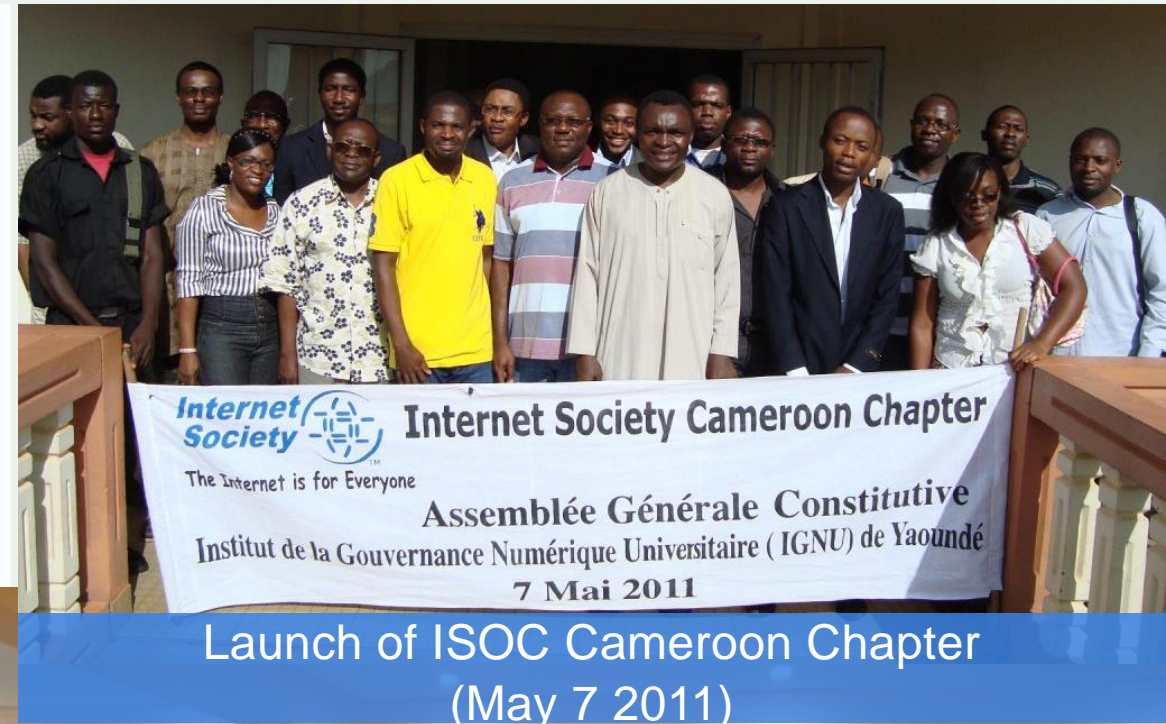October 2018

How the Internet works

Internet
Society

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Founded in 1992 by pioneers of the early Internet, the Internet Society works for an open, globally connected, secure and trustworthy Internet for everyone.

Building and Growing our Community in Africa

Countries with an Internet Society (ISOC) Chapter
- Active Chapter
- Chapter in Formation
- Chapter in Rejuvenation

Statistics as September 2018
- 27662 members (Yearly growth: 22.7%)
- 34 Active Chapters
- 1 Chapter in Rejuvenation
- 1 Chapter in Formation

- Oldest Chapter (1996): Morocco
- Youngest Chapters (2018): Guinea, Madagascar

Launch of ISOC Cameroon Chapter (May 7 2011)

Launch of ISOC Madagascar Chapter (15 June 2018)

Outline

- What do we like about the Internet?

- What is a network?

- Circuit switching vs packet switching

- Internetworking

What do we like about the Internet?

- It's always on
- It's almost instantaneous
- It's global
- It's open
- It is "cheap"
- It is fairly "trusted" and "reliable"
- It has scaled up very well (in terms of users but also speed)
- New applications that simplify our work and life are created every day

What is a network?

