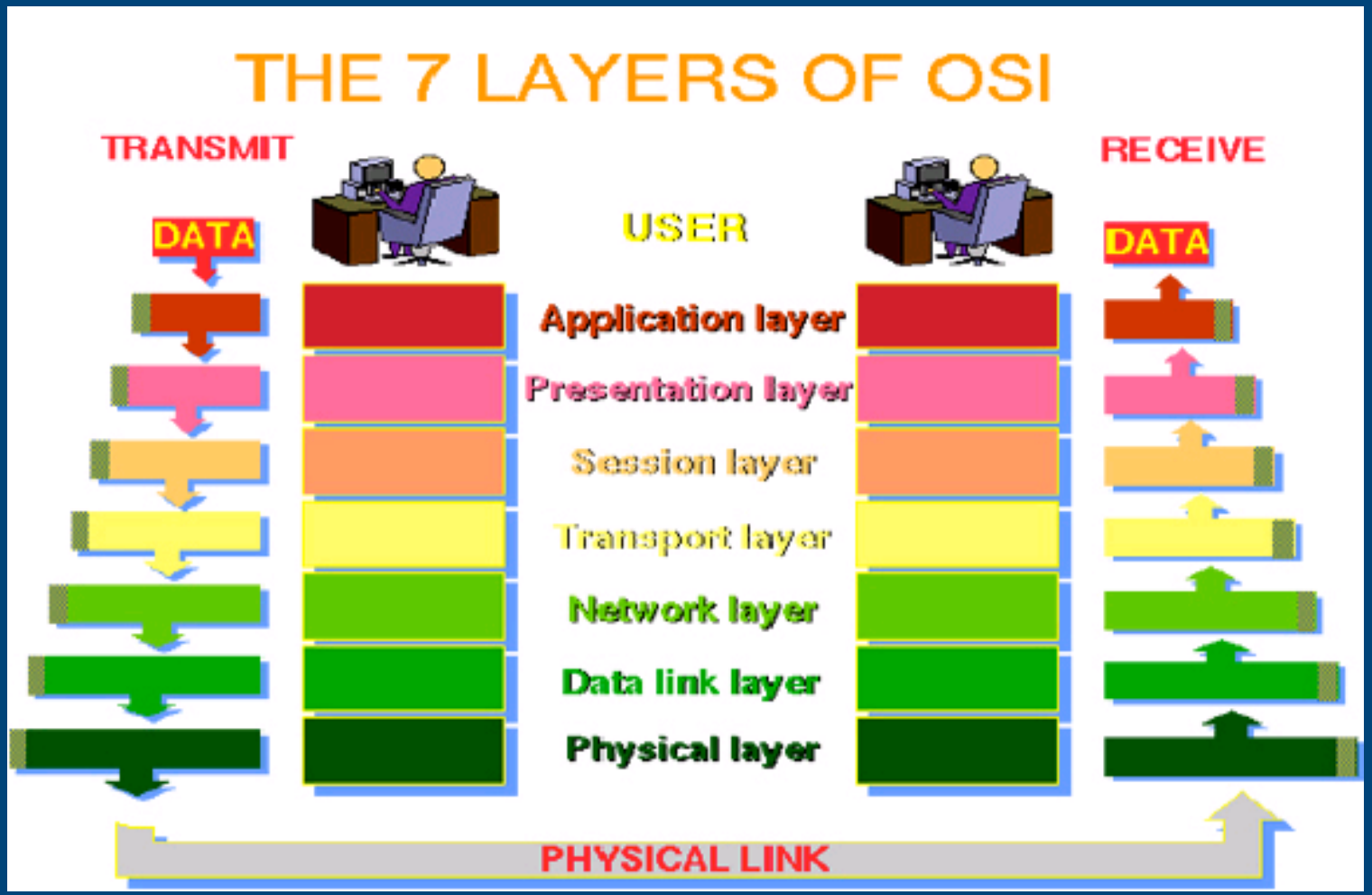
IP Basics

How the computer passport system works

Layers

- Complex problems can be solved using the common divide and conquer principle. In this case the internals of the Internet are divided into separate layers.
  - Makes it easier to understand
  - Developments in one layer need not require changes in another layer
  - Easy formation (and quick testing of conformation to) standards
- Two main models of layers are used:
  - OSI (Open Systems Interconnection)
  - TCP/IP

