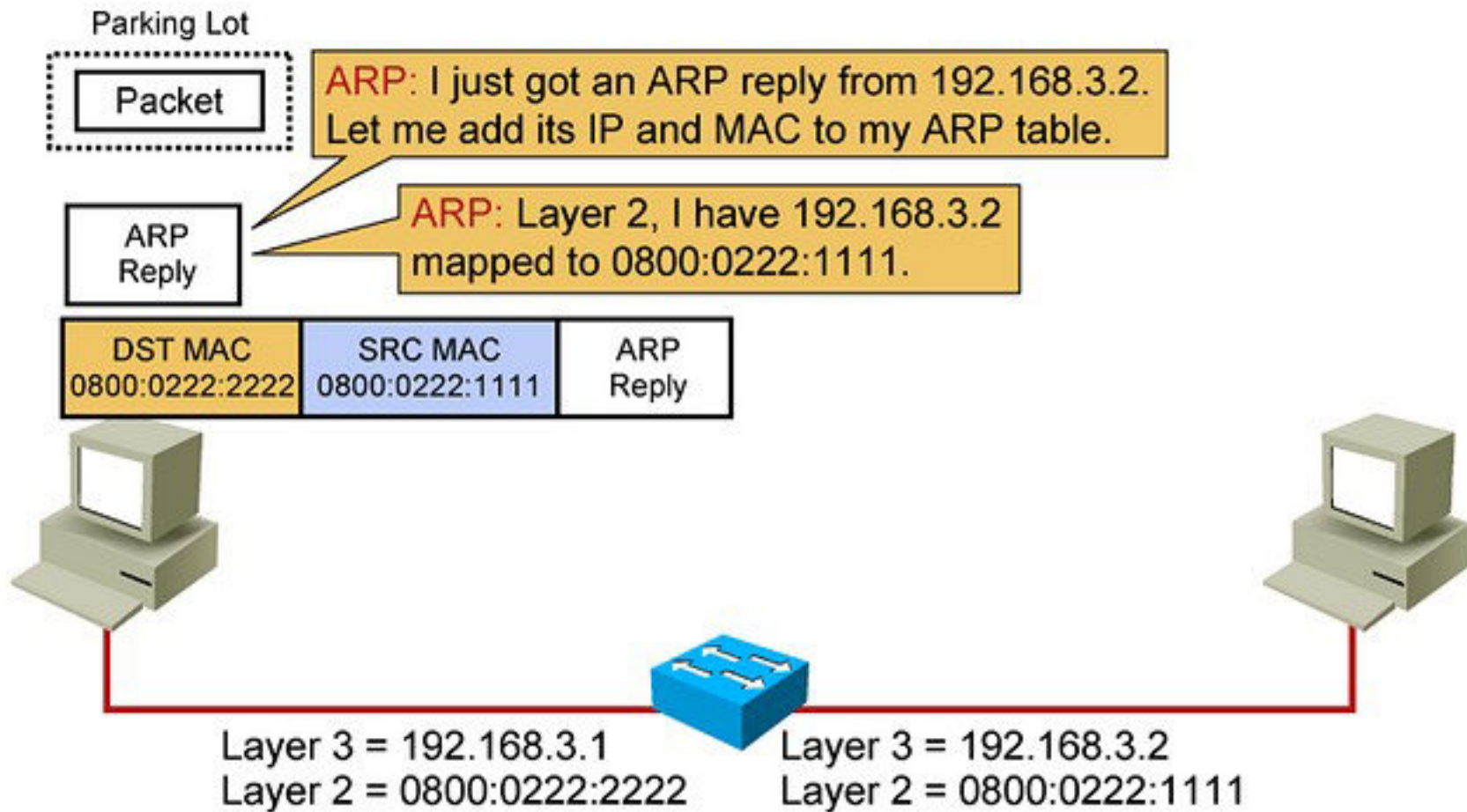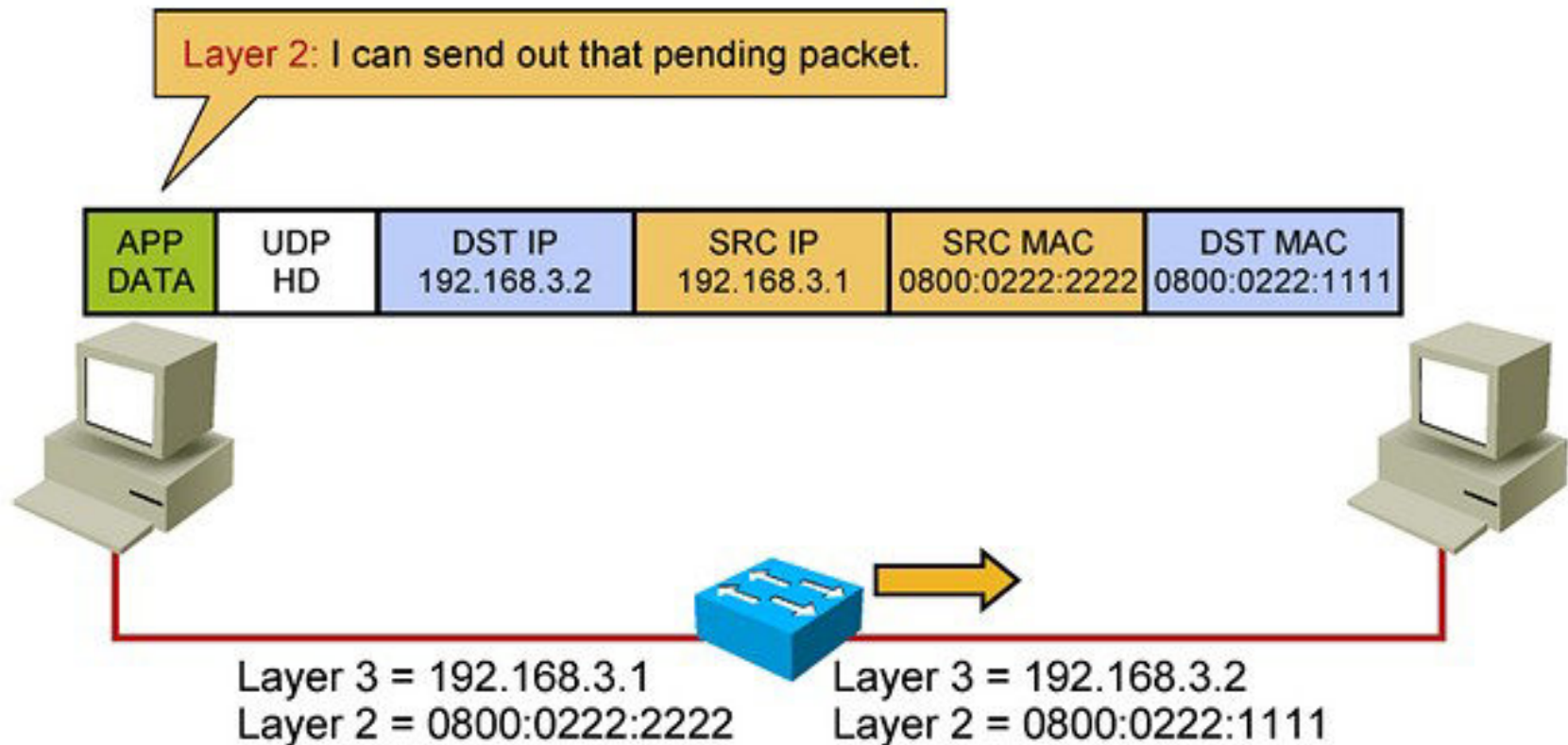 - **Institute of Electrical and Electronics Engineers (IEEE)**: An international organization that publishes several key networking standards; in particular, the official standard for the Ethernet networking system.
  - **International Organization for Standardization (ISO)**: A federation of more than 100 standards organizations from throughout the world.
  - **Internet Engineering Task Force (IETF)**: The organization responsible for the protocols that drive the Internet.
  - **World Wide Web Consortium (W3C)**: An international organization that handles the development of standards for the World Wide Web.