LANs and WANs

- A **Computer network** is a **collection of computing devices** that are **connected** in various ways in order **to communicate** and **share resources**

- Usually, the connections between computers in a network are made using **physical wires** or **cables**

- However, some connections are **wireless**, using **radio waves** or **infrared signals**

- The simplest form of a network is **a Local Area Network (LANs)** that we set in our homes or offices

- **Wide area networks** connect LANs located at different locations using gateways
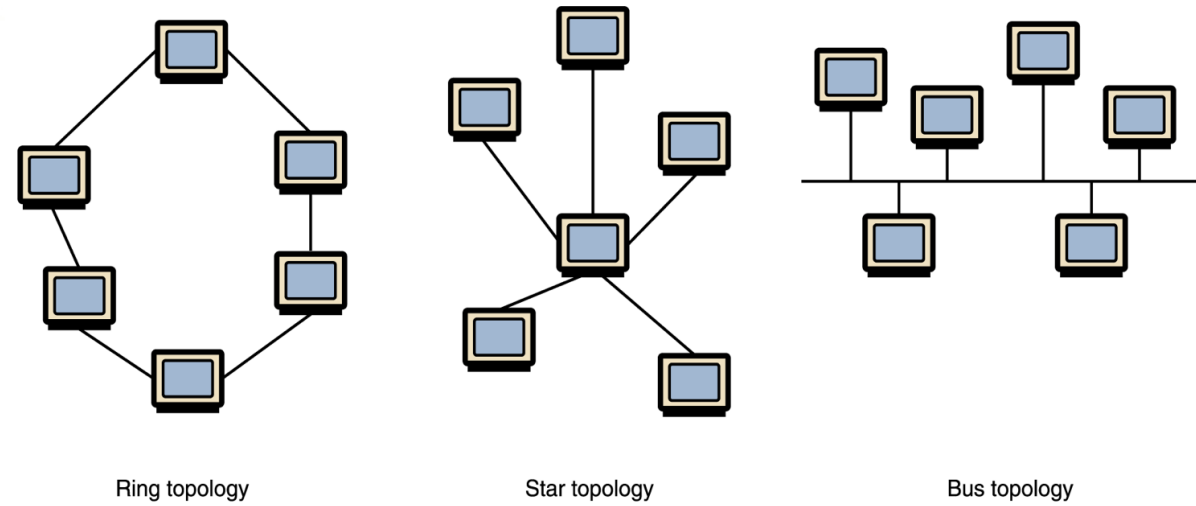
Local Area Network topologies
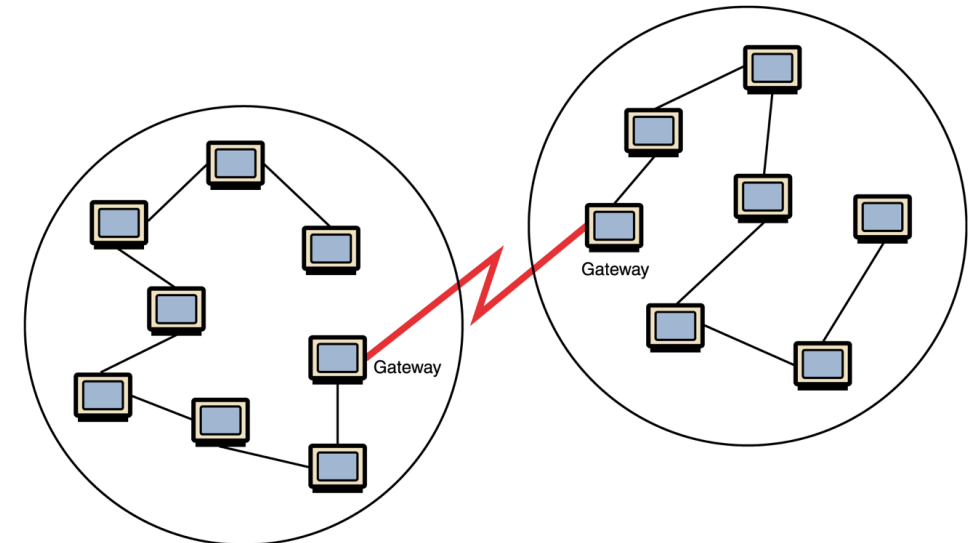
Simple WAN topology

Network Layers

- Networks work by dividing the communication into layers such that each one relies on the layer that underlie it

- Each layer deals with a particular aspect of network communication (divide and conquer)

- Each layer deals with its specific issues and has its own protocol

7	Application layer
6	Presentation layer
5	Session layer
4	Transport layer
3	Network layer
2	Data Link layer
1	Physical layer

The layers of the OSI Reference Model

# Similarities between the Network Layers and Postal system

- As a user of the postal system, you just worry about the content. You rely on the post office to deliver it for you.

