Computer Networking Basics

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Outline

- Networking Basics
- The TCP/IP Protocol Stack

Computer Networking Basics

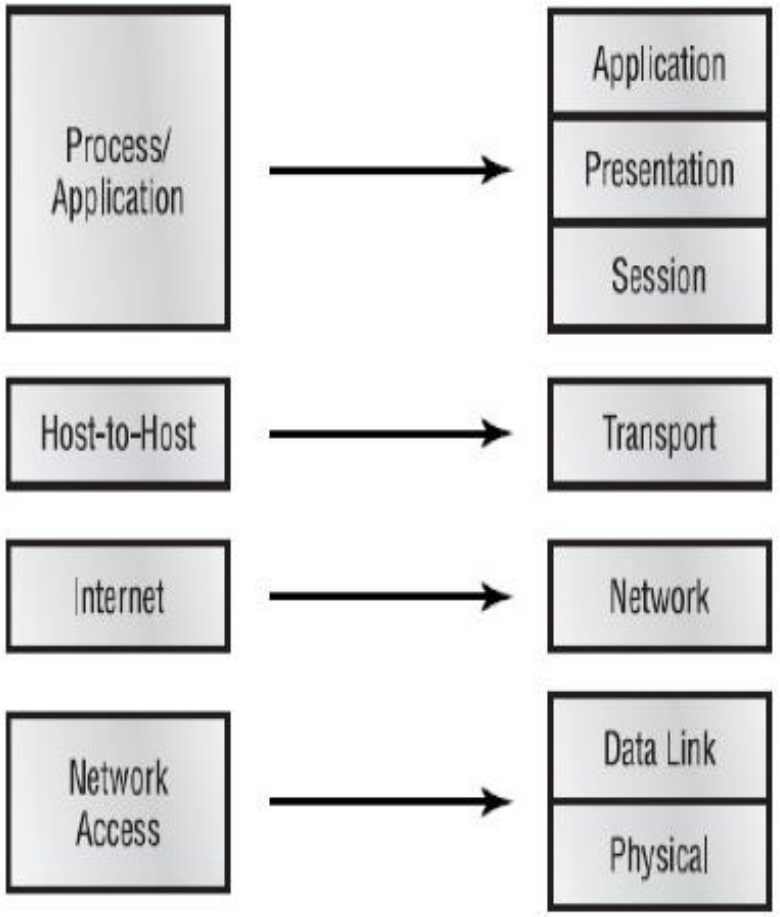
- Computer networking is one of the enabling technologies in Cloud Computing
- Clouds use networking to connect:
  - Two resources within the cloud
  - Resources across clouds
  - On-premise to cloud
  - Etc.
- A computer network is an interconnected collection of **autonomous** computers

Computer Networking Basics

- Computer networking models
  - **OSI : Open system Interconnection model**
    - Composed of seven layers, each specifying particular network functions
    - Never fully implemented

