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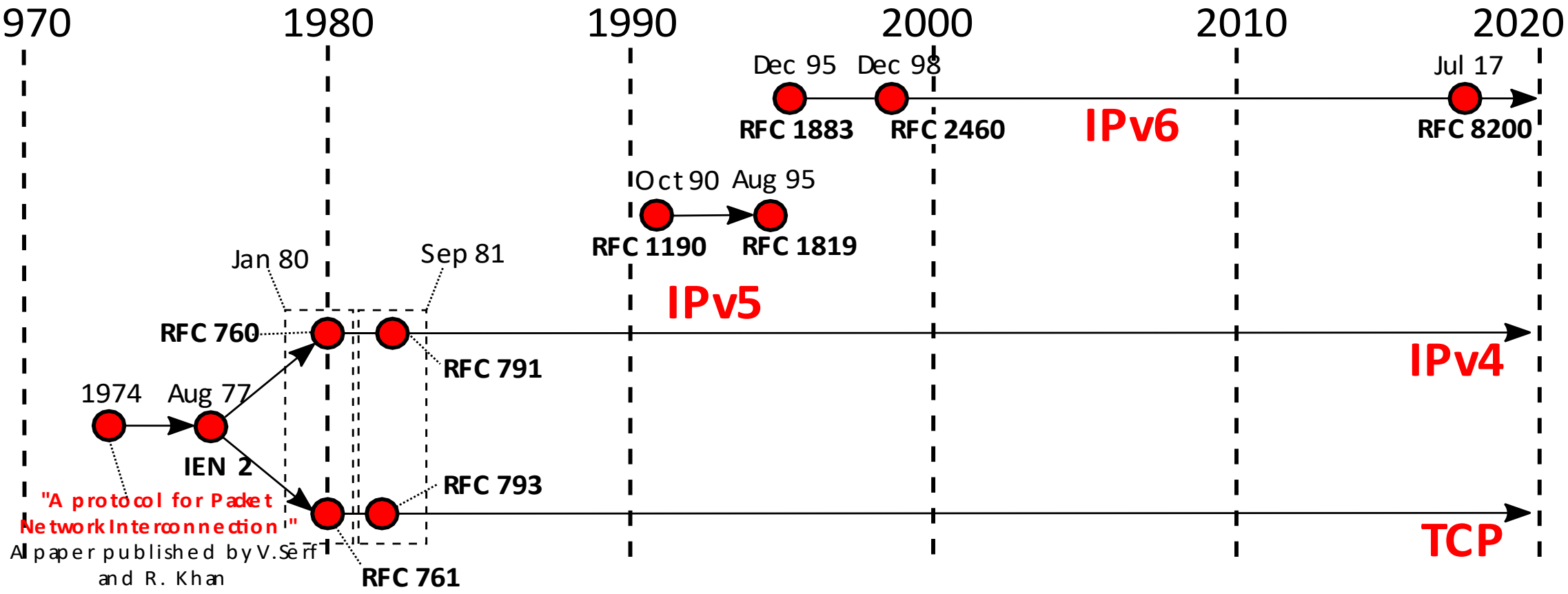
Computing Fundamentals

Planning

Session	Subject	Test – Hand-in
1	Network Models	
2	Internet Protocol Suite	
3	Network segmentation	
4	Network protocols	
5	Operating systems	
6	Command Line	
-- 30/10 – 5/11 --	Autumn break – HERFSTVAKANTIE	
7	Command Line	
8	Mid-term test	**Test**
9	**Scripting**	
10	Virtualization - Cloud computing	

Computing Fundamentals

The TCP/IP development timeline



Computing Fundamentals

The TCP/IP 5-Layer Reference Mode (V1 – AKA original)

- 4 Layers of Transmission Control Protocol/ Internet Protocol (TCP/IP)

LAYER (NUMBER)	DESCRIBES/DEFINES
Application (4)	The Application layer is responsible for providing network services directly to end-users.
Transport (3)	The Transport layer ensures reliable delivery of data between network hosts. It includes protocols like TCP and UDP (User Datagram Protocol).
Internet (2)	The Internet layer, primarily governed by the IP protocol, handles the addressing and routing of data packets across different networks.
Network Interface Link Layer (1)	The Network Interface layer, also known as the Link layer or Network Access layer, deals with the physical transmission of data over the network medium.

Computing Fundamentals

The TCP/IP 5-Layer Reference Mode (V2 – AKA updated)

- 5 Layers of Transmission Control Protocol/ Internet Protocol (TCP/IP)

LAYER (NUMBER)	DESCRIBES/DEFINES
Application (5)	The Application layer is responsible for providing network services directly to end-users.
Transport (4)	The Transport layer ensures reliable delivery of data between network hosts. It includes protocols like TCP and UDP (User Datagram Protocol).
Network (3)	Handles the addressing and routing of data packets across different networks.
Data Link (2)	Error detection and packet framing across a physical network
Physical (1)	Provide the physical interface for data transmission.