- The post office branch receives your letter and gives it to the driver asking him to will take it to a forwarding center. The post office branch relies on the driver to deliver it to the center.

- The driver delivers to letter to the forwarding center. She deals with traffic issues and might even change the mode of transportation and you or even the post office branch might not know it.

- The post office branch might have received an information saying that the forwarding center will be on strike and decide to use another forwarding center and you might not know it.

- Thus every layer is concerned about a few issues and relies on the underlying layer for some of the other issues of the communication

Circuit switching vs packet switching

Circuit Switching

- Dedicated communication path between two stations

- Three phases

  - Establish
  - Transfer
  - Disconnect

- Must have switching capacity and channel capacity to establish connection

- Must have intelligence to work out routing

- Drawbacks

  - Resources dedicated to a particular call
  - Much of the time a data connection is idle
  - Data rate is fixed
  - Both ends must operate at the same rate
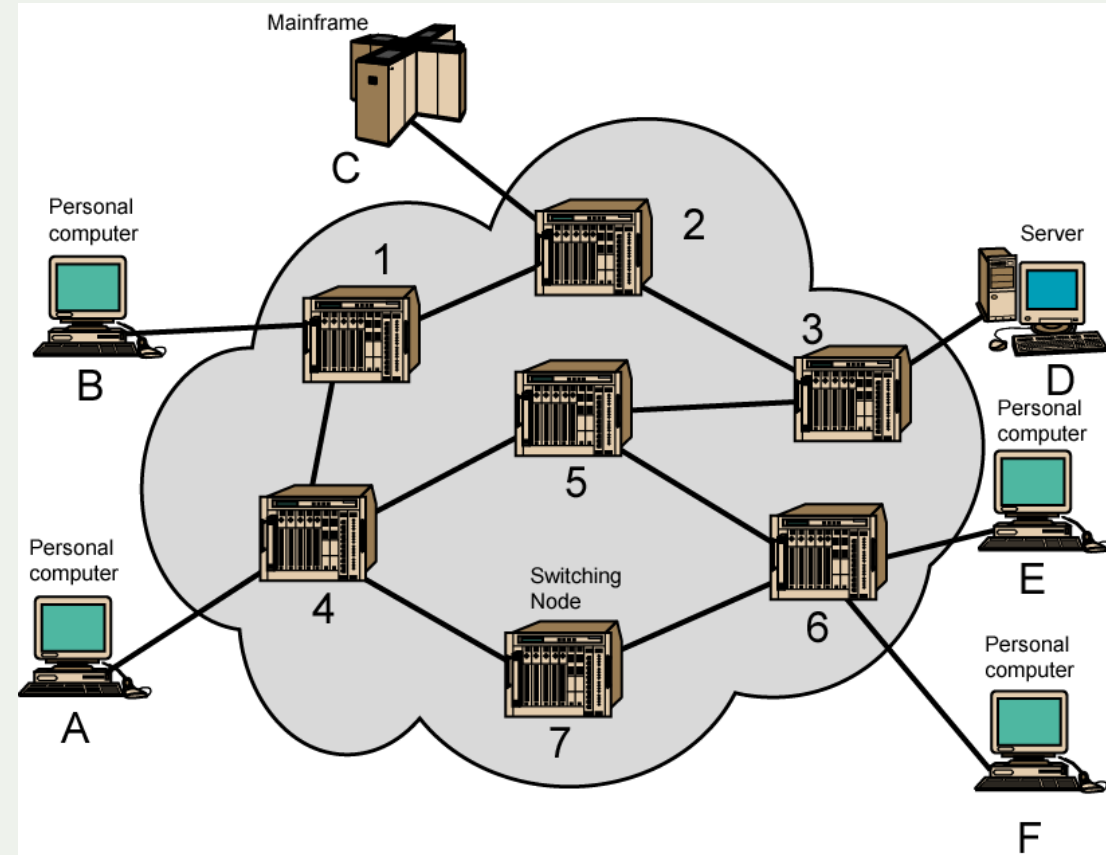
Source: William Stallings, Data and Computer Communications, 7th Edition

Packet switching

- Data transmitted in small packets (Typically 1000 octets)

- Each packet contains a portion of user data plus some control (addressing) information
- Packets are received, stored briefly (buffered) and past on to the next node

