

# 102: Linux

May, 2023

# Audience

- Those who have some basic knowledge of how an OS works

# Materials

- Filesystems overview
- Linux filesystem
- Bash command review
- Shell script flow control
- Networking

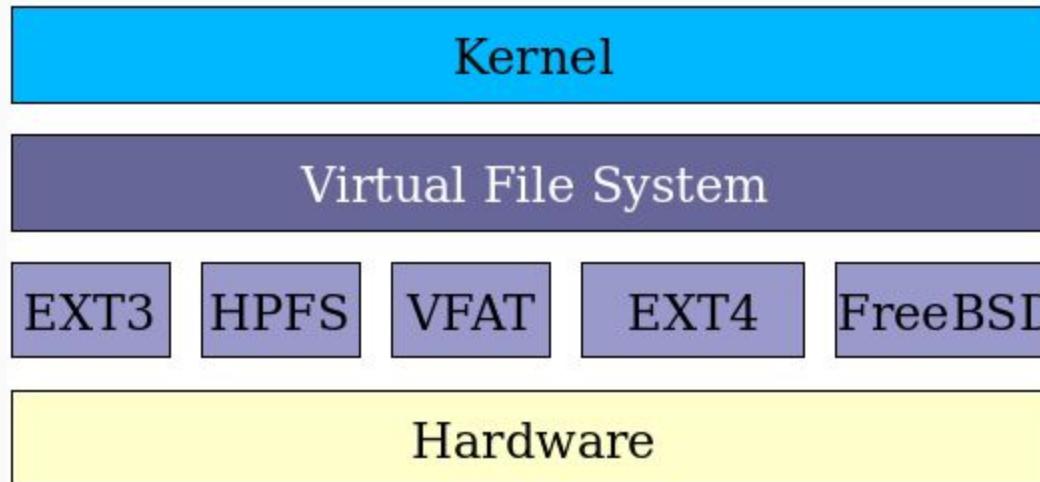


# File Allocation Table (FAT) (1977~)

- FAT12 (1982, MS-DOS 1.25)
  - Volume max 32MB
  - Max no. of files: 4068
- FAT16 (1988, MS-DOS 4.0)
  - Volume max 2GB\*
  - Max no. of files: 65460
- FAT32 (1996, Windows 95 OSR2)
  - Max file size: 4GB
  - Volume max 16TB\*
- exFAT (2006)
  - Max file size: 16EB\*
  - Volume max 128PB
- 8.3 filename and LFN
  - FILEA~1.TXT
- NTFS (1993, Windows NT 3.1)
  - Volume max 256TB-8PB\*
  - Max file size: 16EB
  - encryption, compression
  - journaling

# Linux and MacOS

- ext2/ext3/ext4
  - btrfs
  - XFS
  - ZFS
  - ...
- HFS/HFS+
  - APFS

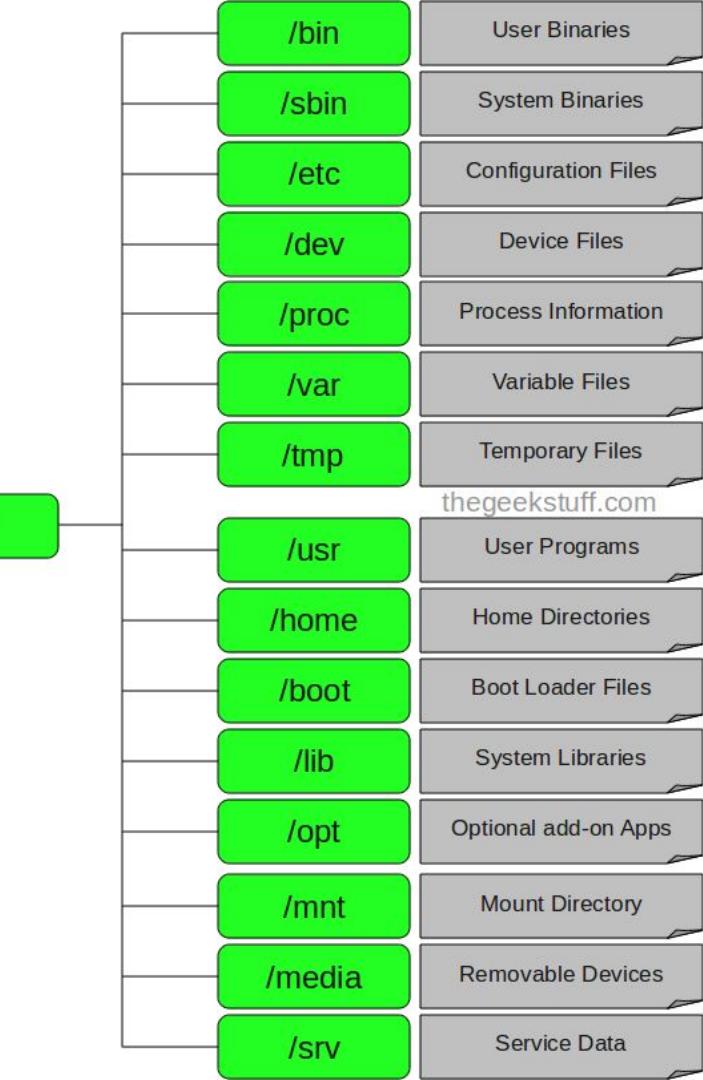


# Directory/folder

```
$ ls /
```

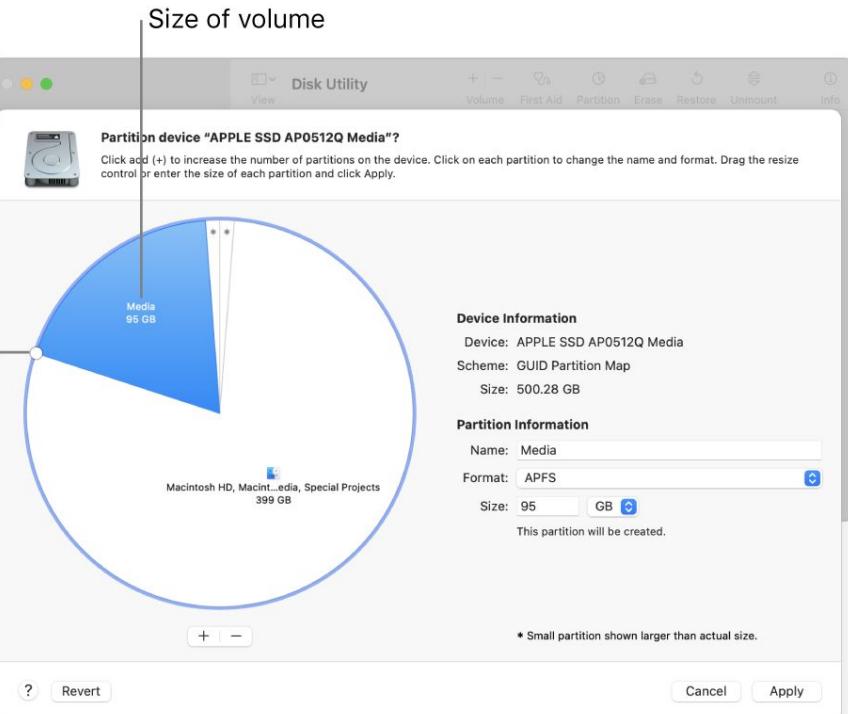
Filesystem Hierarchy Standard

<https://www.pathname.com/fhs/pub/fhs-2.3.pdf>



# Partition vs volume

Drag to resize a volume.



Volume	Layout	Type	File System	Status	Capacity	Free Spa...	% Free
(H:)	Simple	Basic	NTFS	Healthy (P...)	192.08 GB	180.56 GB	94 %
(J:)	Simple	Basic	NTFS	Healthy (P...)	63.29 GB	63.12 GB	100 %
New Volume (F:)	Striped	Dynamic	NTFS	Healthy	20.27 GB	20.16 GB	99 %
New Volume (G:)	Simple	Dynamic	NTFS	Healthy	10.24 GB	10.15 GB	99 %
New Volume (I:)	Mirror	Dynamic	NTFS	Healthy	1003.62 GB	1002.25 ...	100 %
System Reserved	Simple	Basic	NTFS	Healthy (S...)	100 MB	64 MB	64 %
System Reserved (...)	Simple	Basic	NTFS	Healthy (A...)	628 MB	376 MB	60 %

**Disk 0**  
Basic  
60.00 GB  
Online

System 100 MB Healthy	(C): 30.60 GB NTFS Healthy (Boot, Page)	(E): 10.08 GB NTFS Healthy (Primary)	19.21 GB Unallocated
-----------------------------	---	--	-------------------------

**Disk 1**  
Dynamic  
1024.00 GB  
Online

New Volume (G): 10.24 GB NTFS Healthy	New Volume (F): 10.14 GB NTFS Healthy	New Volume (I): 1003.62 GB NTFS Healthy
---	---	---

**Disk 2**  
Dynamic  
2048.00 GB

New Volume (F): 10.14 GB NTFS	New Volume (I): 1003.62 GB NTFS	1034.24 GB
----------------------------------	------------------------------------	------------

Legend:  
■ Unallocated  
■ Primary partition  
■ Simple volume  
■ Striped volume  
■ Mirrored volume

# Master Boot Record (MBR) (1983)

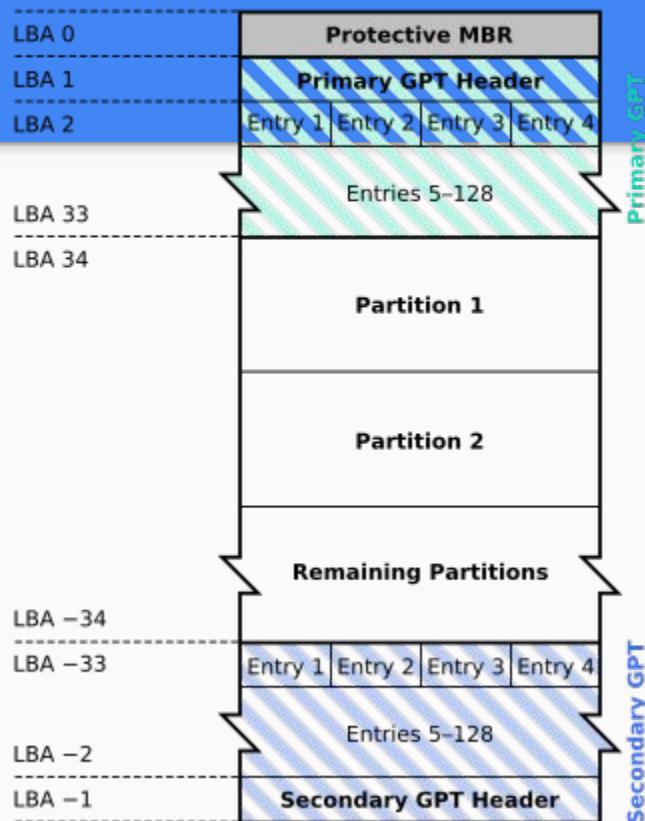
- Boot code
  - 16 bit
  - beginning of the disk
- Partition table
  - 4 primary partitions
  - or 3 primary partitions and 1 extended partition (many logical partitions inside)
  - max 2TB disk

1990s, Intel

# GUID Partition Table (GPT)

- No boot code
- Stored at the beginning and the end of the disk
- Max 256 partitions
- Max 64ZB disk
- Windows Vista ~ requires UEFI

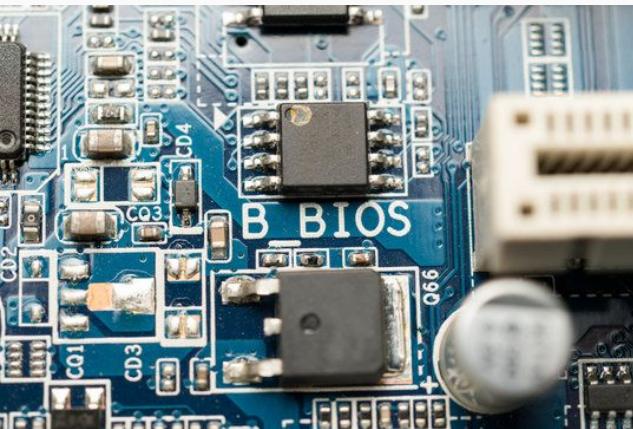
## GUID Partition Table Scheme



# BIOS vs UEFI



- BIOS (Basic Input/Output System) (1975)
  - initialize hardware, boot OS
  - 16 bit
- UEFI (Unified Extensible Firmware Interface) (2004)
  - initialize hardware, boot OS
  - 32/64 bit
  - support GPT
  - support mouse, network, FAT, (NTFS), secure boot\*
  - boot from (ESP)/EFI/boot/bootx64.efi
  - support legacy boot using CSM



- ▶ Standard CMOS Features
- ▶ Advanced BIOS Features
- ▶ Advanced Chipset Features
- ▶ Integrated Peripherals
- ▶ Power Management Setup
- ▶ PnP/PCI Configurations
- ▶ PC Health Status

- ▶ Frequency/Voltage Control
- Load Fail-Safe Defaults
- Load Optimized Defaults
- Set Supervisor Password
- Set User Password
- Save & Exit Setup
- Exit Without Saving

Esc : Quit

↑ ↓ → ← : Select Item

F10 : Save & Exit Setup

Time, Date, Hard Disk Type...

## Aptio Setup - AMI

Main Advanced AMD CBS AMD PBS Option Chipset Server Mgmt Security Boot Save & Exit

## BIOS Information

Project Name MZ72-HB0-00  
Project Version M02  
Build Date and Time 02/05/2021 18:22:06

## BMC Information

BMC Firmware Version 12.50.09

## Processor Information

CPU 0 Brand String AMD EPYC 7763 64-Core

Processor

CPU 1 Brand String AMD EPYC 7763 64-Core

Processor

CPU Speed 2450 MHz

Processor Core

64

Microcode Patch A001114

Total Memory 524288 MB

Memory Speed 3200 MT/s

## VR Information

Version 8160

## AGESA PI Version

PI Version 1.0.0.0

++: Select Screen

↑↓: Select Item

Enter: Select

+/-: Change Opt.