OSI Model


THE 7 LAYERS OF OSI
TRANSMIT
RECEIVE
DATA
USER
DATA
Application layer
Presentation layer
Session layer
Transport layer
Network layer
Data link layer
Physical layer
PHYSICAL LINK

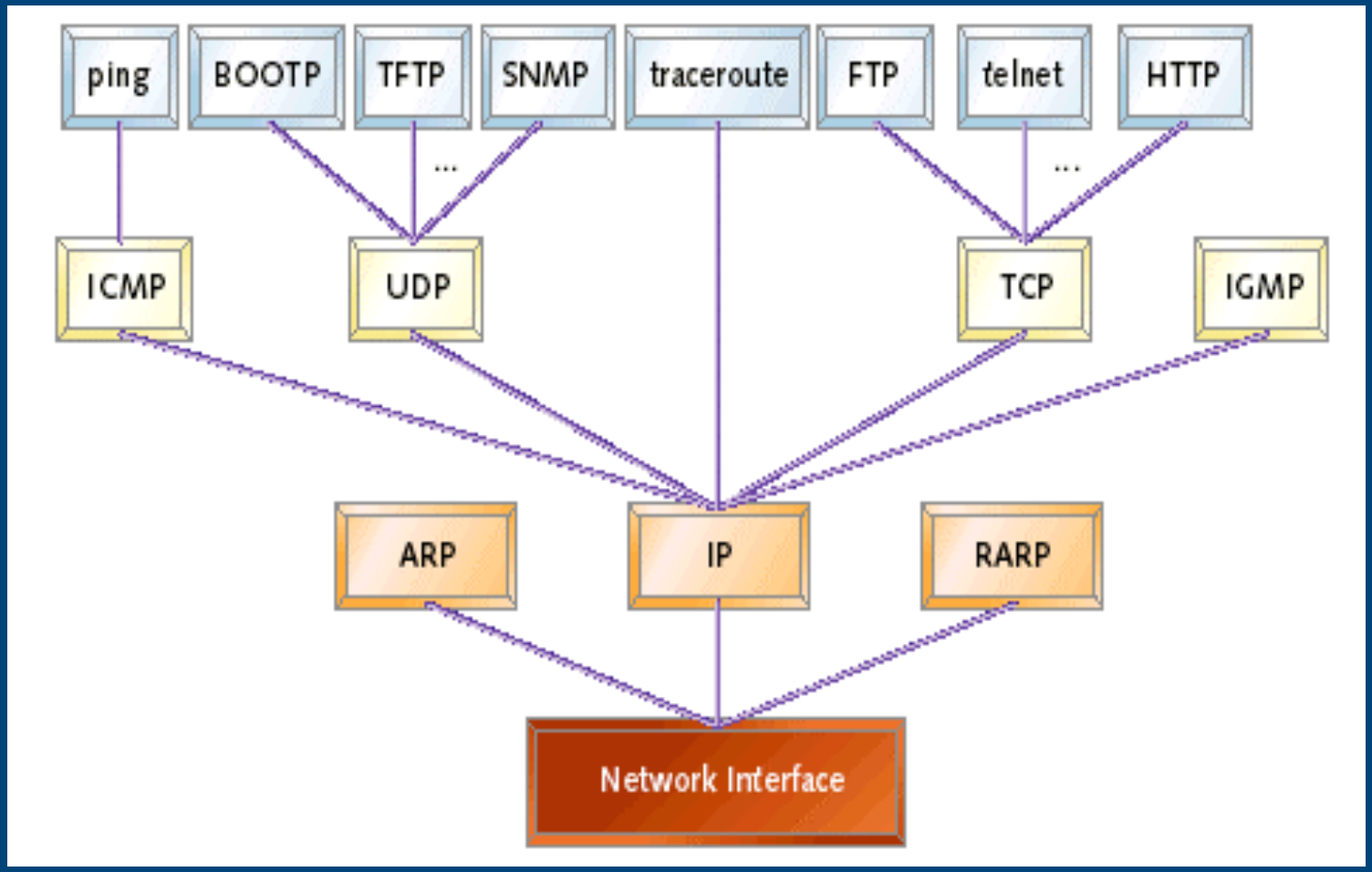
OSI

- Conceptual model composed of seven layers, developed by the International Organization for Standardization (ISO) in 1984.
  - Layer 7 – Application (servers and clients etc web browsers, httpd)
  - Layer 6 – Presentation (file formats e.g pdf, ASCII, jpeg etc)
  - Layer 5 – Session (conversation initialisation, termination,)
  - Layer 4 – Transport (inter host comm – error correction, QOS)
  - Layer 3 – Network (routing – path determination, IP[x] addresses etc)
  - Layer 2 – Data link (switching – media acces, MAC addresses etc)
  - Layer 1 – Physical (signalling – representation of binary digits)
- Acronym: All People Seem To Need Data Processing