- Advantages

    - Line efficiency
    - Each station connects to the local node at its own speed
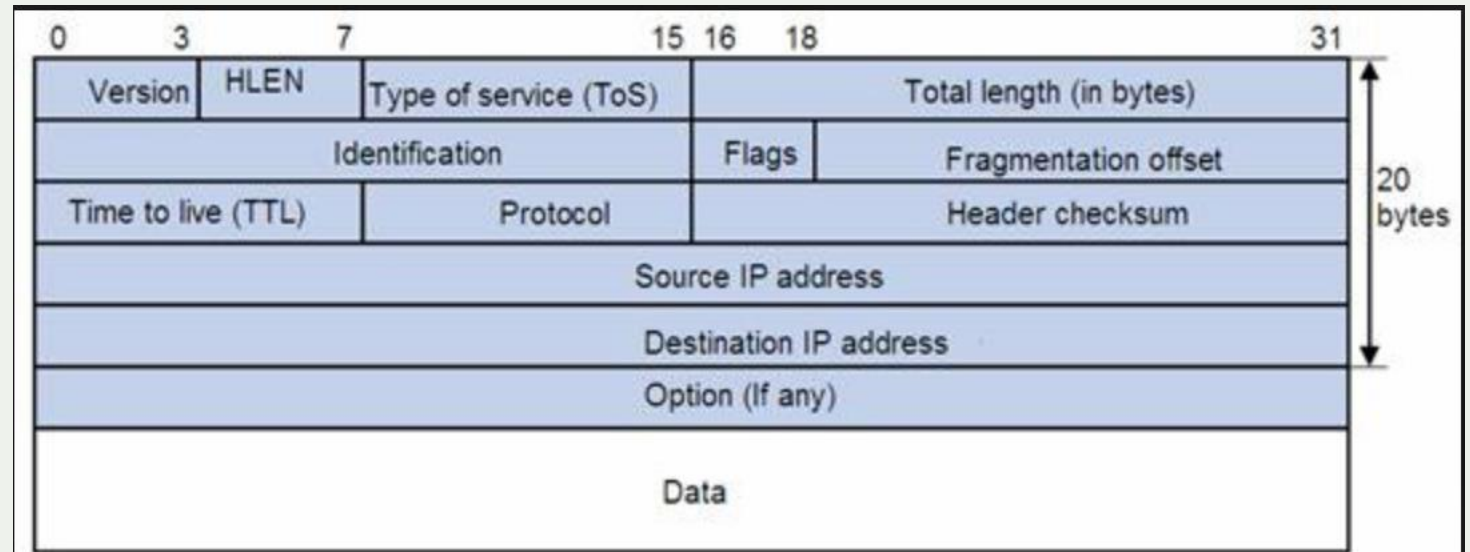   - Priorities can be used
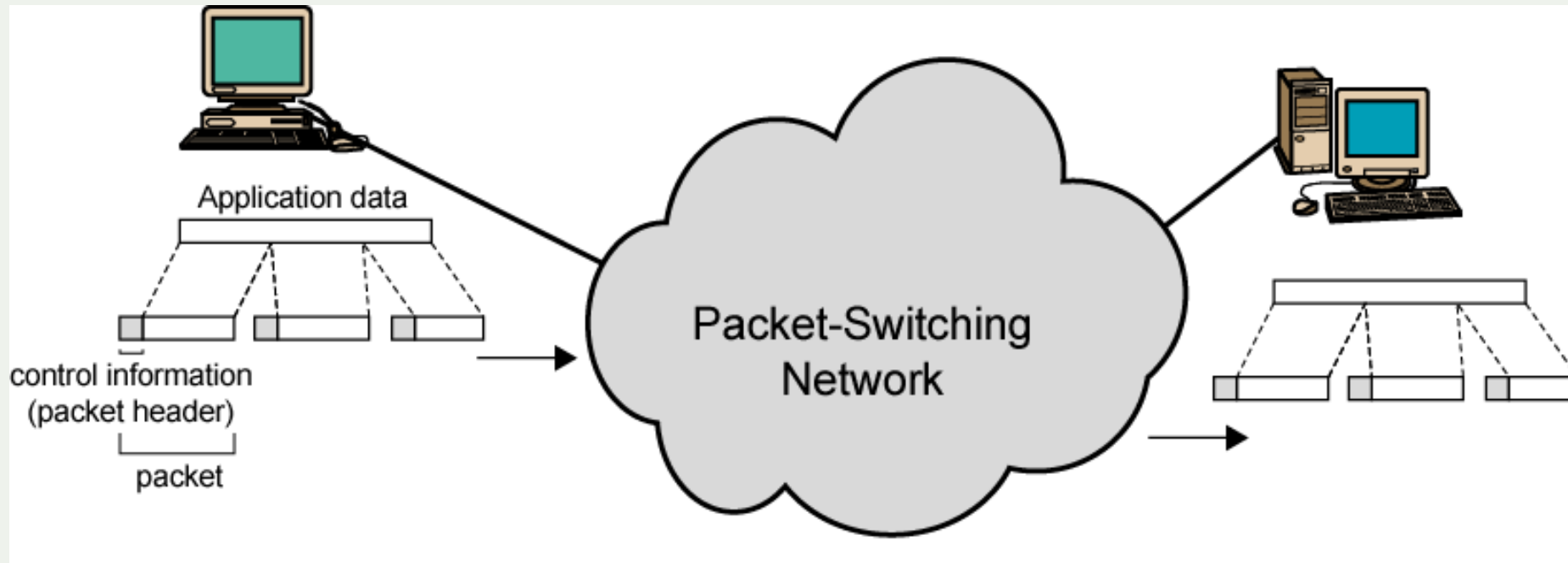
Internetworking