F1: General Help

F3: Previous Values

F9: Optimized Defaults

F10: Save & Exit

ESC: Exit



⌚ 16:31 | Wed 4 Mar, 2020

GAME BOOST

A-XMP



**CPU Speed** 3.90 GHz  
**DDR Speed** 2666 MHz

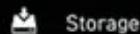
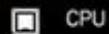
CPU Temperature: 34°C  
MotherBoard Temperature: 32°C

Boot Priority



MB: MEG X570 ACE (MS-7C35)  
CPU: AMD Ryzen 7 3800X 8-Core Processor  
Memory Size: 16384MB  
VCore: 1.444V  
DDR Voltage: 1.220V  
BIOS Ver: E7C35AMS.180  
BIOS Build Date: 01/16/2020

## EZ Mode



Current DRAM Size: 16384MB DRAM Voltage: 1.220V

Model	Size
DIMM A1: unknown	N/A
DIMM A2: A-DATA	8192 MB
DIMM B1: unknown	N/A
DIMM B2: A-DATA	8192 MB

DIMM A1: unknown	N/A
DIMM A2: A-DATA	8192 MB
DIMM B1: unknown	N/A
DIMM B2: A-DATA	8192 MB

Current DRAM Frequency:

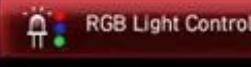
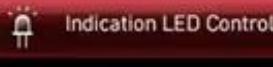
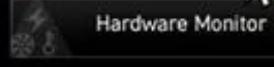
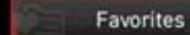
2666 MHz

The  
WindowsClub

## XMP Profile

Profile1: DDR4 3600MHz 17-18-18-38

Profile2: DDR4 2666MHz 16-16-16-39



# Install Linux: a demonstration

copy + paste text

# Bash (Bourne Again SHeLL)

- ls
- man
- cd
- echo
- touch
- mkdir
- touch
- grep
- pwd
- cp
- mv
- rmdir
- rm
- type
- cmp
- diff
- head
- tail
- cat
- more
- less
- sleep
- history
- clear
- ps
- kill
- nano
- ln
- whoami
- useradd  
(adduser也可)
- sudo
- usermod
- userdel
- su
- exit
- passwd
- whatis
- which
- ssh
- curl
- wget
- zip
- unzip
- tar
- find
- chmod
- chown
- ip
- ping
- nslookup
- date
- time
- users
- groups
- uname
- free
- df
- top
- systemctl
- reboot
- shutdown

# (bash) shell script

```
#!/bin/bash
```

```
for (( c=1; c<=5; c++ ))
do
    echo "Welcome $c"
done
```

```
script.sh
```

```
for c in {1..5..1}
do
    echo "Welcome $c"
done
```

```
#!/bin/bash

for f in *
do
  if [ -d $f ]
  then
    echo "$f is a directory"
  elif [ -e $f ]
  then
    echo "$f is a file"
  else
    echo "$f is not a file"
  fi
done
```

jing@builder: ~

GNU nano 7.2

#!/bin/bash

```
for f in *
do
  if [ -d $f ]
  then
    echo "$f is a directory"
  elif [ -e $f ]
  then
    echo "$f is a file"
  else
    echo "$f is not a file"
  fi
done
```

dof.sh

jing@builder:~ \$ chmod +x dof.sh

jing@builder:~ \$ ./dof.sh

Arch-MOTD is a directory

checksum is a file

Desktop is a directory

Documents is a directory

dof.sh is a file

Downloads is a directory

FastFlix is a directory

flashrom\_1.2-5build1\_amd64.deb is a file

grubnetx64.efi is a file

ipxe is a directory

ipxe-amd64.efi is a file

ipxe-arm64.efi is a file

lcthw is a directory

learn-c-the-hard-way-lectures is a directory

Music is a directory

Pictures is a directory

Public is a directory

raspi-jumbo-frames.patch is a file

script.sh is a file

Templates is a directory

undionly.kpxe is a file

update\_motd.sh is a file

Videos is a directory

yay is a directory

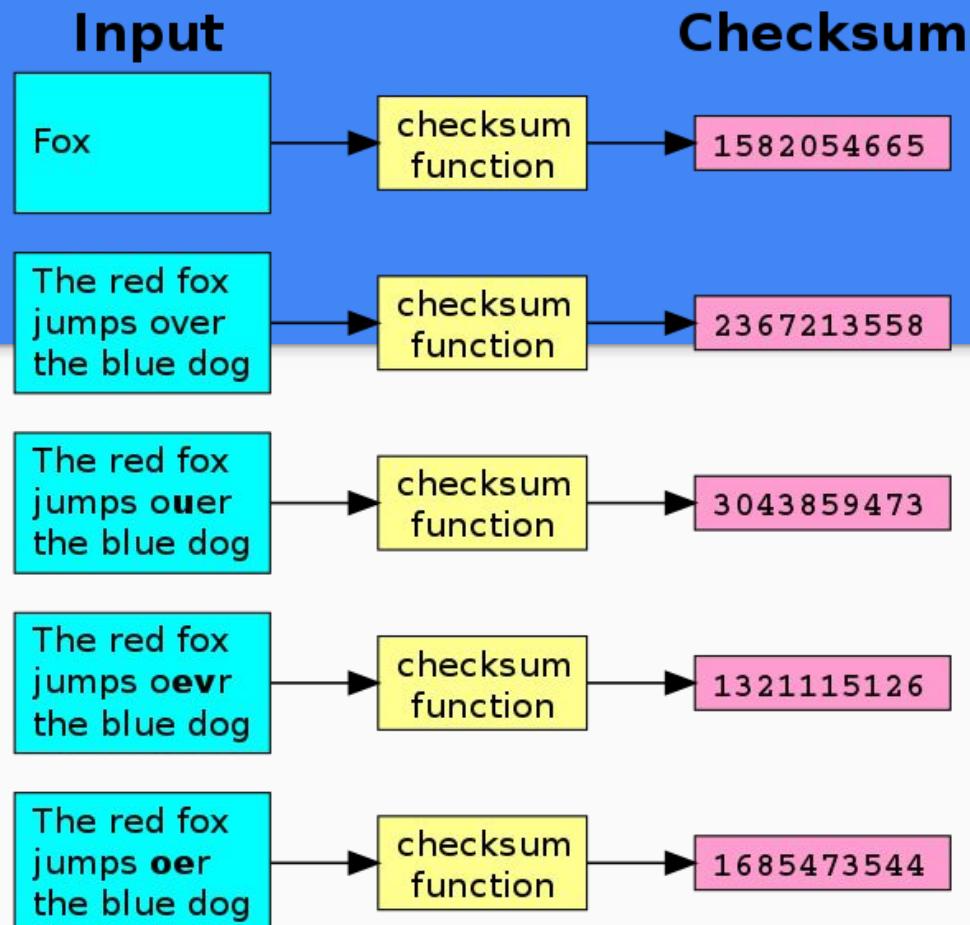
jing@builder:~ \$

[ Read 15 lines ]

^G Help ^O Write Out ^W Where Is ^K Cut ^T Execute  
^X Exit ^R Read File ^\ Replace ^U Paste ^J Justify

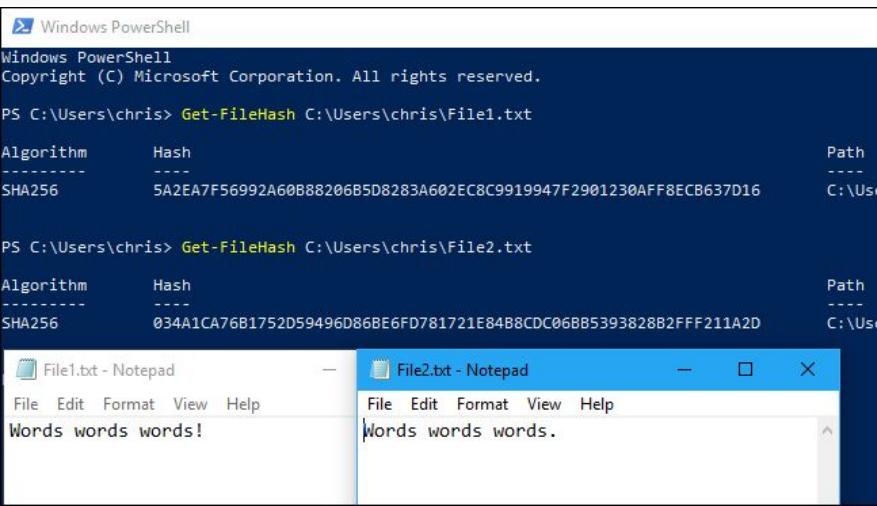
# Checksum & Hash algorithm

- CRC
- CRC64
- MD5
- SHA1
- SHA256
- SHA512
- ...



# SHA256

- **Get-FileHash C:\file.txt -Algorithm SHA256**



Windows PowerShell  
Copyright (C) Microsoft Corporation. All rights reserved.  
PS C:\Users\chris> **Get-FileHash C:\Users\chris\File1.txt**  
Algorithm Hash Path  
---- ----  
SHA256 5A2EA7F56992A60B88206B5D8283A602EC8C9919947F2901230AFF8ECB637D16  
  
PS C:\Users\chris> **Get-FileHash C:\Users\chris\File2.txt**  
Algorithm Hash Path  
---- ----  
SHA256 034A1CA76B1752D59496D86BE6FD781721E84B8CDC06BB5393828B2FFF211A2D

File1.txt - Notepad File2.txt - Notepad  
File Edit Format View Help File Edit Format View Help  
Words words words! Words words words.

<https://man7.org/linux/man-pages/man1/sha256sum.1.html>

\$ sha256sum file.txt

\$ echo -n "foobar" | sha256sum

\$ sha256sum file.txt > file.txt.checksum

\$ sha256sum -c file.txt.checksum

# Exercise: write a shell script

Calculate the SHA256 hash of every file in a directory, and store the hash in a file.

```
GNU nano 7.2
#!/bin/bash

files="$HOME/Downloads"

for f in $files/*
do
    if [ ! -d $f ]
    then
        sha256sum $f >> "$files/checksum"
    fi
done
```

# cron

```
# └──────────────── minute (0 - 59)
# └───────── hour (0 - 23)
# └──────── day of the month (1 - 31)
# └───────── month (1 - 12)
# └────────── day of the week (0 - 6) (Sunday to Saturday;
#              7 is also Sunday on some systems)
#
# * * * * * <command to execute>
```

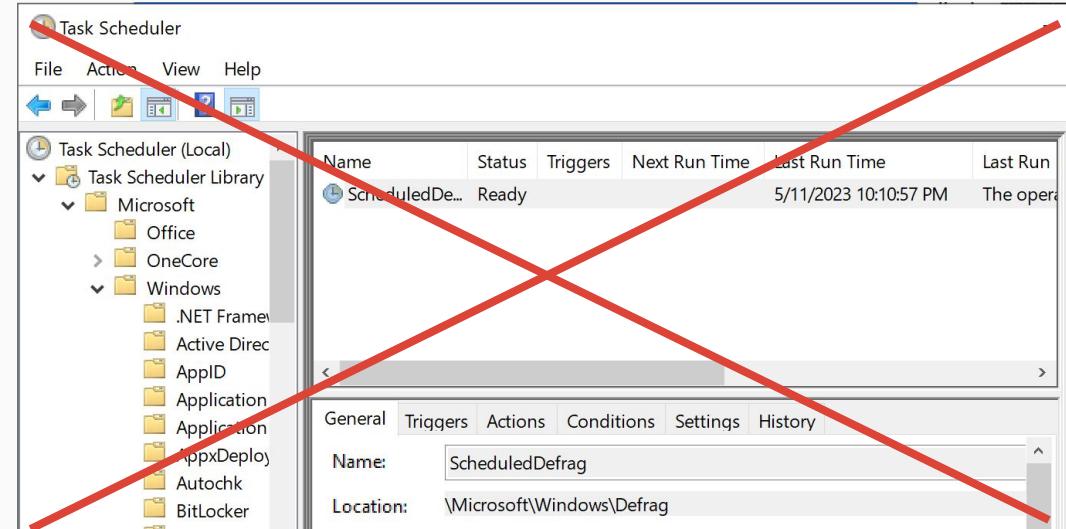
```
$ sudo crontab -e
```

```
# For example, you can run a backup of
# at 5 a.m every week with:
# 0 5 * * 1 tar -zcf /var/backups/home
#
# For more information see the manual
#
# m h dom mon dow   command
* * 1 * * /root/scrub.sh
```

^G Help  
^X Exit

^O Write Out  
^R Read File

^W Where  
^\\ Replace



# Solid state drive (SSD)



3.5 inch SATA HDD



2.5 inch SATA HDD



2.5 inch SATA SSD



22mm x 80mm M.2 NVMe SSD

# no TRIM

1. delete a file in OS
2. file deleted from filesystem
  - a. not from SSD
  - b. can be recovered
3. write a new file in the same block/page
  - a. erase the page first
  - b. write new data

D Deleted Data

128KB Logical Block #1			
D	D	D	D
D	D	D	D
D	D	D	D
D	D	D	D
D	D	D	D
D	D	D	D
D	D	D	D

What the Operating System Knows

128KB Physical Block #1			
1	2	3	4
5	6	7	8
9	10	11	12
13	14	15	16
17	18	19	20
21	22	23	24
25	26	27	28
29	30	31	32

What the SSD Controller Thinks

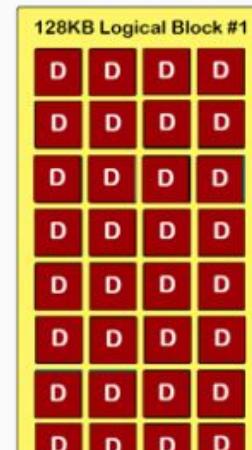
E Erased Page  
V Valid Data  
D Dirty/Stale Data

Without TRIM Command

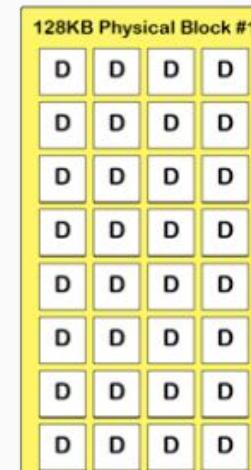
# TRIM

1. delete a file in OS
2. TRIM (auto or manual)
  - a. data marked deleted
  - b. active garbage collection when SSD idle
3. file cannot be recovered
4. write new data into the same block/page
  - a. write only, no erase, faster

**D** Deleted Data



What the Operating System Knows



What the SSD Controller Thinks



With TRIM Command

[What is Trim? | Crucial.com](#)

# fstrim

```
Usage:  
fstrim [options] <mount point>
```

Discard unused blocks on a mounted filesystem.

## Options:

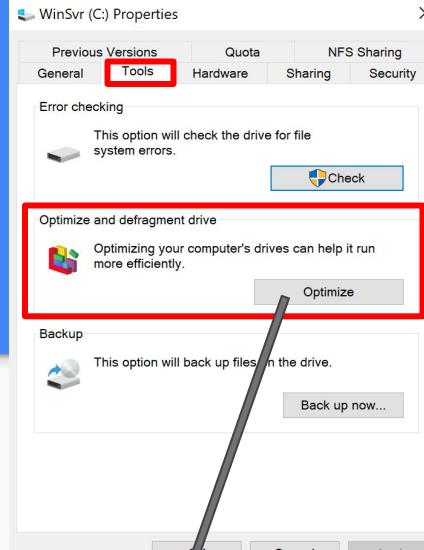
-a, --all	trim mounted filesystems
-A, --fstab	trim filesystems from /etc/fstab
-I, --listed-in <list>	trim filesystems listed in specified files
-o, --offset <num>	the offset in bytes to start discarding from
-l, --length <num>	the number of bytes to discard
-m, --minimum <num>	the minimum extent length to discard
-v, --verbose	print number of discarded bytes
--quiet-unsupported	suppress error messages if trim unsupported
-n, --dry-run	does everything, but trim
-h, --help	display this help
-V, --version	display version

## Arguments:

<num> arguments may be followed by the suffixes for  
GiB, TiB, PiB, EiB, ZiB, and YiB (the "iB" is optional)

For more details see fstrim(8).

```
jing@h12ssl-nt:~$ sudo fstrim -v /  
/: 553.9 MiB (580763648 bytes) trimmed
```



Optimize Drives

You can optimize your drives to help your computer run more efficiently, or analyze them to find out if they need to be optimized. Only drives on or connected to your computer are shown.