Computer Networking Basics

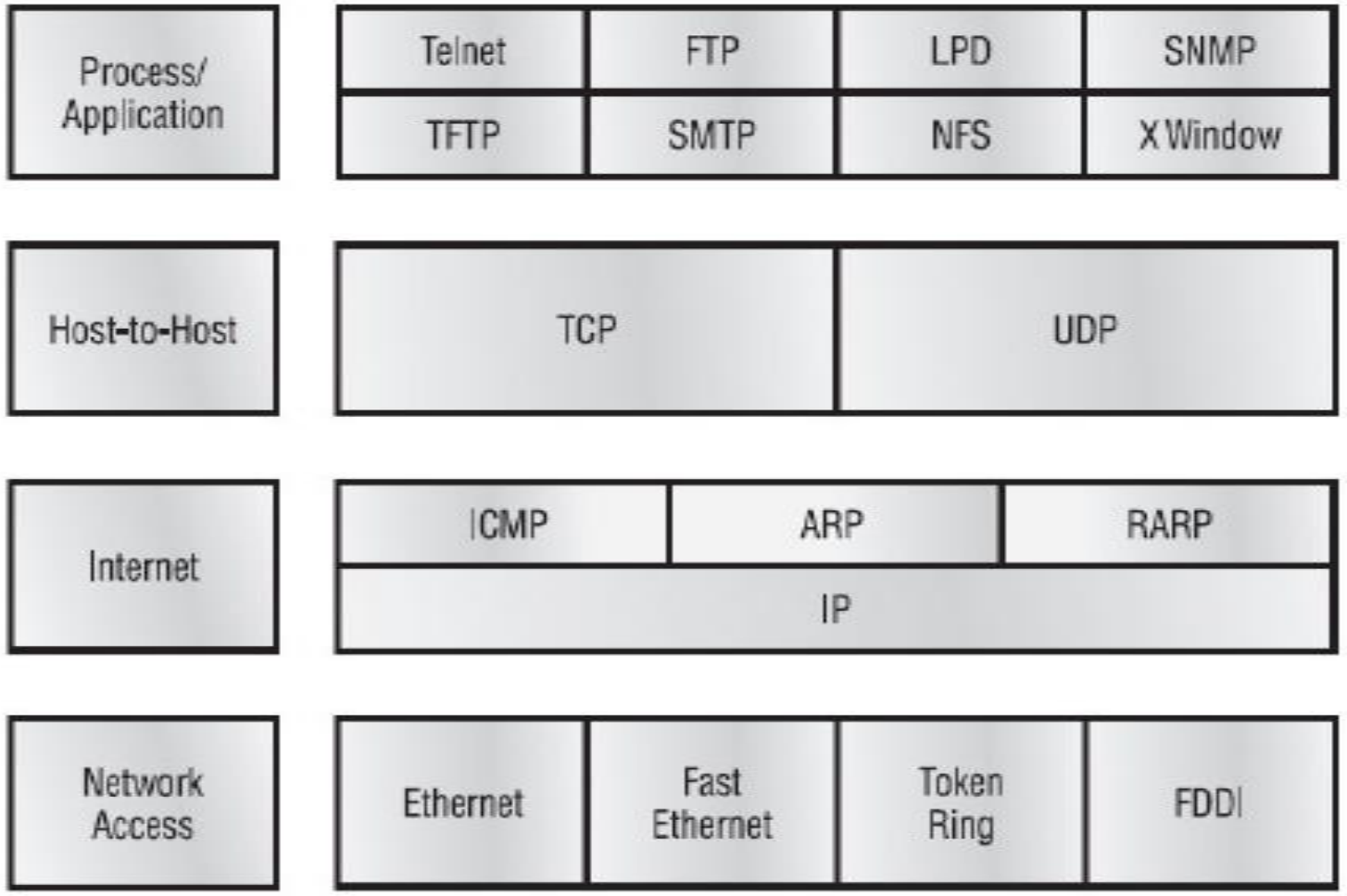
- **TCP/IP Reference model**
  - Developed by Department of Defense (DoD) with the goal of multiple networks communicate in a seamless way
  - The network be able to survive loss of subnet hardware
  - Handle applications with divergent requirements



Computer Networking Basics

- The Process/Application
  - Protocols for node-to-node application communication and also controls user-interface specifications
- The Host-to-Host
  - Defines protocols for setting up the level of transmission service for applications
- The Internet layer
  - Corresponds to the OSI's Network layer, designating the protocols relating to the logical transmission of packets over the entire network
- Network Access layer
  - The equivalent of the Data Link and Physical layers of the OSI model
  - Oversees hardware addressing and defines protocols for the physical transmission of data