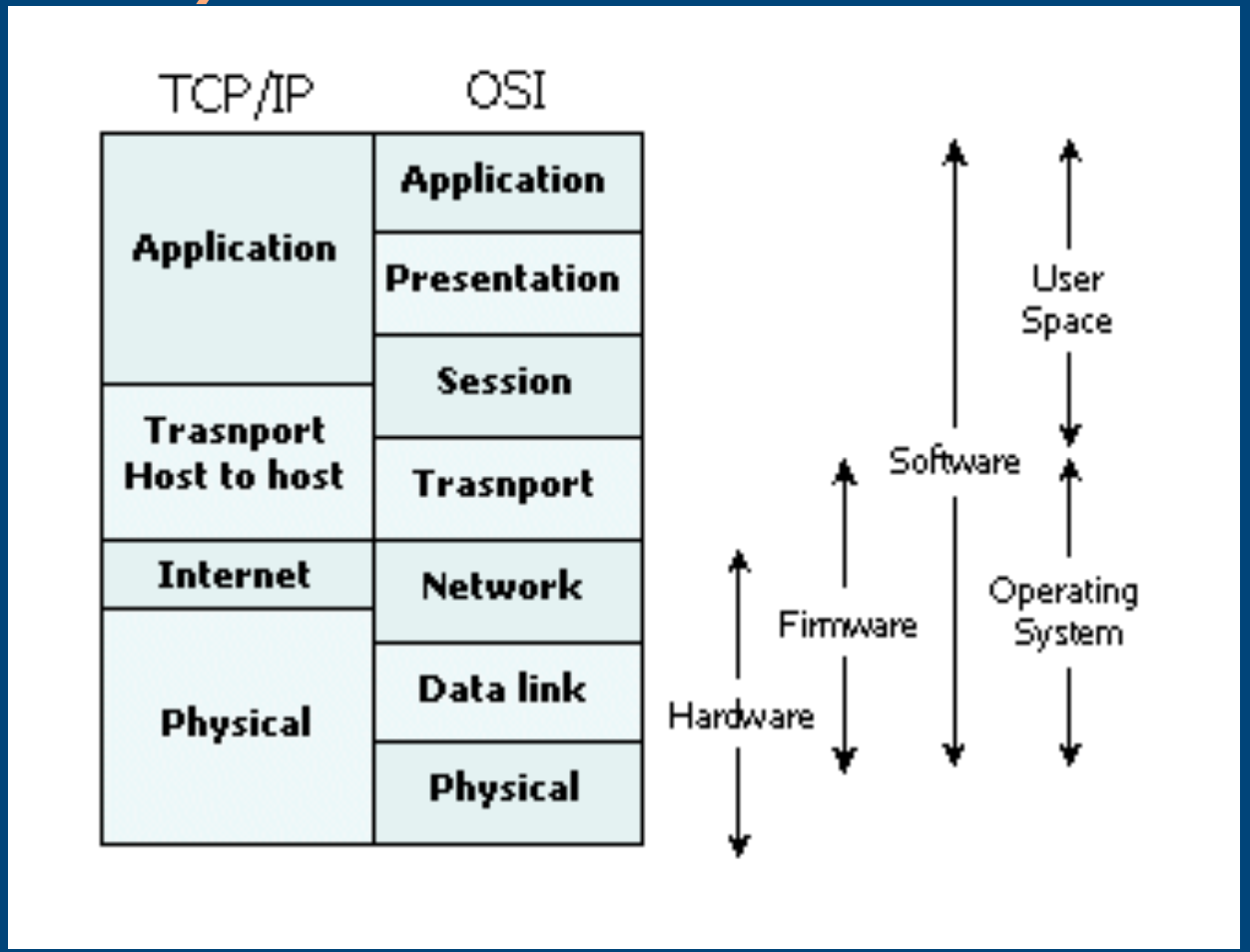
TCP/IP

- Generally, TCP/IP (Transmission Control Protocol/Internet Protocol) is described using three to five functional layers. We have chosen the common DoD reference model, which is also known as the Internet reference model.
  - Process/Application Layer consists of applications and processes that use the network.
  - Host-to-host transport layer provides end-to-end data delivery services.
  - Internetwork layer defines the datagram and handles the routing of data.
  - Network access layer consists of routines for accessing physical networks.