## Status

Drive	Media type	Last analyzed or o...	Current status
WinSrv (C:)	Solid state drive	5/3/2023 12:13 AM	OK (9 days since last retrim)
[redacted]	Solid state drive	5/4/2023 3:15 AM	OK (8 days since last retrim)
Solid state drive	Never run		Needs optimization
Solid state drive	5/3/2023 12:13 AM	OK (9 days since last retrim)	
Solid state drive	5/4/2023 3:15 AM	OK (8 days since last retrim)	

Advanced View

Analyze

Optimize

# Exercise: a cron job to TRIM the SSD

Write a cron job to TRIM the SSD once a week, at 00:00 every Sunday.  
Bonus: save the output to a log file.

Hint: schedule the cron job as root so that it runs as root

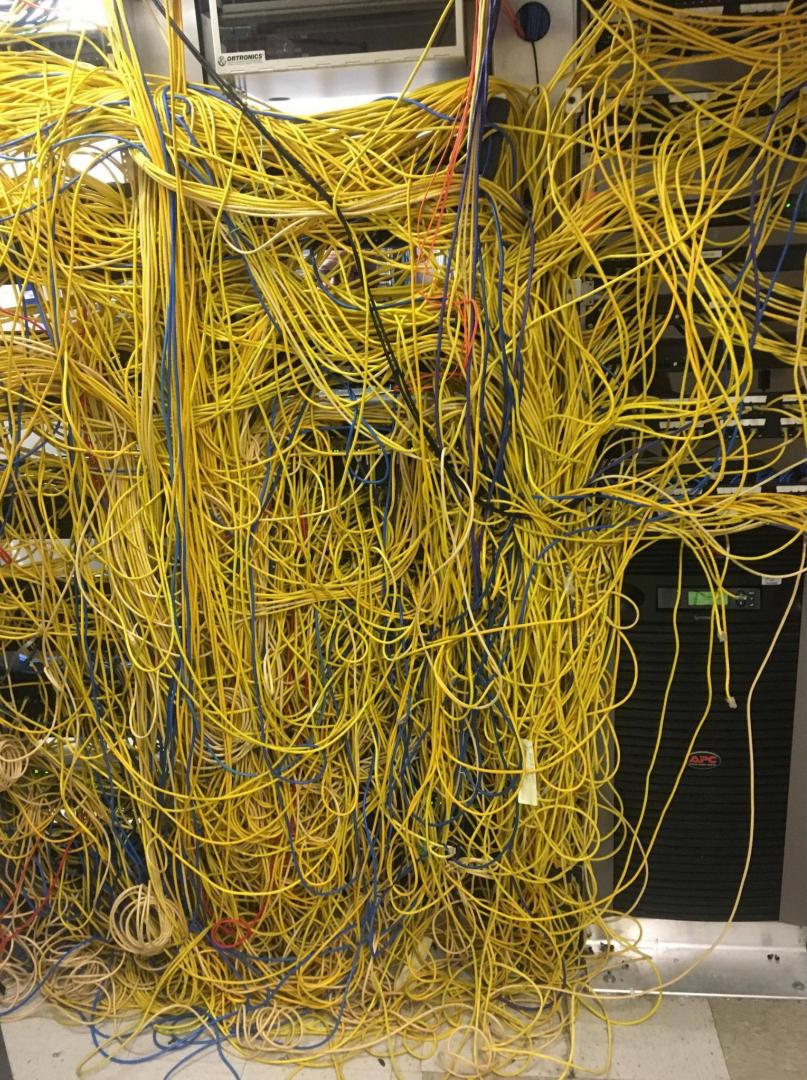
# Exercise: cron job 2

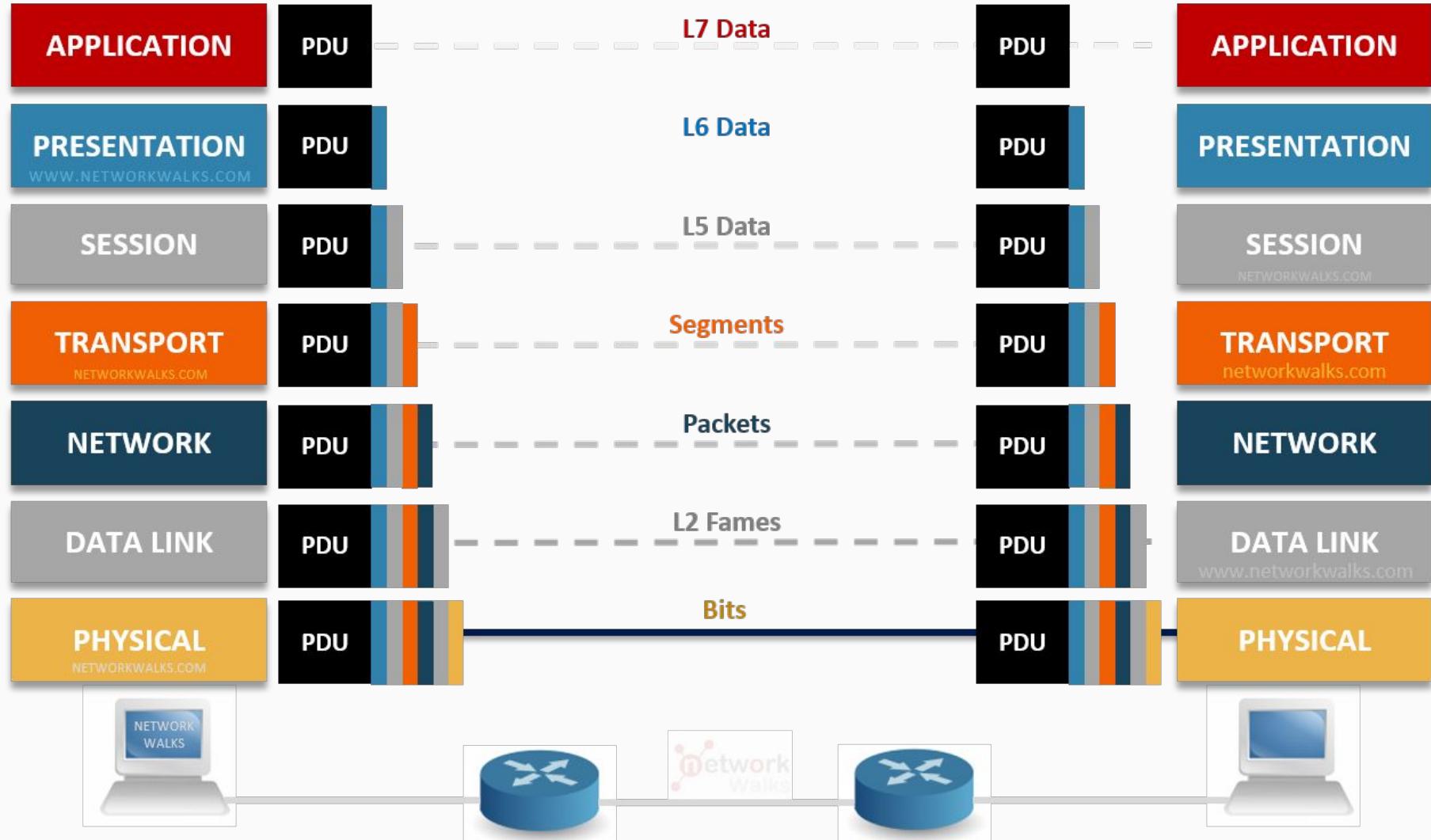
Create a cron job to backup your home directory or all users' home directory.

Hint: use `tar -zcvf` to compress a file or a directory.

# Networking

r/forbiddensnacks





7	APPLICATION networkwalks.com	DNS, DHCP, FTP, PDU, Telnet, POP3/IMAP
6	PRESENTATION networkwalks.com	ASCII, JPEG, GIF, SSL, TLS,...
5	SESSION NETWORKWALKS.COM	SIP, PPTP
4	TRANSPORT NETWORKWALKS.COM	TCP, UDP
3	NETWORK	IPv4, IPv6, OSPF, RIP, BGP, ICMP,...
2	DATA LINK	Ethernet, PPP, Frame Relay
1	PHYSICAL networkwalks.com	WiFi, USB, Bluetooth, RJ45, SDH, MW/RF,..



**APPLICATION**

[networkwalks.com](http://networkwalks.com)

**PRES**  
**ESENTATION**

**SESSION**

[networkwalks.com](http://networkwalks.com)

**TRANSPORT**

[networkwalks.com](http://networkwalks.com)

**NETWORK**

**DATA LINK**

**PHYSICAL**

[networkwalks.com](http://networkwalks.com)

**Please Do Not Throw Sausage Pizza Away**

**All People Seem To Need Data Processing**



# Ethernet



80 00 20 7A 3F 3E  
Destination MAC Address

80 00 20 20 3A AE  
Source MAC Address

08 00  
EtherType

IP, ARP, etc.  
Payload

00 20 20 3A  
CRC Checksum

**MAC Header**  
(14 bytes)

**Data**  
(46 - 1500 bytes)

(4 bytes)

**Ethernet Type II Frame**  
(64 to 1518 bytes)

MAC (media access control) address

Full duplex vs half duplex

Node A



Half Duplex  
Media

Node B



Collision

Command Prompt

```
C:\Users\user>ipconfig /all
Windows IP Configuration

Host Name . . . . . : WIN-7NHASUKCI7D
Primary Dns Suffix . . . . . : localdomain
Node Type . . . . . : Hybrid
IP Routing Enabled . . . . . : No
WINS Proxy Enabled . . . . . : No
DNS Suffix Search List . . . . . : localdomain

Ethernet adapter Local Area Connection:

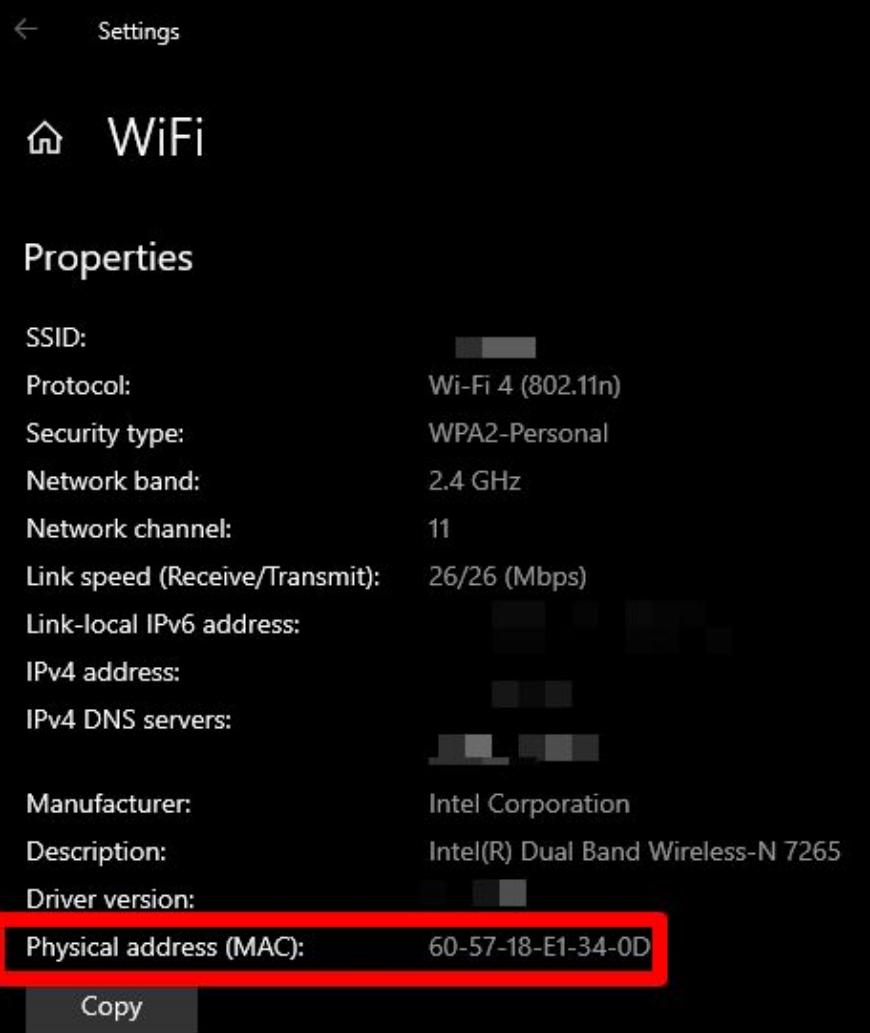
Connection-specific DNS Suffix . . . . . : localdomain
Description . . . . . : Intel(R) PRO/1000 MT Network Connection
Physical Address . . . . . : 00-0C-29-6C-F3-E5
DHCP Enabled . . . . . : Yes
Autoconfiguration Enabled . . . . . : Yes
Link-local IPv6 Address . . . . . : fe80::b82d:1e2b:ed4d:b89d%11<Preferred>
IPv4 Address . . . . . : 10.10.100.131<Preferred>
Subnet Mask . . . . . : 255.255.255.0
Lease Obtained . . . . . : Monday, March 25, 2013 2:34:36 PM
Lease Expires . . . . . : Monday, March 25, 2013 3:04:36 PM
Default Gateway . . . . . :
DHCP Server . . . . . : 10.10.100.254
DHCPv6 IAID . . . . . : 234884137
DHCPv6 Client DUID . . . . . : 00-01-00-01-18-C6-CD-56-00-0C-29-6C-F3-E5
DNS Servers . . . . . : 10.10.100.1
NetBIOS over Tcpip . . . . . : Enabled

Tunnel adapter isatap.localdomain:

Media State . . . . . : Media disconnected
Connection-specific DNS Suffix . . . . . : localdomain
Description . . . . . : Microsoft ISATAP Adapter
Physical Address . . . . . : 00-00-00-00-00-00-E0
DHCP Enabled . . . . . : No
Autoconfiguration Enabled . . . . . : Yes

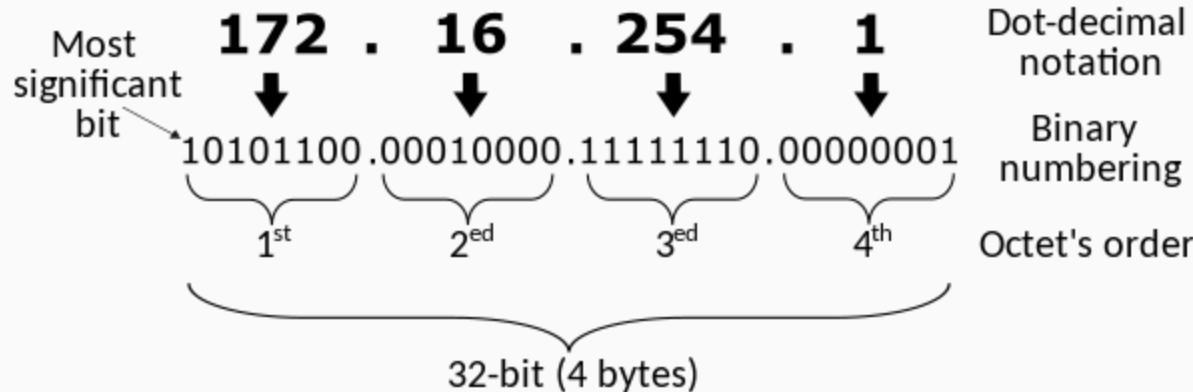
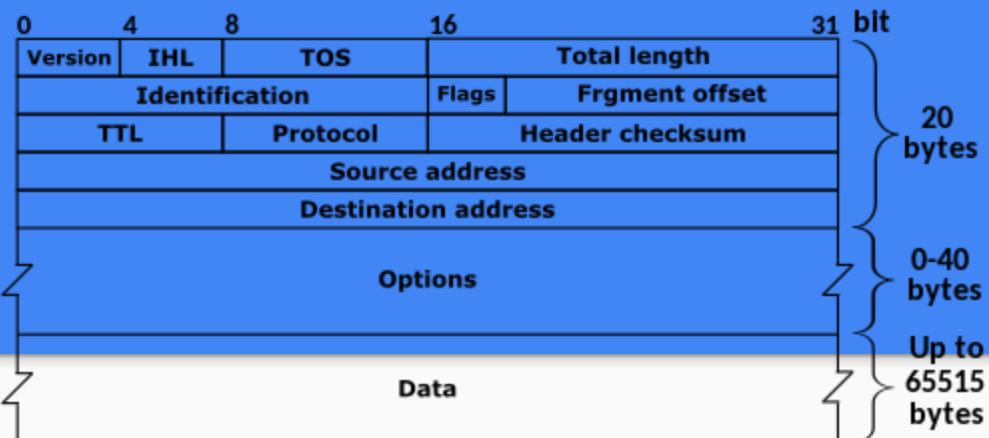
C:\Users\user>
```

```
sagar@itsfoss:~$ ip link
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN mode
DEFAULT group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
2: enp1s0: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 1500 qdisc fq_codel stat
e UP mode DEFAULT group default qlen 1000
    link/ether 52:54:00:5c:92:bf brd ff:ff:ff:ff:ff:ff
sagar@itsfoss:~$
```