IEEE 802 Standards

- http://standards.ieee.org/about/get/

- 802: Overview & Architecture
- 802.1: Bridging & Management
- 802.2: Logical Link Control
- 802.3: Ethernet
- 802.11: Wireless LANs
- 802.15: Wireless PANs
- 802.16: Broadband Wireless MANs
- 802.17: Resilient Packet Rings
- 802.20: Mobile Broadband Wireless Access
- 802.21: Media Independent Handover Services
- 802.22: Wireless Regional Area Networks

Internet Engineering Task Force

- http://www.ietf.org/
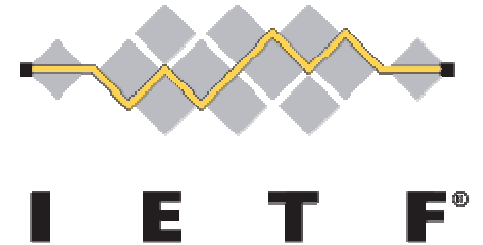
- STD 9 (RFC0959) **File Transfer Protocol** J. Postel, J. Reynolds, October 1985. STANDARD (Obsoletes RFC0765) (Updated by RFC2228 RFC2640 RFC2773 RFC3659), txt=143K

- STD 7 (RFC0793) **Transmission Control Protocol** J. Postel, September 1981. STANDARD (Updated by RFC3168), txt=168K

- STD 6 (RFC0768) **User Datagram Protocol** J. Postel, August 1980. STANDARD, txt=5K

- STD 5 (RFC0791) **Internet Protocol** J. Postel, September 1981. STANDARD (Obsoletes RFC0760) (Updated by RFC1349), txt=95K

- …