Significance of the TCP/IP Model

- *The TCP/IP model holds several key advantages and significance in network communication:*

1. **Universal Adoption:** The TCP/IP model is the foundation of internet communication and is universally adopted across the globe. It enables devices from different vendors and platforms to communicate seamlessly, facilitating the interconnectedness of the digital world.
2. **Scalability and Flexibility:** The TCP/IP model's modular design allows for easy integration of new technologies and protocols. It can adapt to evolving networking requirements, making it scalable and flexible for future advancements.
3. **Interoperability:** The TCP/IP model ensures interoperability between different systems and networks, allowing seamless communication across diverse devices and platforms. It facilitates the exchange of data between different protocols and technologies.
4. **Internet Standardization:** The TCP/IP model serves as a standard for internet communication, guiding the development and implementation of networking protocols and technologies. It provides a common framework that enables compatibility and uniformity across networks.

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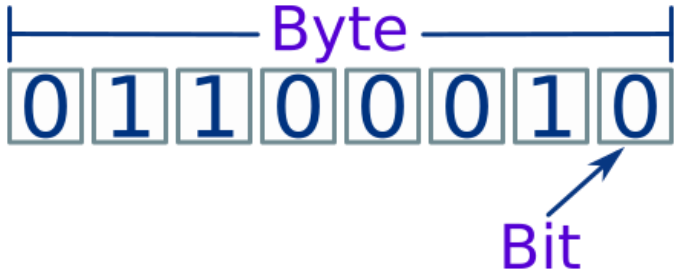
Computing Fundamentals – Number Systems

Number systems

- Bits & bytes
- It's all about the base



Computing Fundamentals – IP ADDRESSES

IP Address

- An IP address, short for Internet Protocol address, is an identifying number for network hardware connected to a network. Having an IP address allows a device to communicate with other devices over an IP-based network like the internet.
- ipconfig -> Windows Command Prompt
- ifconfig or ip a -> Unix Based Shell

- Communication models:
- OSI model (Layer 3 Router – Layer 2 Switch MAC Address 12bit)
- TCP/IP model (layer 4 & 3 of OSI)

Computing Fundamentals – IP ADDRESSES

IP Address

- Unique address in a network
  E.g.: 172.14.100.3
- IPv4
  Adopted around 1980
  4 billion addresses
- IPv6
  Multi-year transition
  340 undecillion addresses

	IPv4	IPv6
Standard since Developed by	1974 IETF	1998 IETF
Length in bits Amount of addresses	32 2^{32} = 4,294,967,296	128 2^{128} = 340,282,366,920,938,463,463,374,607,431,768,211,456
Address format	Dotted decimal 192.168.100.1	Hexadecimal Notation: 2001:0DB8:0234:AB00:0123:4567:8901:ABCD
Dynamic addressing	DHCP	SLAAC / DHCPv6
IPSec	Optional	Mandatory
Header length	Variable	Fixed
Minimal packet size	576 bytes (fragmented)	1280 bytes
Header checksum	Yes	No
Header options	Yes	No (extensions)
Flow	No	Packet flow label

Computing Fundamentals – IP subnets

IP addressing and subnetting

- Network devices use IP addresses and subnets to identify the source and destination of communications and manage network addresses respectively.

- IP addresses contain two parts: a network identifier and a host identifier. The network ID specifies an area of the network where a device resides, much like an area code identifies a section of a telephone network. The host ID labels a specific device in that network section, similar to how a telephone number identifies a specific phone within an area code.

Computing Fundamentals – IPV4

IPV4

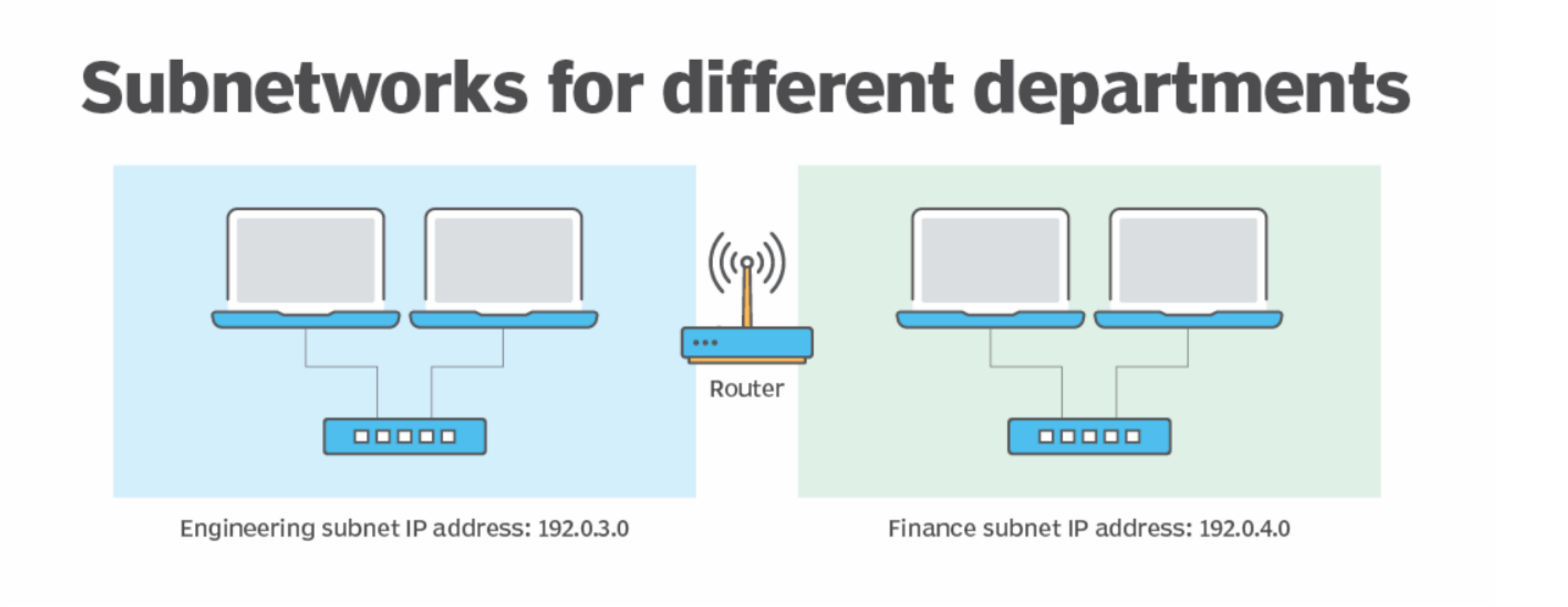
- Unique
- 4 bytes
- 4 Octets
- Or 32 bits