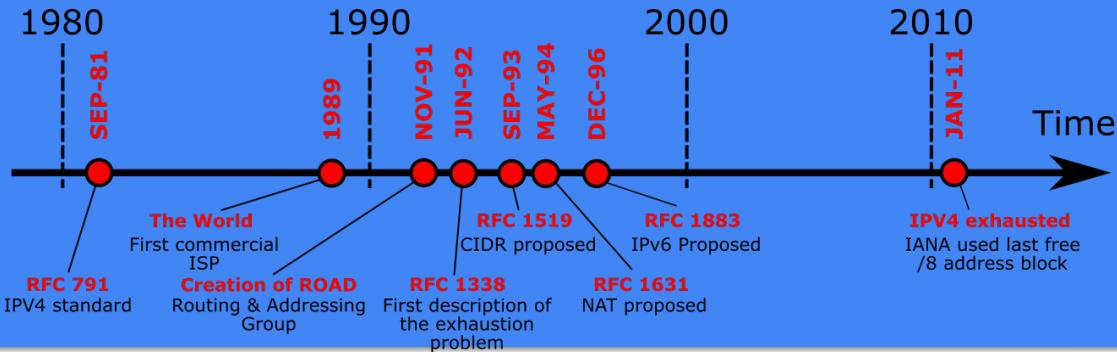


# Layer 3

# IP (Internet Protocol)



# IPv4



- 0.0.0.0 Entire Internet
- 127.0.0.0/8 Host loopback
- 169.254.0.0/16 Link-local

public(グローバル) IP address vs private IP address:

Reserved private IPv4 network ranges<sup>[8]</sup>

Name	CIDR block	Address range	Number of addresses	Classful description
24-bit block	10.0.0.0/8	10.0.0.0 – 10.255.255.255	16 777 216	Single Class A.
20-bit block	172.16.0.0/12	172.16.0.0 – 172.31.255.255	1 048 576	Contiguous range of 16 Class B blocks.
16-bit block	192.168.0.0/16	192.168.0.0 – 192.168.255.255	65 536	Contiguous range of 256 Class C blocks.

Type	Binary form	Dot-decimal notation
Network space	11000000.10101000.00000101. <b>00000000</b>	192.168.5.0
Broadcast address	11000000.10101000.00000101. <b>11111111</b>	192.168.5.255

# IPv4 Subnet

Home LAN: 192.168.0.0 ~ 192.168.255.255

Router/gateway: 192.168.0.1

PC1: 192.168.0.2 (192.168.0.2/16)

PC2: 192.168.0.3

Subnet mask: 255.255.0.0

Broadcast address: 192.168.255.255

▼

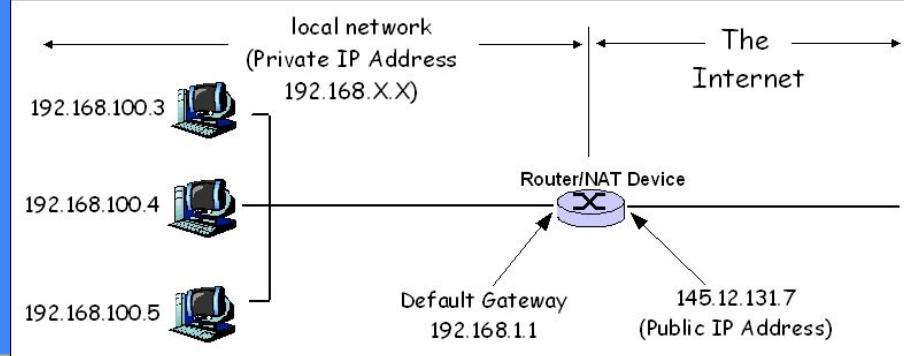
## Classless Inter-Domain Routing (CIDR) notation

## IPv4 Subnet Calculator

## Result

IP Address:	192.168.0.2
Network Address:	192.168.0.0
Usable Host IP Range:	192.168.0.1 - 192.168.255.254
Broadcast Address:	192.168.255.255
Total Number of Hosts:	65,536
Number of Usable Hosts:	65,534
Subnet Mask:	255.255.0.0
Wildcard Mask:	0.0.255.255
Binary Subnet Mask:	11111111.11111111.00000000.00000000
IP Class:	B
CIDR Notation:	/16
IP Type:	Private
Short:	192.168.0.2 /16
Binary ID:	11000000101010000000000000000010

# IPv4 Subnets



Router0: 192.168.0.1/16

Router2: 192.168.2.1/24

Router1: 192.168.1.1/24

Server1: 192.168.2.2

PC1: 192.168.1.2

Server2: 192.168.2.3

PC2: 192.168.1.3

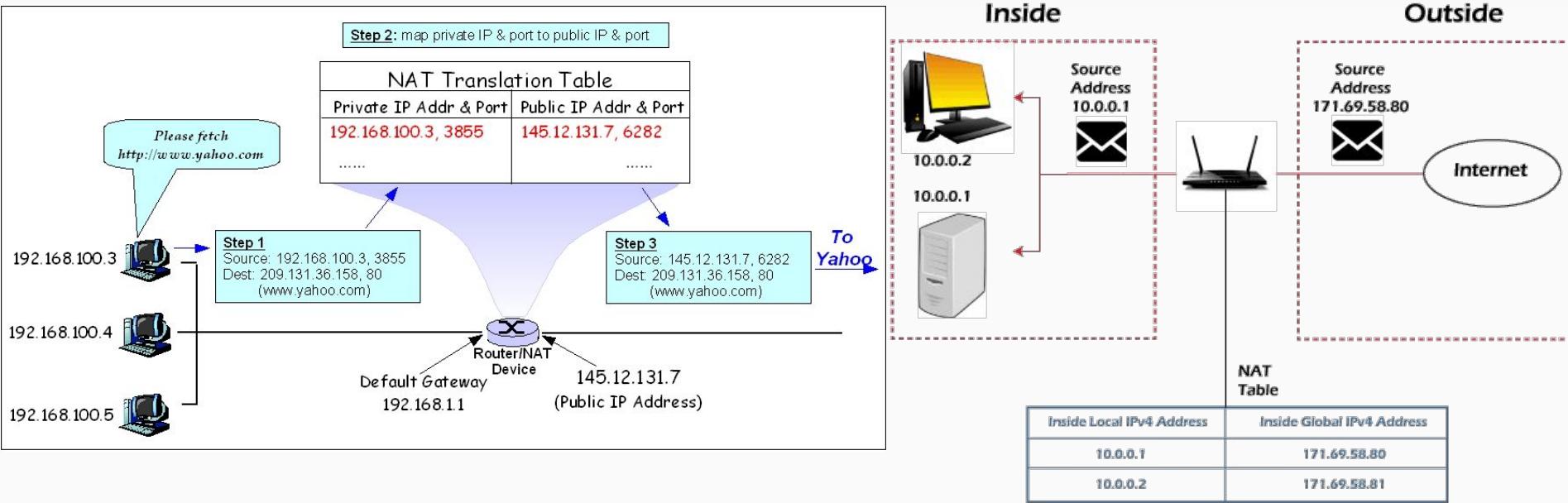
Subnet mask: 255.255.255.0

Subnet mask: 255.255.255.0

Broadcast address: 192.168.2.255

Broadcast address: 192.168.1.255

# NAT (network address translation)



# Address Resolution Protocol (ARP)

The MAC address of  
192.168.0.2?

12:33:DB:8G:0F:E3

FF:FF:FF:FF:FF:FF broadcast

```
Command Prompt  
C:\Users\user>arp -a  
  
Interface: 10.10.100.131 --- 0xb  
    Internet Address        Physical Address          Type  
    10.10.100.1              00-50-56-c0-00-01      dynamic  
    10.10.100.255            ff-ff-ff-ff-ff-ff      static  
    224.0.0.22                01-00-5e-00-00-16      static  
    224.0.0.252                01-00-5e-00-00-fc      static  
    255.255.255.255          ff-ff-ff-ff-ff-ff      static  
  
C:\Users\user>
```

# ICMP (Internet Control Message Protocol)

### Layer 3. (ping)

```
jing@builder:~ $ ping -c 2 yahoo.co.jp
PING yahoo.co.jp (182.22.16.251) 56(84) bytes of data.
64 bytes from 182.22.16.251 (182.22.16.251): icmp_seq=1 ttl=53 time=4.69 ms
64 bytes from 182.22.16.251 (182.22.16.251): icmp_seq=2 ttl=53 time=5.09 ms
...
--- yahoo.co.jp ping statistics ---
2 packets transmitted, 2 received, 0% packet loss, time 1002ms
rtt min/avg/max/mdev = 4.694/4.891/5.089/0.197 ms
jing@builder:~ $
```

```
PS C:\Users\jing> ping yahoo.co.jp

Pinging yahoo.co.jp [182.22.25.252] with 32 bytes of data:
Reply from 182.22.25.252: bytes=32 time=4ms TTL=56
Reply from 182.22.25.252: bytes=32 time=5ms TTL=56
Reply from 182.22.25.252: bytes=32 time=5ms TTL=56
Reply from 182.22.25.252: bytes=32 time=4ms TTL=56

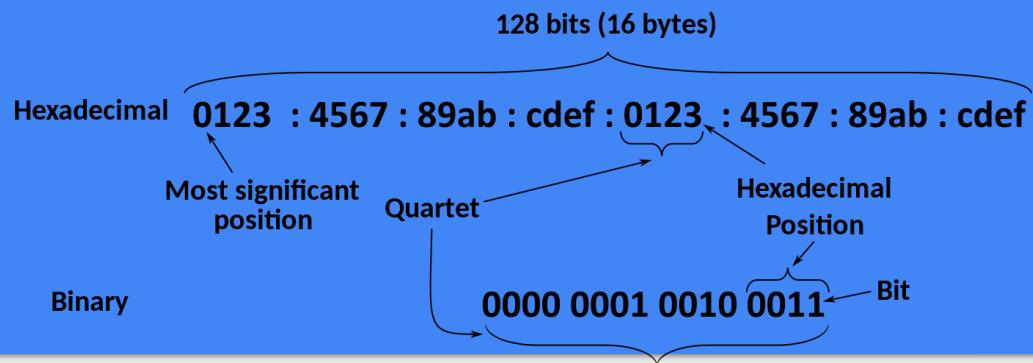
Ping statistics for 182.22.25.252:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
Approximate round trip times in milli-seconds:
    Minimum = 4ms, Maximum = 5ms, Average = 4ms
PS C:\Users\jing>
```

## ICMP header format

# IPv6

- :: Entire Internet
- ::1/128 localhost
- fe80::/64 link local (non-routable)
- fc00::/7 unique local address (ULA)
  - fc00::/8 undefined
  - fd00::/8
  - = IPv4 private address

RFC 4193 block	Prefix/L	Global ID (random)	Subnet ID	Number of addresses in subnet
	48 bits		16 bits	64 bits
fd00::/8	fd	xx:xxxx:xxxx	yyyy	18 446 744 073 709 551 616



## Abbreviation

1. 0042→42, 0000→0, 0880→880
  2. (use only once) consecutive zeros→::
- 0000:0000:0000:0000:0000:0000:0001→::1
  - 2001:0db8:0000:0000:0000:ff00:0042:8329→2001:db8:ff00:42:8329
  - fc80:0000:0000:0001:0000:0000:0ff0:ffff→fc80::1:0:ff0:ffff

[https://en.wikipedia.org/wiki/IPv6\\_address](https://en.wikipedia.org/wiki/IPv6_address)

## Link-local address format

bits	10	54	64
field	prefix	zeroes	interface identifier

# IPv6

Global Unicast Address (GUA)

2000::/3

= IPv4 public address

- Don't use NAT6

- 2001::/16 IPv6 Internet
- 2002::/16 6to4 (deprecated)
- 2400::/12 APNIC IPv6 Internet
- 2600::/12 ARIN IPv6 Internet
- 2800::/12 LACNIC IPv6 Internet
- 2c00::/12 AFRINIC IPv6 Internet
- ...