Internet Protocol (IP)

- IP provides <u>connectionless</u> (datagram) service

- Each packet treated separately

- Network layer protocol common on the Internet is the Internet Protocol (IP)

- Design issues

    - **Routing**
    - Datagram lifetime
    - Fragmentation and re-assembly
    - Error control
    - Flow control
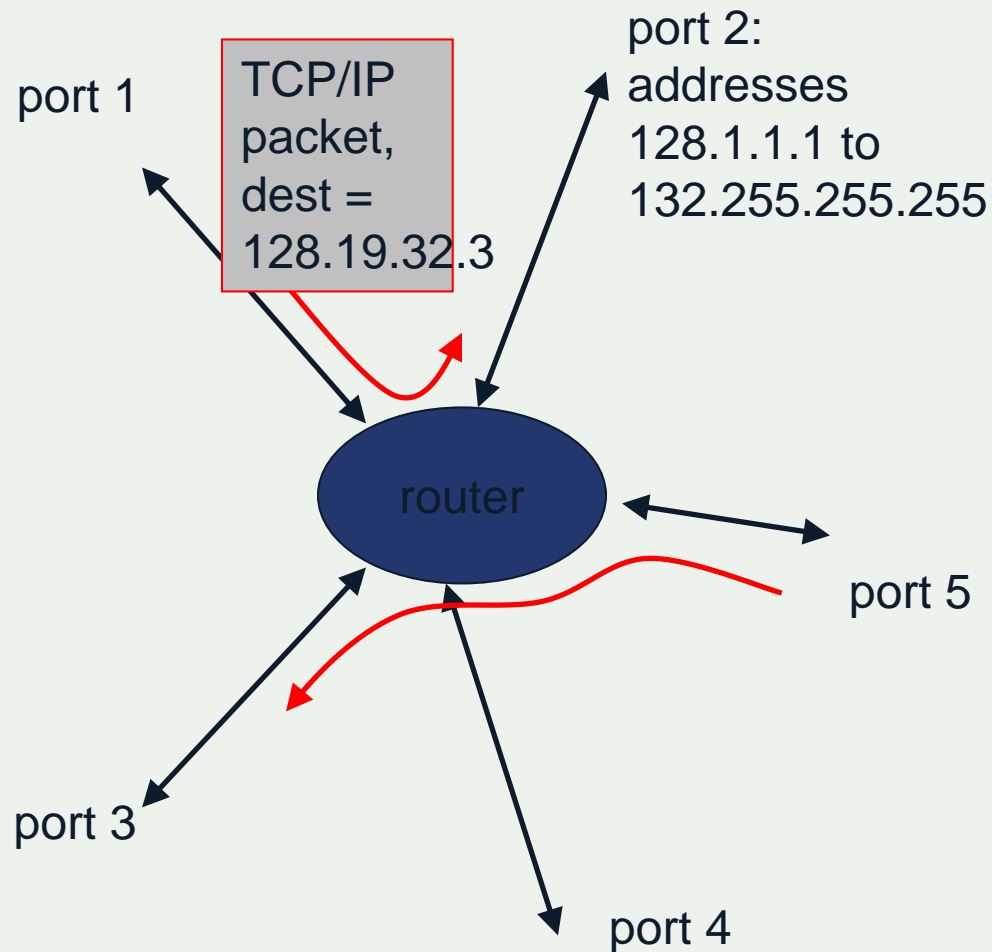   - **Addressing**