- **Notation:**
- Dotted decimal notation

- Same format each interface

Computing Fundamentals – IPV4

IPV4



Computing Fundamentals – IPV4 Subnet

- **Subnet 255.255.255.0**
- **/32 CIDR**

- **Defines the number of hosts that can be used.**
- **Network classes defines the IPs that are used.**

Computing Fundamentals

IP Address Classes

Class	First octet value	Subnet mask
A	0-127	8
B	128-191	16
C	192-223	24
D	224-239	-
E	240-255	-

- **Class A**
- Public IP Range: 1.0.0.0 to 127.0.0.0
    - First octet value range from 1 to 127
- Private IP Range: 10.0.0.0 to 10.255.255.255
- **Class B**
- Public IP Range: 128.0.0.0 to 191.255.0.0
    - First octet value range from 128 to 191
- Private IP Range: 172.16.0.0 to 172.31.255.255

- **Class C**
- Public IP Range: 192.0.0.0 to 223.255.255.0
    - First octet value range from 192 to 223
- Private IP Range: 192.168.0.0 to 192.168.255.255 Special IP Range: 127.0.0.1 to 127.255.255.255
- **Class D (Multicast – Broadcast)**
- Range: 224.0.0.0 to 239.255.255.255
    - First octet value range from 224 to 239
- **Class E (Research/Reserved/Experimental)**
- Range: 240.0.0.0 to 255.255.255.255
    - First octet value range from 240 to 255

Computing Fundamentals – IPV4 / IPV6

- **IPV4 address -> 32bit - 4 Octets Written in Decimal**
- **IPV6 address -> 128bit – 8 Octets Written in Hexadecimal**

- **Example IPV4:**
- **11111111. 11111111. 11111111. 11111111 Binary**
- **255.255.255.255 Decimal**
- **/32 CIDR**

- **Example IPV6:**
- **1111111111111111.1111111111111111.1111111111111111.1111111111111111.1111111111111111.1111111111111111.1111111111111111.1111111111111111 Binary**
- **ffff. ffff.ffff.ffff.ffff.ffff.ffff.ffff eight groups of four hexadecimal digits**

Computing Fundamentals – IPV4

IPV4

- 192.168.3.0/24
- 2^8 = 256
- 256-2 IPs
- 192.168.3.1 to 192.168.3.254

- 192.168.4.0/24
- 2^8 = 256
- 256-2 IPs
- 192.168.4.1 to 192.168.4.254

NETWORK

Host

Computing Fundamentals – IPV4 Subnet

- **Convert Subnet using the base value:**

128	64	32	16	8	4	2	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

00000000=256

11111111.11111111.11111111.00000000

255.255.255.0

Computing Fundamentals – IPV4 Subnet

- **Convert IP using the base value:**

128	64	32	16	8	4	2	1
2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0

10000000=128

11000000.10101000.00000001.00000001

192.168.1.1

Computing Fundamentals – IPV4

CIDR	Subnet mask	Wildcard mask	# of IP addresses	# of usable IP addresses
/32	255.255.255.255	0.0.0.0	1	1
/31	255.255.255.254	0.0.0.1	2	2*
/30	255.255.255.252	0.0.0.3	4	2
/29	255.255.255.248	0.0.0.7	8	6
/28	255.255.255.240	0.0.0.15	16	14
/27	255.255.255.224	0.0.0.31	32	30
/26	255.255.255.192	0.0.0.63	64	62
/25	255.255.255.128	0.0.0.127	128	126
/24	255.255.255.0	0.0.0.255	256	254