<https://www.iana.org/assignments/ipv6-unicast-address-assignments/ipv6-unicast-address-assignments.xhtml>

**General unicast address format (routing prefix size varies)**

<b>bits</b>	48 (or more)	16 (or fewer)	64
<b>field</b>	<i>routing prefix</i>	<i>subnet id</i>	<i>interface identifier</i>

# Example: Arch Linux

```
jing@builder:~ $ ip a
1: lo: <LOOPBACK,UP,LOWER_UP> mtu 65536 qdisc noqueue state UNKNOWN group default qlen 1000
    link/loopback 00:00:00:00:00:00 brd 00:00:00:00:00:00
        inet 127.0.0.1/8 scope host lo
            valid_lft forever preferred_lft forever
        inet6 ::1/128 scope host
            valid_lft forever preferred_lft forever
2: ens18: <BROADCAST,MULTICAST,UP,LOWER_UP> mtu 9014 qdisc fq_codel state UP group default qlen 1000
    link/ether 00:15:5d:0b:[REDACTED] brd ff:ff:ff:ff:ff:ff
    altname enp0s18
        inet 192.168.0.[REDACTED]/16 metric 20 brd 192.168.255.255 scope global ens18
            valid_lft forever preferred_lft forever
        inet6 240b:10:[REDACTED]/128 scope global dynamic noprefixroute      GUA
            valid_lft 1035079sec preferred_lft 1035079sec
        inet6 fd69:[REDACTED]/128 scope global dynamic noprefixroute      ULA
            valid_lft 1035079sec preferred_lft 1035079sec
        inet6 fe80::215:5dff:fe0b:[REDACTED]/64 scope link
            valid_lft forever preferred_lft forever
link local
jing@builder:~ $
```

# IPv4 vs IPv6

- IPv4: address exhaustion
- IPv4: simple address pattern
- IPv6: built-in IPsec
- IPv6: built-in Quality of Service (QoS)
- IPv6: everyone gets an address, no need for NAT
- IPv6: no checksum
- speed: ?

# ICMPv6

```
jing@builder:~ $ ping -6 -c 10 google.co.jp
PING google.co.jp(nrt13s52-in-x03.1e100.net (2404:6800:4004:823::2003)) 56 data bytes
64 bytes from nrt13s52-in-x03.1e100.net (2404:6800:4004:823::2003): icmp_seq=1 ttl=115 time=15.1 ms
64 bytes from nrt13s52-in-x03.1e100.net (2404:6800:4004:823::2003): icmp_seq=2 ttl=115 time=8.89 ms
64 bytes from nrt13s52-in-x03.1e100.net (2404:6800:4004:823::2003): icmp_seq=3 ttl=115 time=8.23 ms
64 bytes from nrt13s52-in-x03.1e100.net (2404:6800:4004:823::2003): icmp_seq=4 ttl=115 time=8.61 ms
64 bytes from nrt13s52-in-x03.1e100.net (2404:6800:4004:823::2003): icmp_seq=5 ttl=115 time=8.87 ms
64 bytes from nrt13s52-in-x03.1e100.net (2404:6800:4004:823::2003): icmp_seq=6 ttl=115 time=8.15 ms
64 bytes from nrt13s52-in-x03.1e100.net (2404:6800:4004:823::2003): icmp_seq=7 ttl=115 time=7.78 ms
64 bytes from nrt13s52-in-x03.1e100.net (2404:6800:4004:823::2003): icmp_seq=8 ttl=115 time=7.91 ms
64 bytes from nrt13s52-in-x03.1e100.net (2404:6800:4004:823::2003): icmp_seq=9 ttl=115 time=8.20 ms
64 bytes from nrt13s52-in-x03.1e100.net (2404:6800:4004:823::2003): icmp_seq=10 ttl=115 time=9.19 ms

--- google.co.jp ping statistics ---
10 packets transmitted, 10 received, 0% packet loss, time 9014ms
rtt min/avg/max/mdev = 7.781/9.087/15.050/2.034 ms
jing@builder:~ $
```



# MTU (maximum transmission unit)

L2: Ethernet frame: 1514 bytes

L3: 1500 bytes

IPv4: min 576 bytes / max 65536 bytes

IPv6: min 1280 bytes / max 4GB\*

Jumbo frames: 1501 bytes~

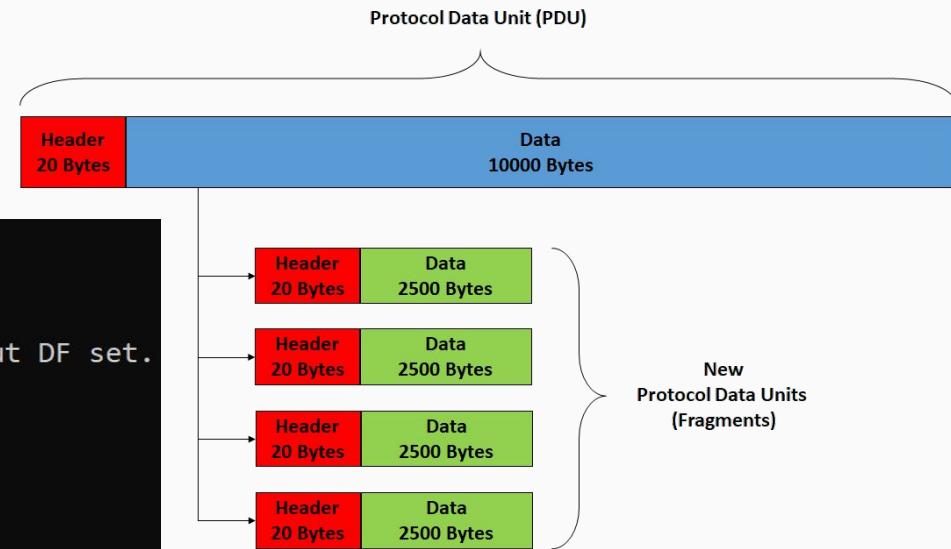
Name:	Ethernet 2
Description:	Marvell AQtic Adapter
Physical address (MAC):	60:32:b1:06:e
Status:	Operational
Maximum transmission unit:	1500
Link speed (Receive/Transmit):	10/10 (Gbps)

PS C:\Users\jing> Get-NetIPInterface							
ifIndex	InterfaceAlias	AddressFamily	NlMtu(Bytes)	InterfaceMetric	Dhcp	ConnectionState	PolicyStore
14	Ethernet 3	IPv6	1500	25	Enabled	Connected	ActiveStore
5	Ethernet 2	IPv6	1500	15	Enabled	Connected	ActiveStore
12	Local Area Connection* 11	IPv6	1500	25	Disabled	Disconnected	ActiveStore
18	Local Area Connection* 10	IPv6	1500	25	Disabled	Disconnected	ActiveStore
10	Ethernet	IPv6	1500	20	Enabled	Connected	ActiveStore
11	Wi-Fi	IPv6	1500	30	Enabled	Connected	ActiveStore
1	Loopback Pseudo-Interface 1	IPv6	4294967295	75	Disabled	Connected	ActiveStore
14	Ethernet 3	IPv4	9000	25	Enabled	Connected	ActiveStore
5	Ethernet 2	IPv4	9000	15	Enabled	Connected	ActiveStore
12	Local Area Connection* 11	IPv4	1500	25	Enabled	Disconnected	ActiveStore
18	Local Area Connection* 10	IPv4	1500	25	Enabled	Disconnected	ActiveStore
10	Ethernet	IPv4	1500	20	Enabled	Connected	ActiveStore
11	Wi-Fi	IPv4	1500	30	Enabled	Connected	ActiveStore
1	Loopback Pseudo-Interface 1	IPv4	4294967295	75	Disabled	Connected	ActiveStore

# IP packet fragmentation

IPv4: fragment at the router

IPv6: fragment at source

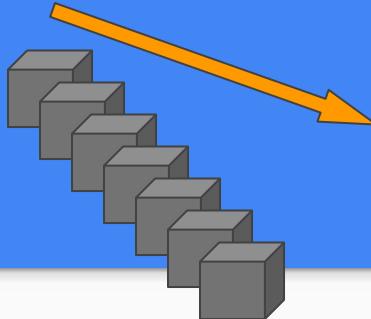


```
PS C:\Users\jing> ping 8.8.8.8 -f -l 1600
```

```
Pinging 8.8.8.8 with 1600 bytes of data:  
Reply from 192.168.0.1: Packet needs to be fragmented but DF set.  
Packet needs to be fragmented but DF set.  
Packet needs to be fragmented but DF set.  
Packet needs to be fragmented but DF set.
```

```
Ping statistics for 8.8.8.8:  
Packets: Sent = 4, Received = 1, Lost = 3 (75% loss),
```

# MTU black hole



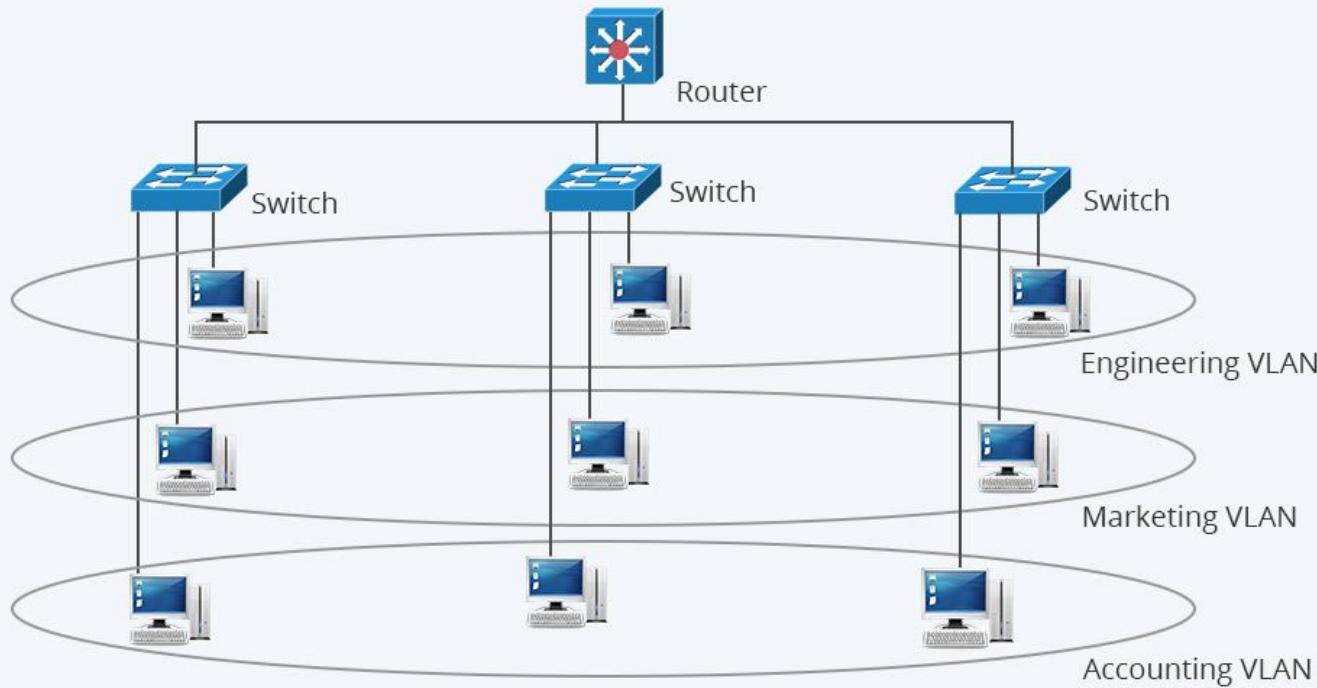
Path MTU Discovery

[https://en.wikipedia.org/wiki/Path\\_MTU\\_Discovery](https://en.wikipedia.org/wiki/Path_MTU_Discovery)

```
jing@builder:~ $ ping -6 -v -a -s 1492 google.com
ping: sock4.fd: -1 (socktype: 0), sock6.fd: 3 (socktype: SOCK_DGRAM), hints.ai_family: AF_INET6
ai->ai_family: AF_INET6, ai->ai_canonname: 'google.com'
PING google.com(nrt12s58-in-x0e.1e100.net (2404:6800:4004:828::200e)) 1492 data bytes
^C
--- google.com ping statistics ---
9 packets transmitted, 0 received, 100% packet loss, time 8109ms

jing@builder:~ $
```

# VLAN



VLAN tag

VLAN10

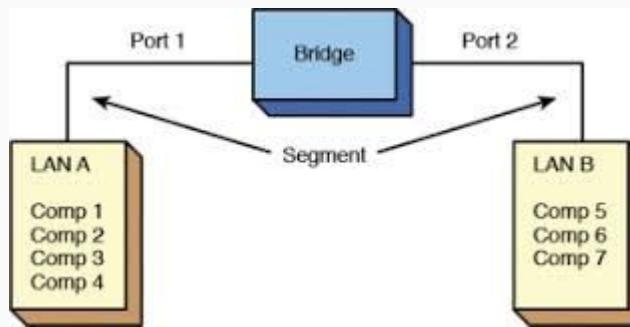
VLAN11

VLAN4095

# Switch vs router

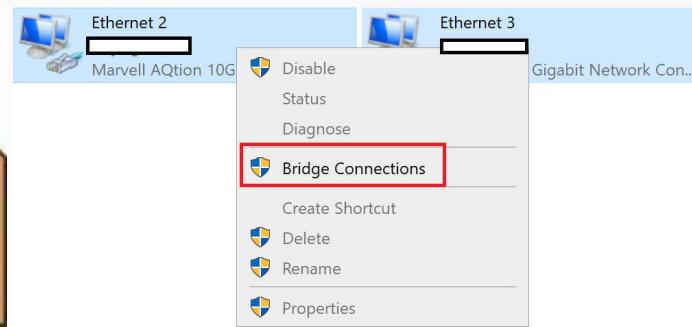
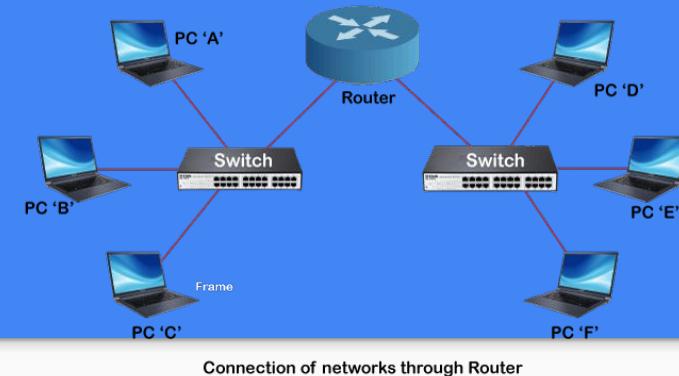
## Switch

- Layer 2 (typically)
- Uses MAC address to forward data
- multiport **bridge** (**connects network segments**)
- no NAT