TCP/IP Protocol Stack



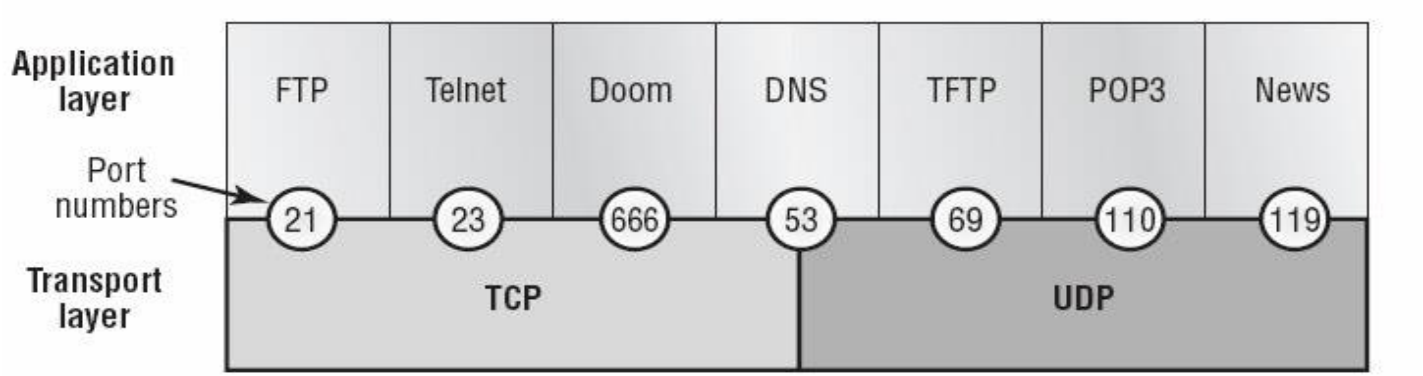
TCP/IP Protocol Stack

- **Host-to-Host Layer**
  - **Transmission Control Protocol (TCP)**
    - Takes large blocks of information from an application and breaks them into **segments**
    - It numbers and sequences each segment
    - Uses **three-way handshaking**
  - **User Datagram Protocol (UDP)**
    - Unreliable transfer of segments
  - TCP for reliability and UDP for faster transfers
  - TCP and UDP must use **port numbers** to communicate with the upper layers

TCP/IP Protocol Stack

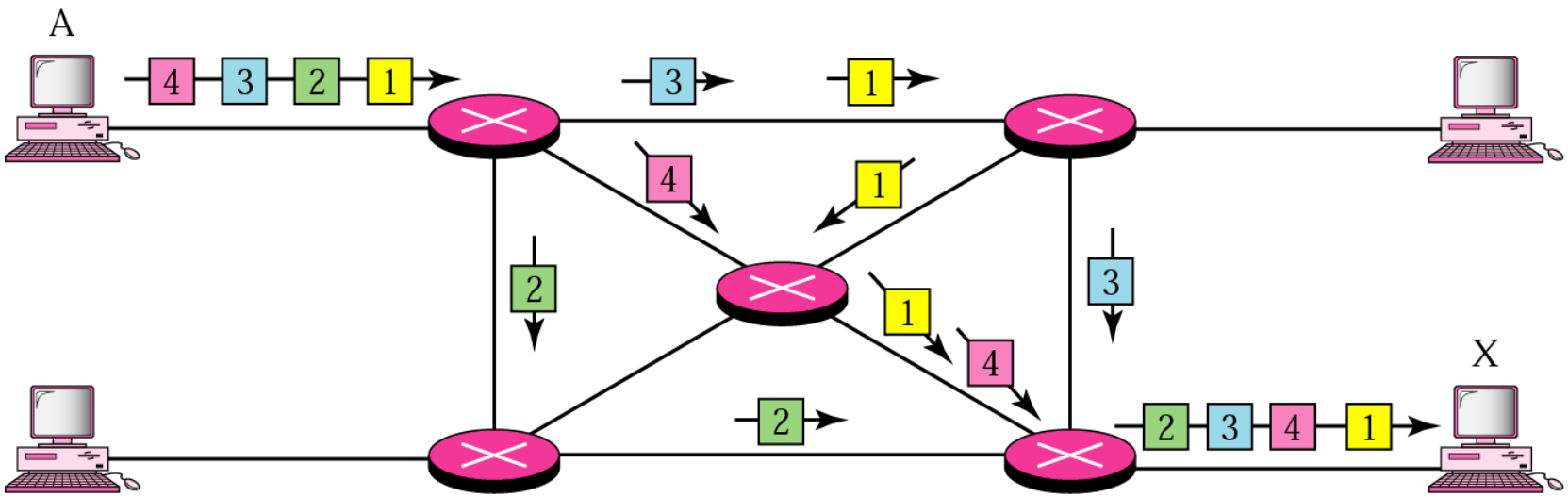
- Port Numbers:
  - Identify the source and destination application or process in the TCP/UDP segment
  - There are 2^**16** = 65536 ports available
    - Well-known ports - 0 to 1023.
    - Registered ports - 1024 to 49151
      - For applications that need to have consistent port assignments
    - Dynamic or private ports - 49152 to 65535.
      - Can be used for any service or application.
  - Firewalls by default block all ports
  - You should know the port numbers of different protocols