IP Packet format

Routers and routing

• Each packet passes through different networks to reach its destination

• Generally, there are many possible paths from source to destination

• The decision to which way the transiting packet should be sent is made by the router at each network based on the routing table

• Ideally, the router sends to the shortest path

• Each router maintains a dynamic *router table* of IP addresses sent on out-going links (plus congestion information)

There are multiple pathways to the destination
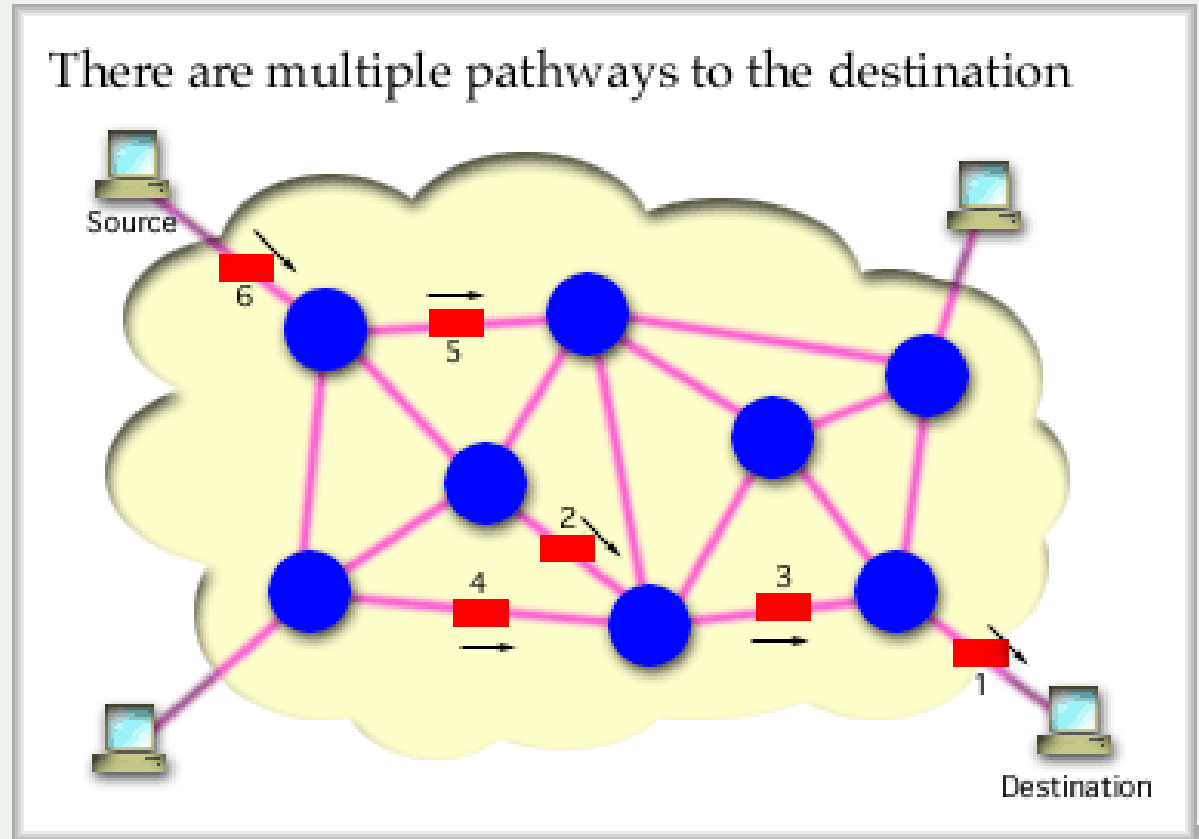
Routers and routing …

- Routers receive packets, extract destination IP, and switch them to an out-going port.
- Each router has a limited capacity (throughput or bandwidth, e.g. 10 GB/s).