## Router

- Layer 3
- Uses IP address
- **Routes** traffic between different subnets
- can have NAT

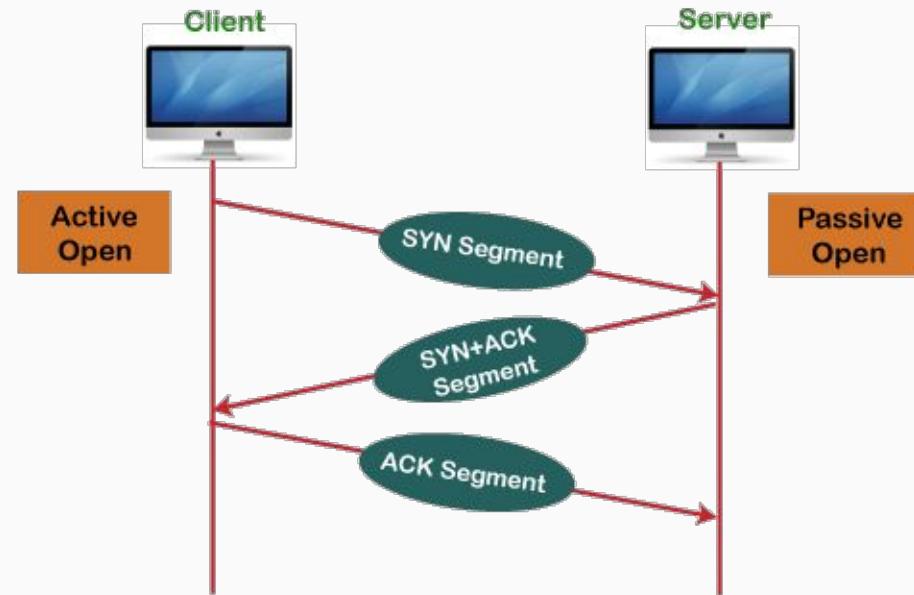


# TCP (Transmission Control Protocol)

Layer 4

- 3 way handshakes
- retransmission
- 65536 ports
- Connection-oriented
- reliable, has error detection, has checksum
- unicast

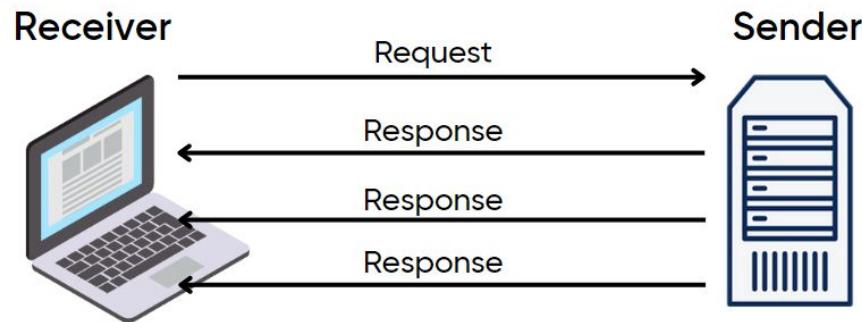
Working of the TCP protocol



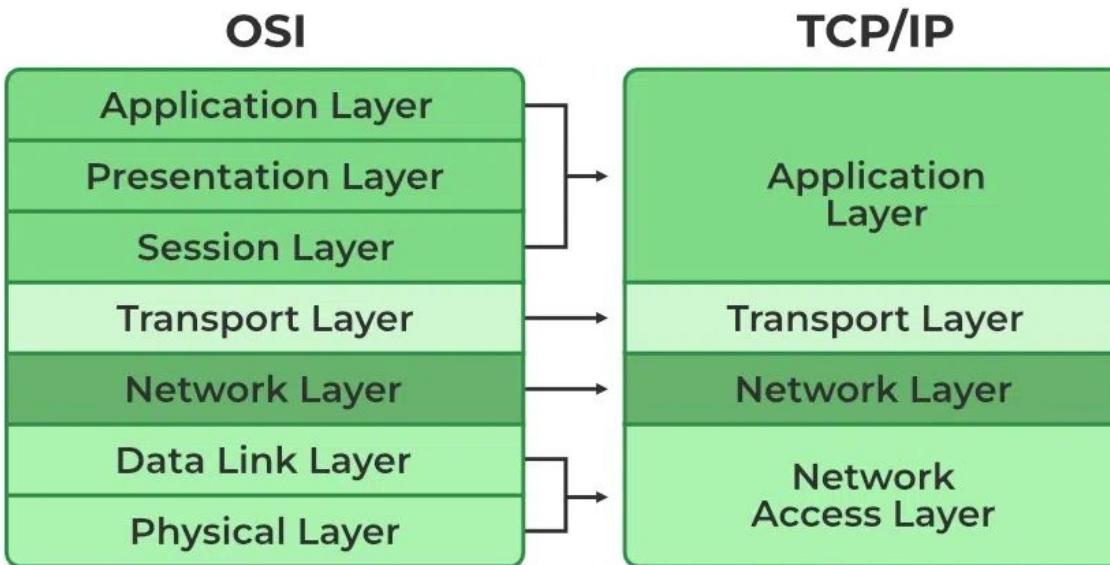
# UDP (User Datagram Protocol)

Layer 4

- connectionless
- no retransmission delay
- 65536 ports
- unreliable but low latency
- has checksum
- unicast, multicast, and broadcast



# TCP/IP model



# HTTP, HTTPS

Hypertext Transfer Protocol (HTTP): layer 7

HTTP request: GET, PUT, POST, DELETE, ...

HTTP status: 200 (OK), 301 (moved permanently), 403 (forbidden), 404 (not found), 502 (bad gateway), 503 (service not available), ...

HTTP: port 80

HTTPS: port 443

```
PS C:\Users\jing> curl http://google.com

StatusCode : 200
StatusDescription : OK
Content : <!doctype html><html itemscope="" itemtype="http://schema.org/WebPage" lang="ja"><head><meta content="世界中のあらゆる情報を検索するためのツールを提供しています。さまざまな検索機能を活用して、お探しの情報を見つけてください。" name="description"><meta content="n...
RawContent : HTTP/1.1 200 OK
Content-Security-Policy-Report-Only: object-src 'none';base-uri 'self';script-src 'nonce-PgT03qFNjvuIt4TVFyG06g' 'strict-dynamic' 'report-sample' 'unsafe-eval' 'unsafe-inline'
https: ...
Forms
Headers
Images
```

HTTP/2

HTTP/3

en.wikipedia.org/wiki/HTTPS

← Security en.wikipedia.org

Connection is secure Your information (for example, passwords or credit card numbers) is private when it is sent to this site. [Learn more](#)

Certificate is valid

Certificate Viewer: \*.wikipedia.org

General Details

## Issued To

Common Name (CN) \*.wikipedia.org  
Organization (O) Wikimedia Foundation, Inc.  
Organizational Unit (OU) <Not Part Of Certificate>

## Issued By

Common Name (CN) DigiCert TLS Hybrid ECC SHA384 2020 CA1  
Organization (O) DigiCert Inc  
Organizational Unit (OU) <Not Part Of Certificate>

## Validity Period

Issued On Thursday, October 27, 2022 at 9:00:00 AM  
Expires On Saturday, November 18, 2023 at 8:59:59 AM

## Fingerprints

SHA-256 Fingerprint 95 A6 25 3C F5 BA 9E 9C 79 C9 E1 66 74 AE 68 DA  
28 99 75 43 93 FF 3F AA 5C 4B D5 10 B3 8D 95 A7  
SHA-1 Fingerprint 91 D4 DD DD 2F F9 18 E0 19 07 D8 6B C7 54 54 F1  
1A 8F 2C DC

# SSH (Secure Shell), Telnet

Layer 7

```
$ ssh username@hostname:port  
$ ssh -l username hostname
```

SSH: port 22

Telnet: port 23

```
jing@ansible-control-node:~$ ssh 192.168.0.234  
Linux dnsmasq4 5.15.107-1-pve #1 SMP PVE 5.15.107-1 (2023-04-20T10:05Z) x86_64  
  
The programs included with the Debian GNU/Linux system are free software;  
the exact distribution terms for each program are described in the  
individual files in /usr/share/doc/*copyright.  
  
Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent  
permitted by applicable law.  
Last login: Thu May 11 22:07:12 2023 from 192.168.1.53  
jing@dnsmasq4:~$
```

# SCP, SFTP

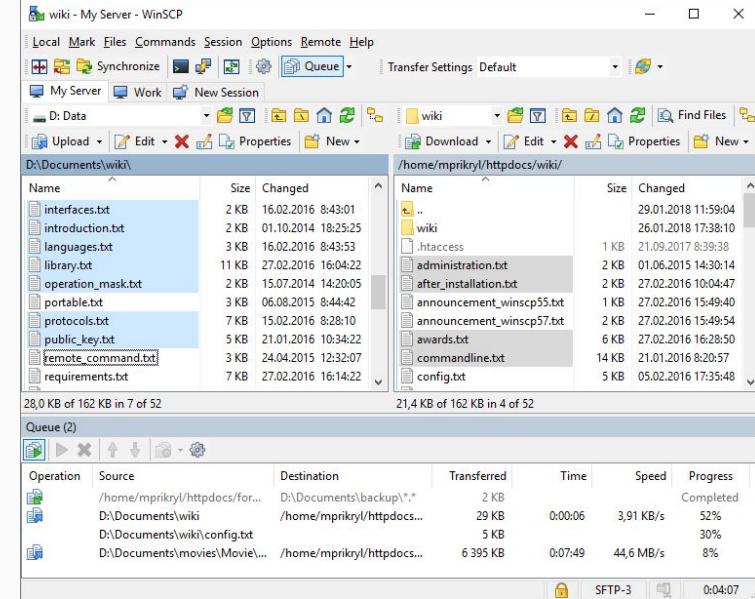
## Secure Copy Protocol (SCP)

```
$ scp file.txt username@hostname:/path  
local → remote
```

```
$ scp username@hostname:/path /localpath  
remote → local
```

openssh-server

## SSH File Transfer Protocol (SFTP)



WinSCP

# DNS (Domain Name System)

The IP address  
of [google.com](http://google.com)?

2404:6800:4004:828::200e  
142.250.198.14

Layer 7

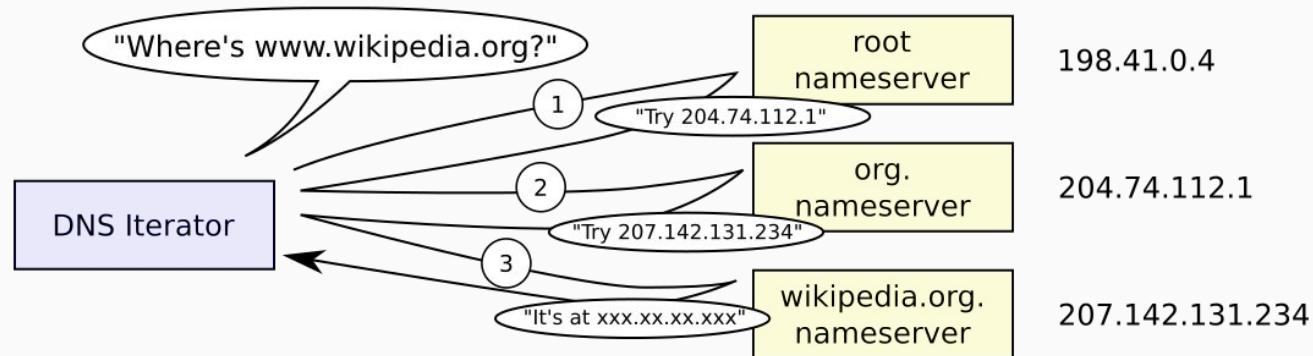
port: 53

nslookup, dig, ...

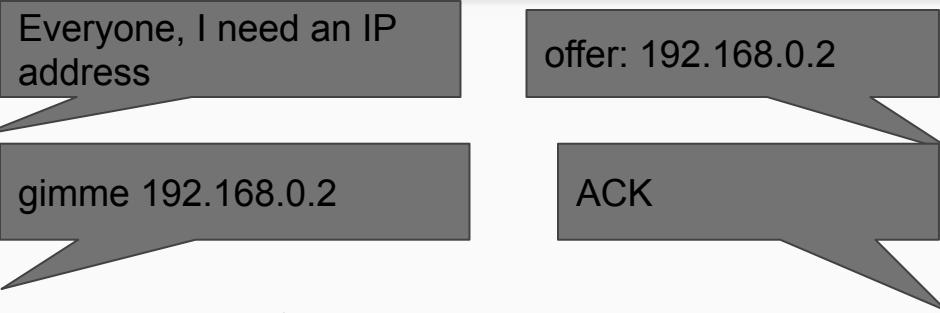
A record: IPv4

AAAA record: IPv6

CNAME record: alias



# DHCP (Dynamic Host Configuration Protocol)



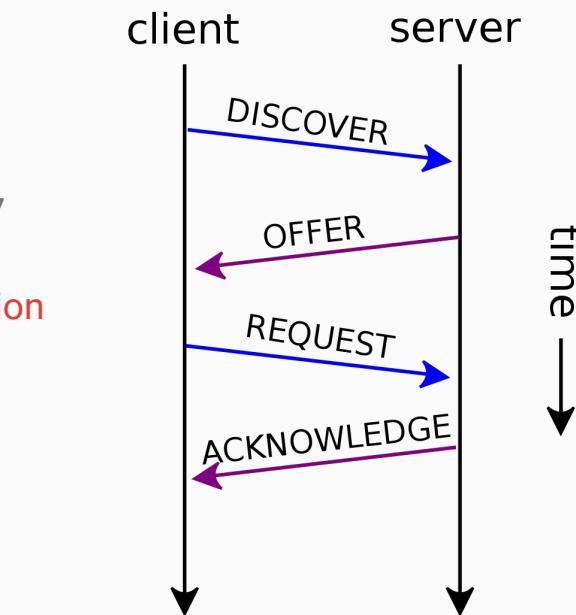
DHCP options:  
1: subnet mask  
3: router  
6: DNS server  
26: interface MTU  
50: requested IP address  
51: lease time  
...

Layer 7

client: UDP port 68

server: UDP port 67

- static allocation



- Client sends a *solicit* from [fe80::aabb:ccff:fedd:eeff]:546 to multicast address [ff02::1:2]:547.<sup>[3]</sup>
- Server replies with an *advertise* from [fe80::0011:22ff:fe33:5566]:547 to [fe80::aabb:ccff:fedd:eeff]:546.
- Client replies with a *request* from [fe80::aabb:ccff:fedd:eeff]:546 to [ff02::1:2]:547.
- Server finishes with a *reply* from [fe80::0011:22ff:fe33:5566]:547 to [fe80::aabb:ccff:fedd:eeff]:546.