TCP/IP Protocol Stack



TCP/IP Protocol Stack

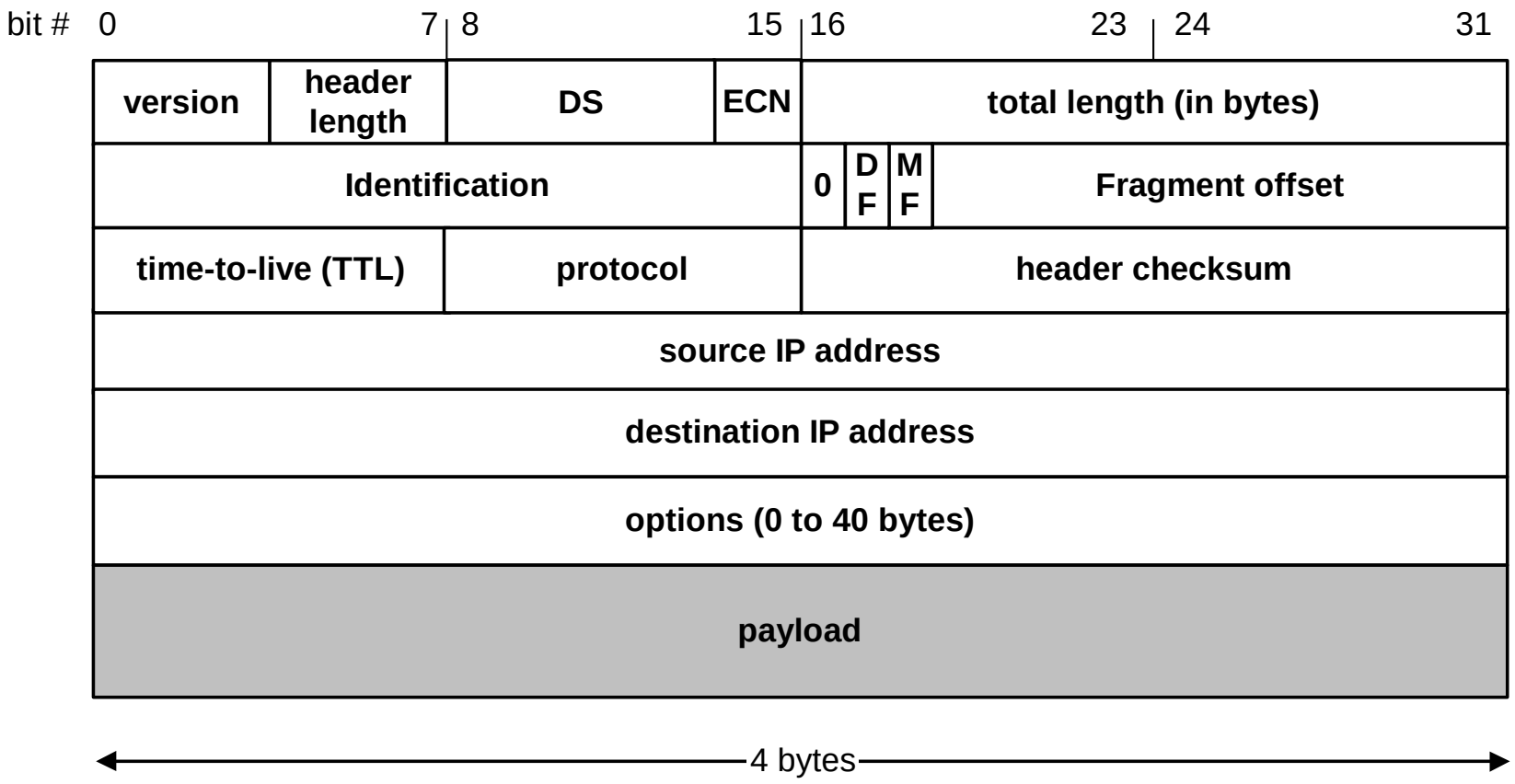
- **Internet Layer**
  - **Internet Protocol (IP)**
    - The main protocol on the Internet layer
    - Important for IP addressing and routing
    - Divide the data into packets