TCP/IP diagram

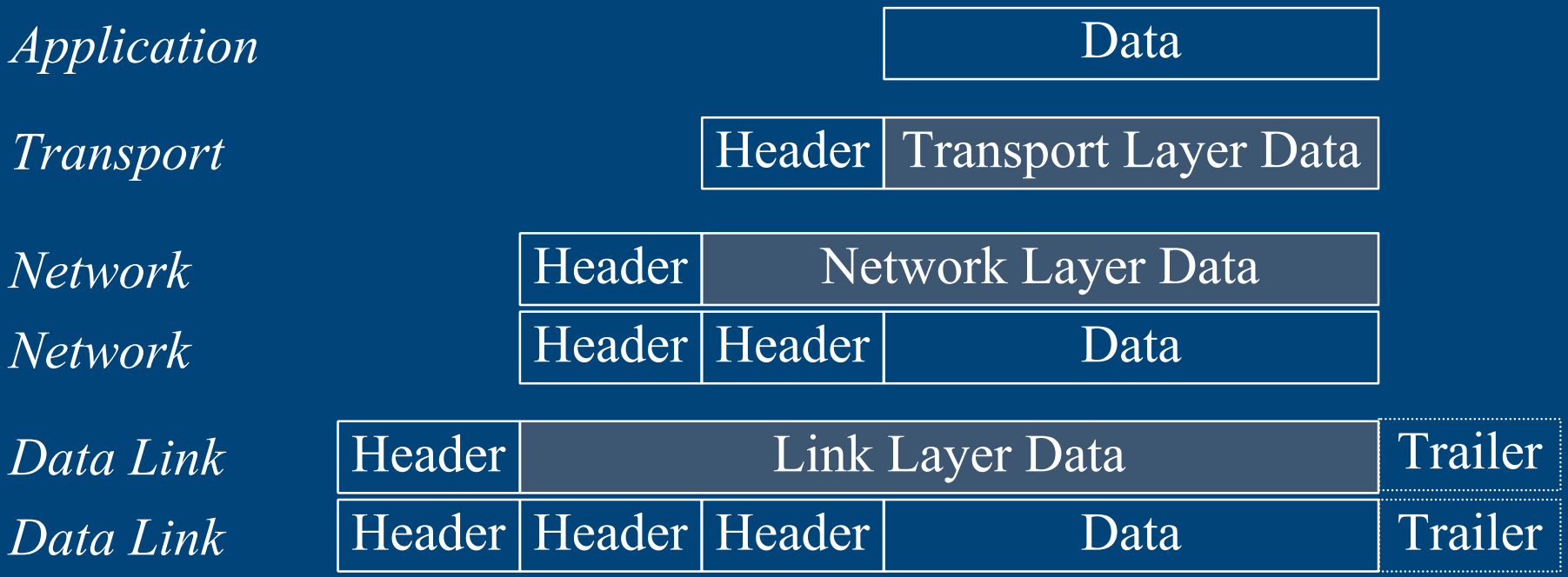


OSI and TCP/IP



Encapsulation & Decapsulation

- Lower layers add headers (and sometimes trailers) to upper layers packets



Frame, Datagram, Segment, Packet

- Different names for packets at different layers
  - Ethernet (link layer) frame
  - IP (network layer) datagram
  - TCP (transport layer) segment
- Terminology is not strictly followed
  - we often just use the term “packet” at any lay

So what is an IP address anyway?