# DHCPv6, SLAAC

DHCPv6: layer 7

client: UDP port 546

server: UDP port 547

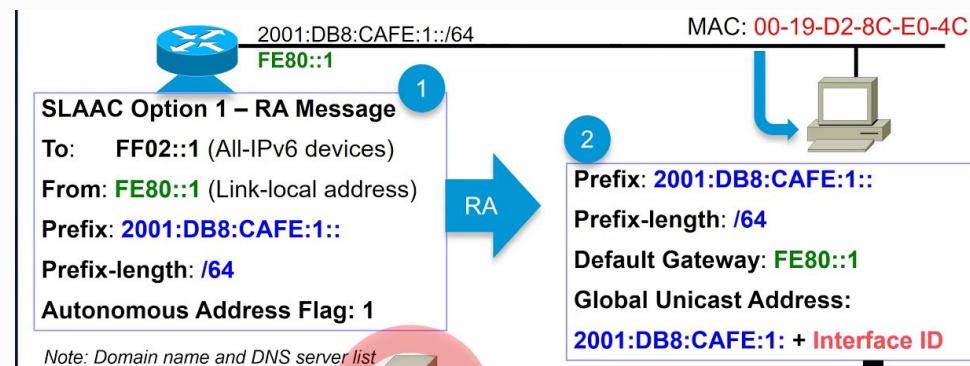
No more MAC address:

DUID (DHCP Unique Identifier)

- Link-layer address plus time (DUID-LLT)
- Vendor-assigned unique ID based on enterprise number (DUID-EN)
- Link-layer address (DUID-LL)
- UUID-based DUID (DUID-UUID)
- MAC address (RFC 6939)

Stateless address autoconfiguration (SLAAC)

1. router solicitation: who's the router?
2. router advertisement: I'm the router and you can set your own address



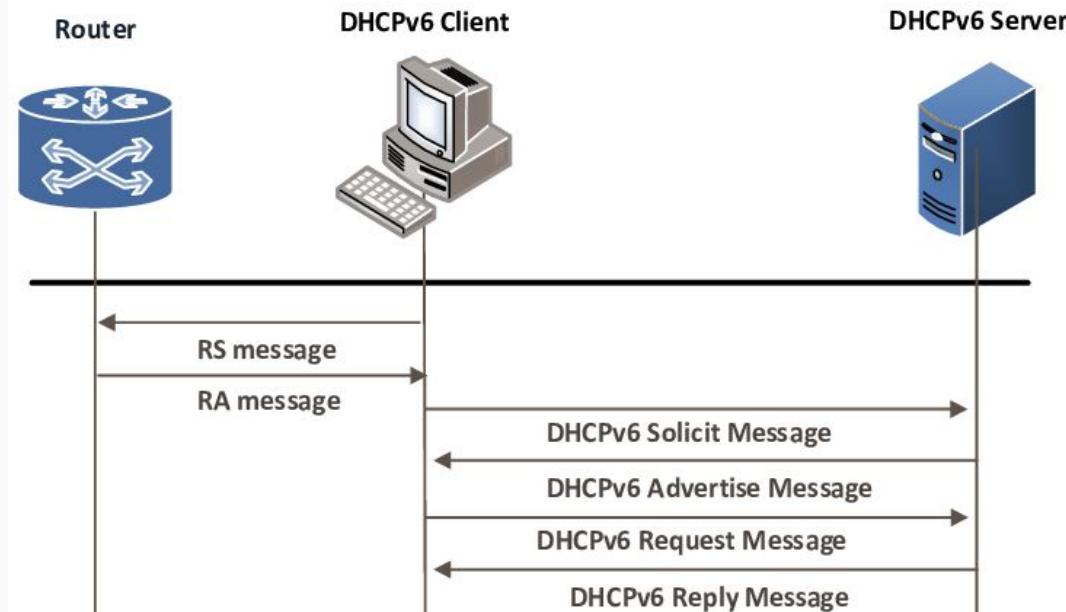
# Router advertisement (RA) Neighbor Discovery Protocol (NDP)

Every X seconds: I'm a router, here's the prefix, router address, and DNS server list...

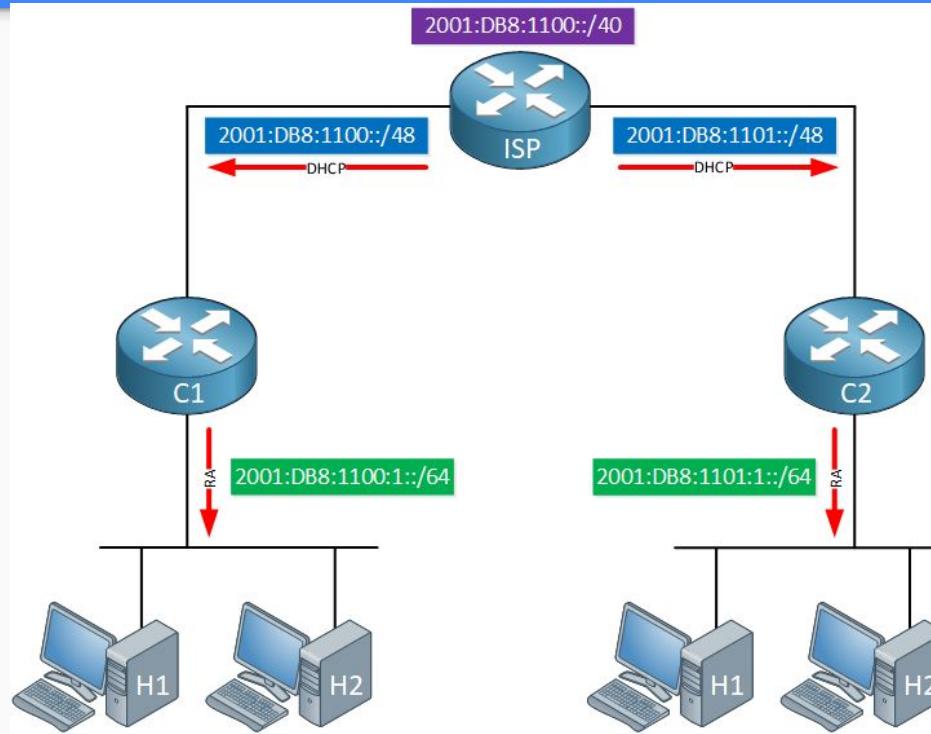
NDP:

- Router Solicitation
- Router Advertisement
- Neighbor Solicitation
- Neighbor Advertisement
- Redirect

DOI:10.1109/ACCESS.2019.2919966

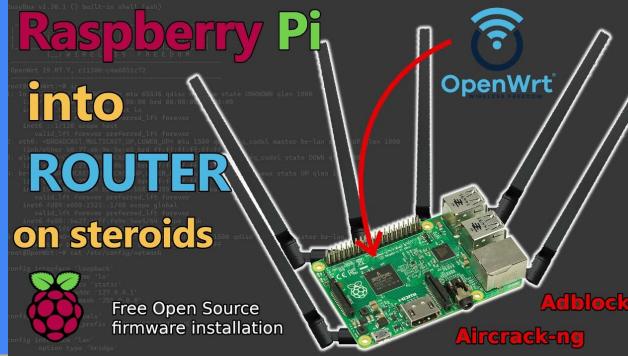


# Prefix delegation (DHCPv6-PD)

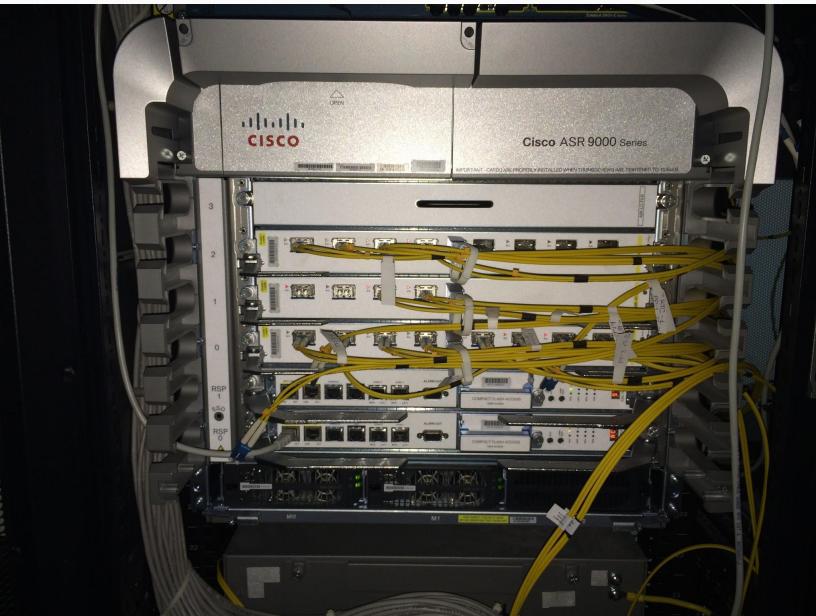


# What is a "router"

- router
- switch
- wireless access point (AP)
- DHCP server
- DHCPv6 server
- DNS server
- NAT (NAT44)
- firewall?

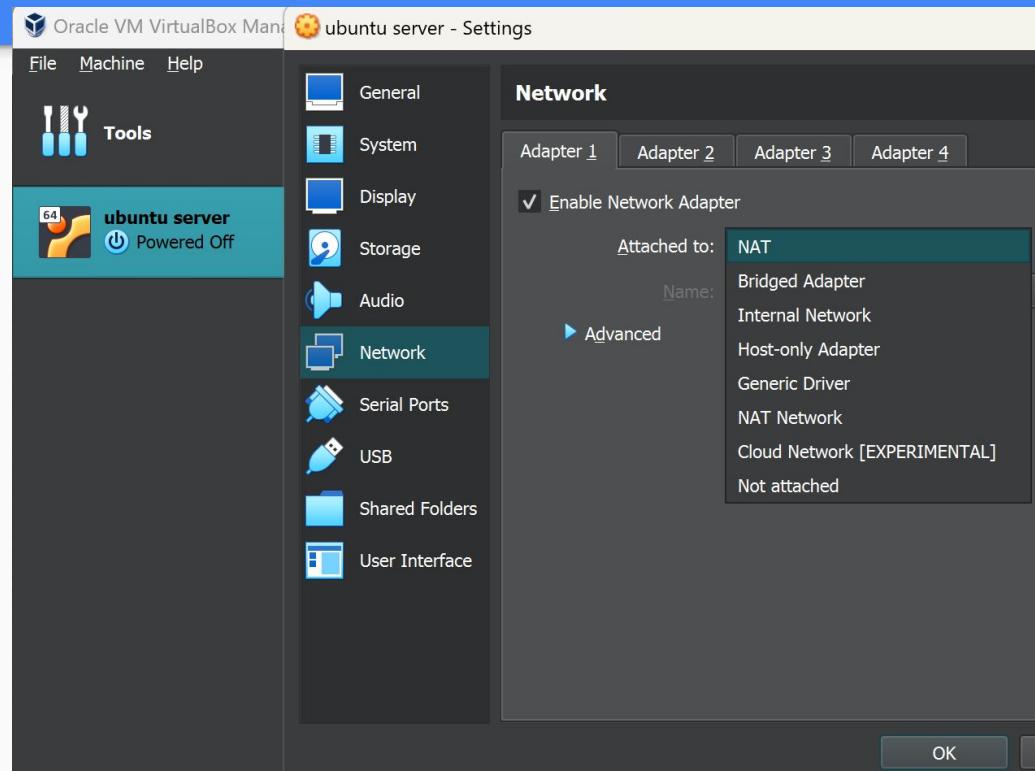
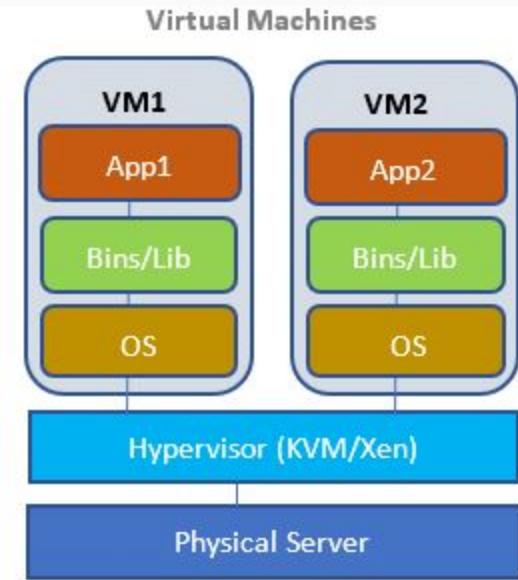


<https://www.youtube.com/watch?v=PuBTE0xmldk>



# VMs and VM network

DOI:10.30534/ijatcse/2020/220942020

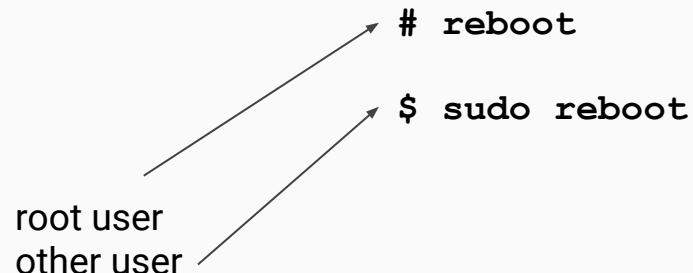


# root user

- sudo: superuser do
- With great power comes great responsibility
- Are you a sudoer? /etc/sudoers
- `sudo -l` ←Letter L check/list sudo permission
- `su -` = `su root` (switch user)
- `sudo -i` (interactive sudo)
- exercise: create a sudo and a non-sudo user
- exercise: lock and unlock root user password



Unlimited power!



# Package manager

DPKG – Debian Package Management System

```
|     \
APT   Synaptic    \
                  Aptitude
(frontend)
```

RPM (Red Hat Package Manager)

```
|     \
YUM   DNF        \
                  ZYpp
```

pacman

homebrew

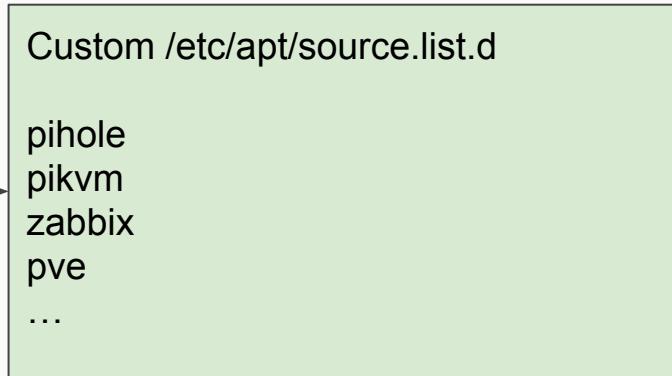
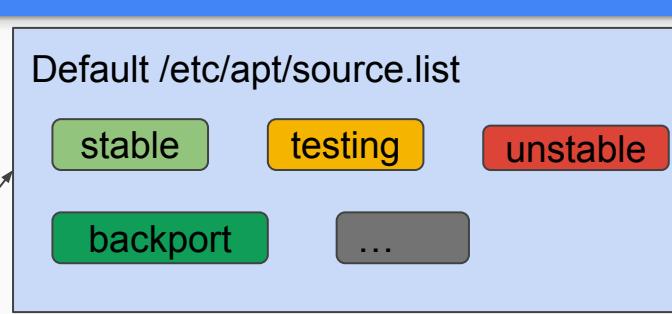
npm yarn pip RubyGems Maven Gradle...