TCP/IP Protocol Stack

- Basic operation
  - Data transmitted in small packets
    - Longer messages split into series of packets
    - Each packet contains a portion of user data plus some control info
  - Control info includes:
    - Routing (addressing) info
  - Packets are received, stored briefly (buffered) and past on to the next node
    - Store and forward
  - Per-packet routing

TCP/IP Protocol Stack



TCP/IP Protocol Stack

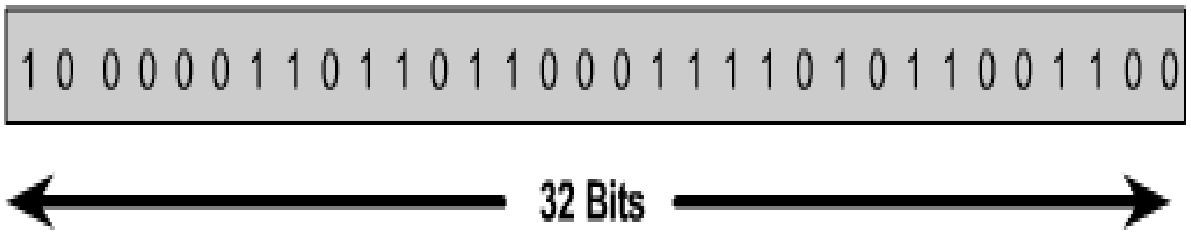
- IP Address
  - logical address on the Internet layer
  - Consisting of **NETWORK** portion, and **HOST** portion
    - A hierarchical ‘numbering scheme’ - for reliable routing
  - May be assigned to a host pc, or router port, etc.
    - A way to identify machines on a network
  - Unique and universal for global communication
    - No 2 hosts have the same address, but a host can have 2 IP addresses

TCP/IP Protocol Stack

- IP Address usage
  - IP addresses are assigned by a central authority (Internet Corporation for Assigned Names and Numbers -- ICANN)
    - IPv4 – 32 bits
    - IPv6 - 128 bits
  - IPv4
    - There are 2^{32} (4,294,267,296) hosts
      - Currently not sufficient due to a number of reasons (mainly wastage)
      - Can be
        - Static IP address
          - Manually input by network administrator
        - Dynamic IP address
          - Assigned by server when host boots

TCP/IP Protocol Stack

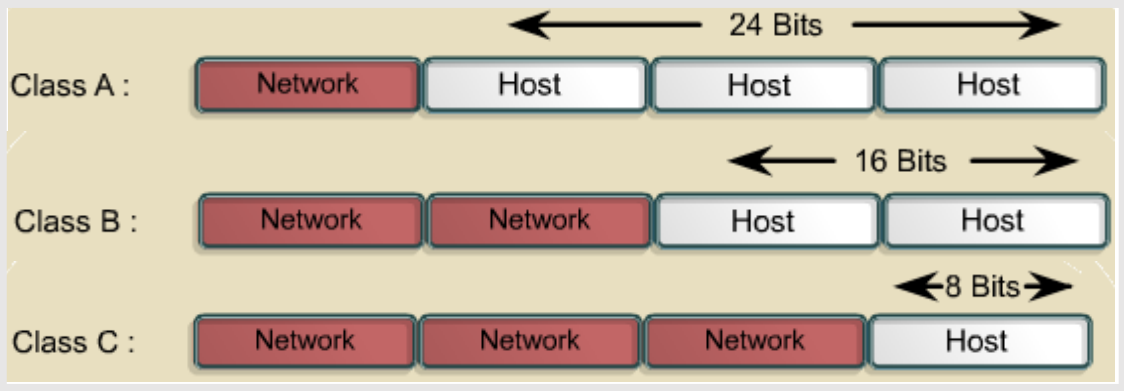
- IP address structure
  - Consist of four sections called **octets**
    - Each octets is 8 bits long
  - To make the IP address easier to use, the address is usually written as four decimal numbers separated by periods.
    - For example, 128.35.0.72
  - Each section can range from 0 to 255
  - An IP address is a 32-bit sequence of 1s and 0s