- 32 bit number (4 octet number) can be represented in lots of ways:

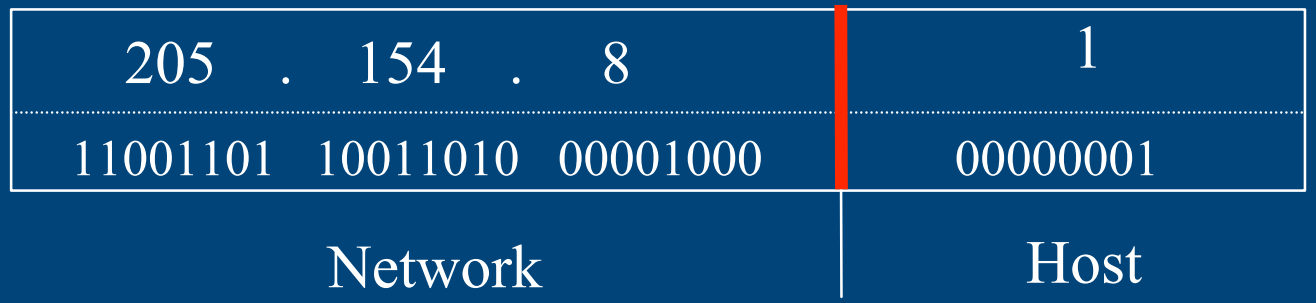
133	27	162	125

10000101	00011011	10100010	01111101

85	1B	A2	7D

More to the structure

- Hierarchical Division in IP Address:
  - Network Part (Prefix)
    - describes which physical network
  - Host Part (Host Address)
    - describes which host on that network



  - Boundary can be anywhere
    - very often NOT at a multiple of 8 bits

Network Masks

- Network Masks help define which bits are used to describe the Network Part and which for hosts
- Different Representations:
  - decimal dot notation: 255.255.224.0
  - binary: 11111111 11111111 11100000 00000000
  - hexadecimal: 0xFFFFE000
  - number of network bits: /19
- Binary AND of 32 bit IP address with 32 bit netmask yields network part of address

Sample Netmasks

137.158.128.0/**17** (netmask **255.255.128.0**)

1111 1111	**1111 1111**	**1**000 0000	**0000 0000**
1000 1001	1001 1110	1000 0000	0000 0000

198.134.0.0/**16** (netmask **255.255.0.0**)

1111 1111	**1111 1111**	**0000 0000**	**0000 0000**
1100 0110	1000 0110	0000 0000	0000 0000

205.37.193.128/**26** (netmask **255.255.255.192**)

1111 1111	**1111 1111**	**1111 1111**	**11**00 0000
1100 1101	0010 0101	1100 0001	10 00 0000

Special IP Addresses

- All 0's in host part: Represents Network
  - e.g. 193.0.0.0/24
  - e.g. 138.37.128.0/17
- All 1's in host part: Broadcast
  - e.g. 137.156.255.255 (137.156.0.0/16)
  - e.g. 134.132.100.255 (134.132.100.0/24)
  - e.g. 190.0.127.255 (190.0.0.0/17)
- 127.0.0.0/8: Loopback address (127.0.0.1)
- 0.0.0.0: Various special purposes

Allocating IP addresses

- The subnet mask is used to define size of a network
- E.g a subnet mask of 255.255.255.0 or /24 implies 32-24=8 host bits
  - 2^8 minus 2 = 254 possible hosts
- Similarly a subnet mask of 255.255.255.224 or /27 implies 32-27=5 hosts bits
  - 2^5 minus 2 = 30 possible hosts

Fun with subnets

Numbering Rules

- Private IP address ranges:
  - 10/8 (10.0.0.0 – 10.255.255.255)
  - 192.168/16 (192.168.0.0 – 192.168.255.255)
  - 172.16/12 (172.16.0.0 – 172.31.255.255)
- Public Address space available from AfriNIC
- Choose a small block from whatever range you have, and subnet your networks (to avoid problems with broadcasts)

FreeBSD IP related settings

- ifconfig_vr0=“196.200.218.10”
- defaultrouter=“196.200.218.254”
- hostname=“pc1.e0.ws.afnog.org”

Forwarding

- If a computer isn't on your subnet, packet's sent via a “gateway” connected to to networks.
- defaultrouter option in /etc/rc.conf sets the default gateway for this system.
- IP forwarding on a FreeBSD box turned on with the gateway_enable option in /etc/rc.conf otherwise the box will not forward packets from one interface to another.

Packet Routing Exercise

Client – Server Arch

- Client makes requests, Server serves requests – e.g HTTP for transferring “websites”. This is the easiest way to provide services on demand and provides a means of sharing resources more effectively.
- Example: Mimicking the browser with telnet (client) talking to a web server (server)

  telnet www.google.com 80
  GET / HTTP/1.0
  Host: www.google.com
  <blank line>

Debugging

- ping
- traceroute
- tcpdump