port 1

TCP/IP packet, dest = 128.19.32.3

port 2: addresses 128.1.1.1 to 132.255.255.255

router

port 5

port 3

port 4

Router table

port	IP address range
1	001.*.*.* to 127.*.*.*
2	128.1.1.1 to 132.255.255.255
3	133.1.1.1 to 191.255.255.255
4	192.1.1.1 to 253.*.*.*
5	254.1.1.1 255.255.255.255

IP Numbers

- IP numbers are addresses that represent a location on the network

- It is indicated in each packet

- IP numbers should be unique

- IANA keeps the registry of IP throughout the world

- RIRs (such as AFRINIC) are given large blocks of IPs to distribute them in at regional level

- IPv4 addresses are exhausted but IPv6 has brought a large pool of address

IPv4 Header

Bit: 0	4	8	14	16	19	31
Version	IHL	DS	ECN		Total Length	
Identification				Flags	Fragment Offset	
Time to Live		Protocol		Header Checksum		
Source Address						
Destination Address						
Options + Padding						

20 octets
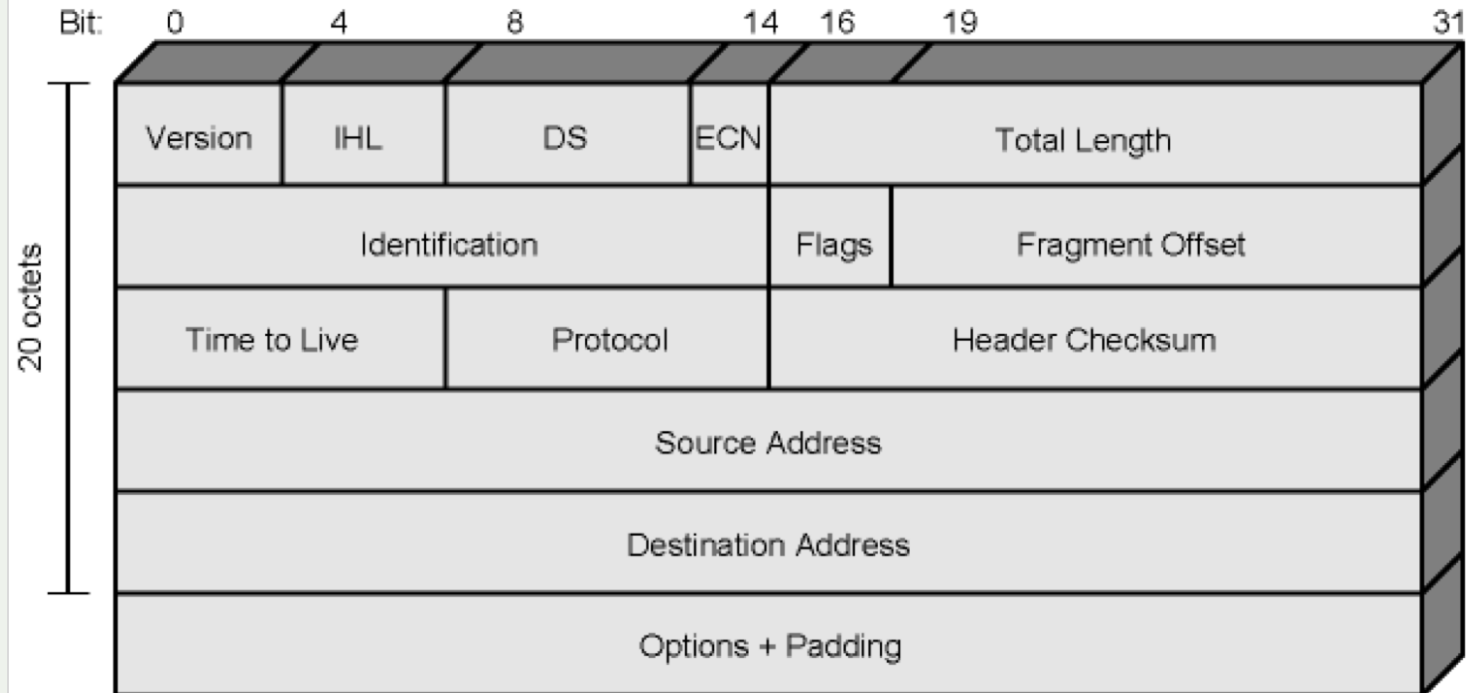
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