TCP/IP Protocol Stack

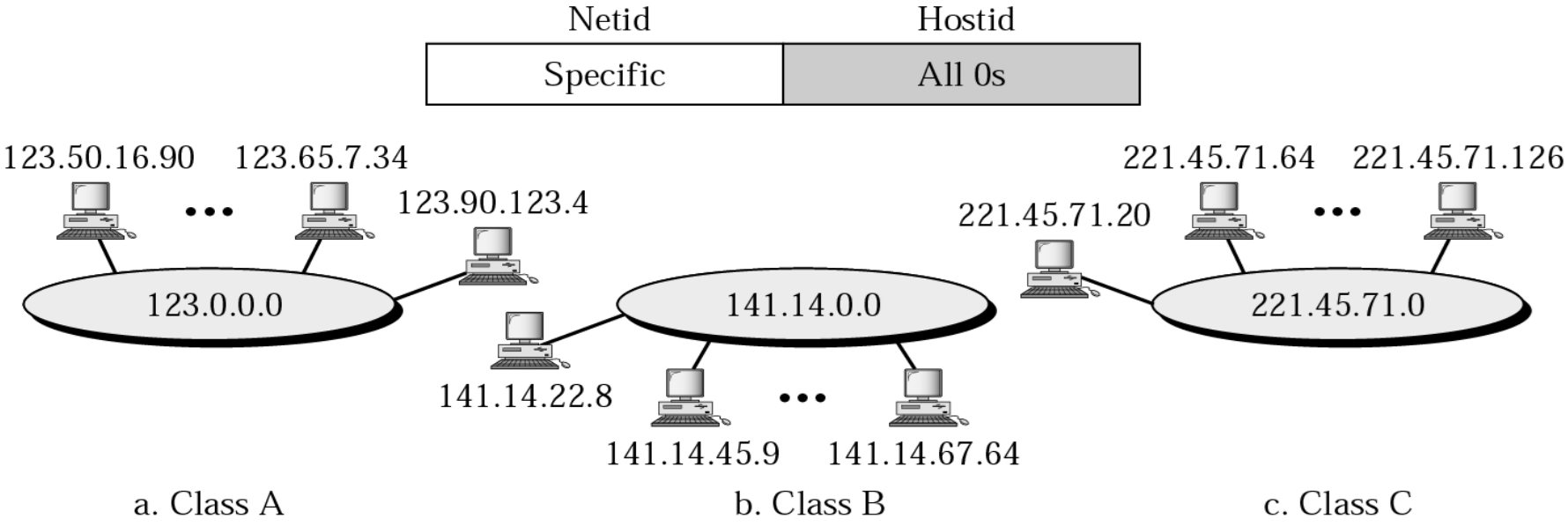
- IP Address Structure
  - The four octets represent the machine itself (hosted) and the network(netid) it is on
    - The network portion is assigned
    - The host section is determined by the network administrator
  - 5 Classes of IP address
    - Class A reserved for large organizations , governments
    - Class B reserved for medium companies
    - Class C reserved for small companies
    - Class D are reserved for multicasting
    - Class E are reserved for future use

TCP/IP Protocol Stack



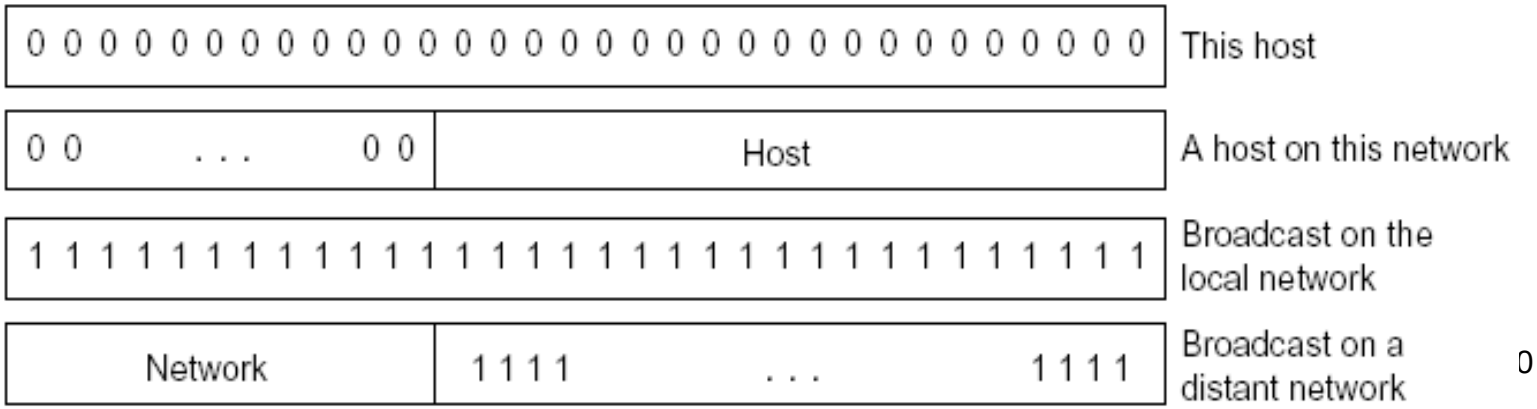
Address Class	High-Order Bits	First Octet Address Range	Number of Bits in the Network Address	Number of Networks	Number of Hosts per Network
Class A	0	0-127	8	126	16,777,216
Class B	10	128-191	16	16,384	65,536
Class C	110	192-223	24	2,097,152	254
Class D	1110	224-239	28	N/A	N/A

TCP/IP Protocol Stack



TCP/IP Protocol Stack

- Reserved IP Addresses
  - Addresses beginning 127 are reserved for loopback and internal testing
  - All hostId bits off - reserved for network address
    - For Example: 11.0.0.0
  - All hostId bits on - reserved for broadcast
    - For Example 11.255.255.255
  - an IP address with all 0s (hostid and/or netid) means this network or this host
  - an IP address with all 1s (netid and/or hostid) means all the hosts on the indicated network for broadcasting



TCP/IP Protocol Stack

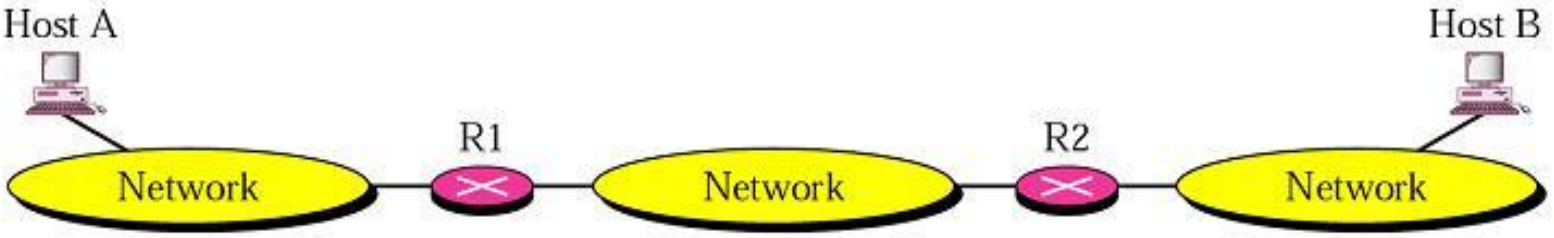
- **Private IP addresses**
  - Addresses that are not routed on the Internet backbone
  - Used only for internal networks
  - Connecting a network using private addresses to the Internet requires the usage of **Network Address Translation (NAT)**

Class	RFC 1918 Internal Address Range	CIDR Prefix
A	10.0.0.0 - 10.255.255.255	10.0.0.0/8
B	172.16.0.0 - 172.31.255.255	172.16.0.0/12
C	192.168.0.0 - 192.168.255.255	192.168.0.0/16

TCP/IP Protocol Stack

- Routing is the act of moving information across a network from a source to a destination.
  - Occurs at layer 3 – the network layer
  - The router is the device that performs routing, and it connects different LAN segments so that larger networks can be created.
  - routing requires a host or a router to have a **routing table** which is constructed by the routing algorithm

TCP/IP Protocol Stack



Routing table for host A

Destination	Route
Host B	R1, R2, Host B

Routing table for R1

Destination	Route
Host B	R2, Host B

Routing table for R2

Destination	Route
Host B	Host B

TCP/IP Protocol Stack

- Classless Interdomain Routing (CIDR)
  - Proposed
    - To slow the growth of routing tables on routers on the Internet
    - To help slow the rapid depletion of IPv4
  - Uses CIDR notation
    - An IP address is followed by a suffix indicating the number of bits of the network id
    - For example: 22.5.0.5/18

References

- Andrew S. Tanenbaum, David J. Wetherall **Computer Networks**. 5th ed.