# Example: APT

```
# apt update
```



APT



# Lottery!

# Configure static IP address and DHCP

## 1. Debian/Ubuntu

### a. /etc/network/interfaces

```
auto eth0
iface eth0 inet static
    address XXX.XXX.XXX.XXX/XX
    gateway
```

### b. /etc/resolv.conf

```
nameserver 8.8.8.8
nameserver 8.8.4.4
```

```
auto eth0
iface eth0 inet dhcp
iface eth0 inet6 dhcp # (or auto)
```

```
# systemctl restart networking
```

# Configure static IP address and DHCP

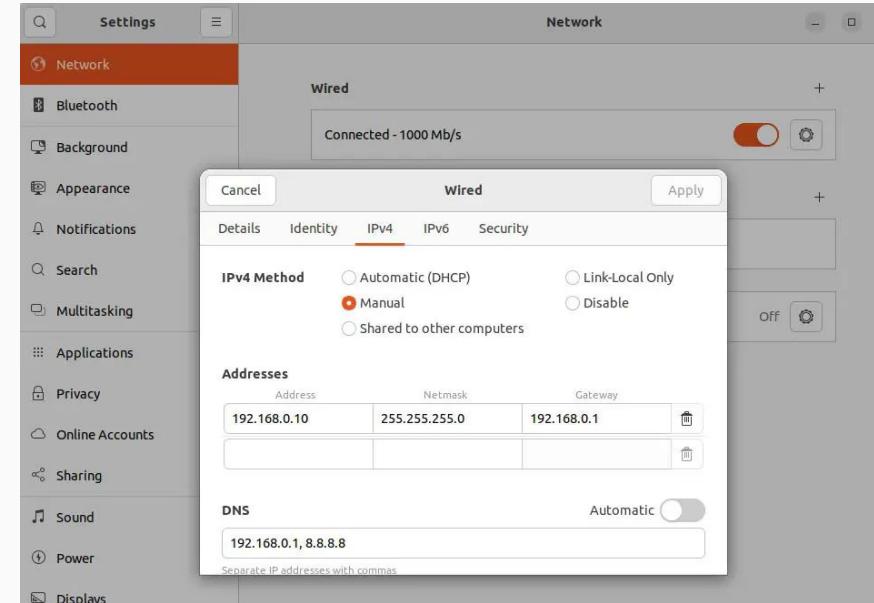
## 2. ip (iproute2) # loses config after reboot

```
$ ip addr add XXX.XXX.XXX.XXX dev eth0  
$ ip route add 192.168.XXX.XXX/24 dev eth0  
$ ip route add default via 192.168.X.1
```

/etc/resolv.conf

```
nameserver 8.8.8.8  
nameserver 8.8.4.4
```

## 3. NetworkManager



# Configure static IP address and DHCP

## 4.1 systemd-networkd

```
/etc/systemd/network/20-wired.network  
  
[Match]  
Name=enp1s0  
  
[Network]  
Address=10.1.10.9/24  
Gateway=10.1.10.1  
DNS=10.1.10.1
```

## 4.2 systemd-resolved

```
# ln -rsf /run/systemd/resolve/stub-resolv.conf /etc/resolv.conf
```

```
/etc/systemd/network/25-wireless.network
```

```
[Match]  
Name=wlp2s0
```

```
[Network]  
DHCP=yes  
IgnoreCarrierLoss=3s
```

```
# systemctl restart <service-name>
```

<https://wiki.archlinux.org/title/Systemd-networkd>

# Configure static IP address and DHCP

5. dhcpcd

/etc/dhcpcd.conf

```
# systemctl restart dhcpcd
```

```
jing@raspberrypi1: ~ /etc/dhcpcd.conf
GNU nano 5.4
# A ServerID is required by RFC2131.
require dhcp_server_identifier

# Generate SLAAC address using the Hardware Address of the interface
#slaac_hwaddr
# OR generate Stable Private IPv6 Addresses based from the DUID
slaac_private

# Example static IP configuration:
#interface eth0
#static ip_address=192.168.0.10/24
#static ip6_address=fd51:42f8:caae:d92e::ff/64
#static routers=192.168.0.1
#static domain_name_servers=192.168.0.1 8.8.8.8 fd51:42f8:caae:d92e::1

# It is possible to fall back to a static IP if DHCP fails:
# define static profile
#profile static_eth0
#static ip_address=192.168.1.23/24
#static routers=192.168.1.1
#static domain_name_servers=192.168.1.1

# fallback to static profile on eth0
#interface eth0
#fallback static_eth0

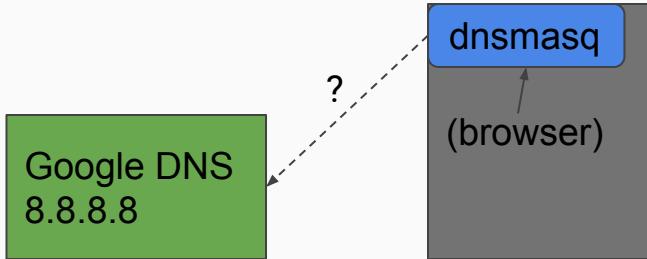
^G Help      ^O Write Out   ^W Where Is   ^K Cut       ^T Execute
^X Exit      ^R Read File   ^V Replace    ^U Paste     ^J Justify
```

# Exercise: setup your own DNS server

1. Install **dnsmasq**
2. /etc/dnsmasq.conf
  - a. server=8.8.8.8
  - b. server=1.1.1.1
3. Change network manager DNS address
4. Start (/enable) dnsmasq

- 3.1 systemd-resolved  
/etc/systemd/resolved.conf  
DNS=127.0.0.1 ::1
- 3.2 dhcpcd  
/etc/dhcpcd.conf  
static domain\_name\_servers=127.0.0.1 ::1

- 3.3 NetworkManager



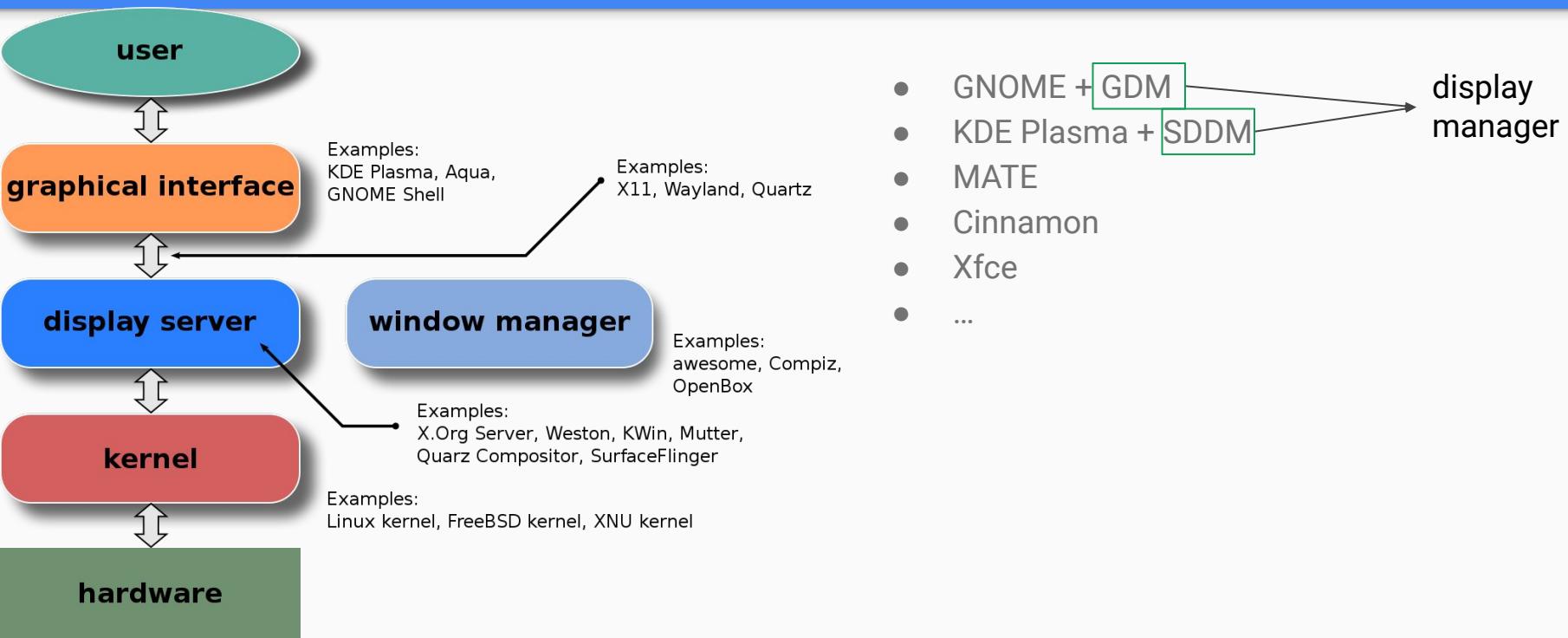
# Browsers to surf the net

```
##### update cache first #####      yum...
```

```
# apt update  
# apt upgrade
```

```
# apt install firefox  
##### or #####  
# apt install chromium-browser
```

# Desktop Environment



# Set up development environment (again)

```
$ java --version  
$ javac --version
```

```
$ git --version
```

```
##### if JDK not installed-  
##### search a package  
$ apt search openjdk
```

```
# apt install openjdk-17-jdk
```

# Eclipse?

<https://www.eclipse.org/downloads/>

The Eclipse Installer 2023-03 R now includes a JRE for macOS, Windows and Linux.



## Get Eclipse IDE 2023-03

Install your favorite desktop IDE packages.

Download x86\_64

Download Packages | Need Help?

The screenshot shows the Eclipse Installer interface. At the top, there's a navigation bar with a red box around the 'download path' tab. Below it is a file browser window showing a directory structure with files like 'configuration', 'features', 'p2', 'plugins', 'readme', 'artifacts.xml', and 'eclipse-inst'. A red box highlights the 'eclipse-inst' file. To the right of the file browser is a sidebar titled 'eclipseinstaller by Oomph' with a search bar. It lists several Eclipse IDE options:

- Eclipse IDE for Java Developers**: Tools for any Java developer, including a Java IDE, Git client, XML Editor, Maven and Gradle integration.
- Eclipse IDE for Enterprise Java and Web Developers**: Tools for developers working with Java and Web applications, including a Java IDE, tools for JavaScript, TypeScript, JavaServer...
- Eclipse IDE for C/C++ Developers**: An IDE for C/C++ developers.
- Eclipse IDE for Embedded C/C++ Developers**: An IDE for Embedded C/C++ developers. It includes managed cross build plug-ins (Arm and RISC-V) and debug plug-ins (SEGGER...).

# MySQL?

MySQL

```
# mysqldump databaseName > file.name
```

mariadb-server

```
# mysqlcheck -A
```

```
# mysql_secure_installation
```

```
$ mysql -u <username> -p
```

# GCC, Python, Makefile

```
##### GNU Compiler Collection           $ python3 --version
$ gcc --version

$ make --version
```

# Visual Studio Code?

<https://code.visualstudio.com/Download>

## Download Visual Studio Code

Free and built on open source. Integrated Git, debugging and extensions.



↓ Windows

Windows 8, 10, 11



↓ .deb

Debian, Ubuntu



↓ .rpm

Red Hat, Fedora, SUSE

↓ Mac

macOS 10.11+

User Installer x64 x86 Arm64

System Installer x64 x86 Arm64

.zip x64 x86 Arm64

CLI x64 x86 Arm64

CLI x64 Arm32 Arm64

CLI x64 x86 Arm64

CLI x64 Arm32 Arm64

.deb x64 Arm32 Arm64

.rpm x64 Arm32 Arm64

.tar.gz x64 Arm32 Arm64

Snap Snap Store

CLI x64 Arm32 Arm64

CLI x64 x86 Arm64

CLI x64 Arm32 Arm64

.deb x64 Arm32 Arm64

.rpm x64 Arm32 Arm64

.tar.gz x64 Arm32 Arm64

CLI Intel chip Apple silicon Universal

CLI Intel chip Apple silicon

The screenshot shows the Visual Studio Code interface with the following details:

- File Menu:** File, Edit, Selection, View, Go, Debug, Terminal, Help.
- Title Bar:** PetClinicApplication.java - spring-petclinic - Visual Studio Code.
- Explorer:** Shows the project structure for "SPRING-PETCLINIC".
- Search:** Shows search results for "PetClinicApplication".
- Code Editor:** Displays the Java code for the "PetClinicApplication" class.
- Bottom Status Bar:** Shows file information: Stephane Nicoll, 7 months ago | 4 authors (Antoine Rey and others).
- Bottom Right:** Includes icons for Run, Debug, and other tools.

```
File Edit Selection View Go Debug Terminal Help
PetClinicApplication.java - spring-petclinic - Visual Studio Code

OPEN EDITORS
PetClinicApplication
SPRING-PETCLINIC

petclinic
model
owner
system
vet
visit
PetClinicApplication

less
resources
wro
test
java
org

JAVA DEPENDENCIES
PetClinicApplication
org.springframework.boot.autoconfigure.SpringBootApplication
org.springframework.boot.context.embedded.EmbeddedServletContainerCustomizer
org.springframework.boot.context.embedded.EmbeddedServletContainerCustomizer
org.springframework.boot.context.embedded.EmbeddedServletContainerCustomizer
org.springframework.boot.context.embedded.EmbeddedServletContainerCustomizer
org.springframework.boot.context.embedded.EmbeddedServletContainerCustomizer

MAVEN PROJECTS
spring-petclinic

PetClinicApplication
main(String[] args) {
    SpringApplication.run(PetClinicApplication.class, args);
}

Stephane Nicoll, 7 months ago | 4 authors (Antoine Rey and others)
/*
 * PetClinic Spring Boot Application.
 *
 * @author Dave Syer
 */
@SpringBootApplication
public class PetClinicApplication {

    public static void main(String[] args) {
        SpringApplication.run(PetClinicApplication.class, args);
    }
}
```

# Other software

## GNOME

- gedit
  - Nautilus
  - gnome-terminal
  - Thunderbird
- 
- LibreOffice
  - Chromium browser/Firefox
  - OBS
  - Audacity

## KDE

- konsole
  - Kate
  - ghost writer
  - Dolphin
  - [KDE Applications](#)
- 
- Steam\*
  - Discord
  - VLC

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- trademark (商標)

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- ...



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Microsoft Windows

バージョン 22H2 (OS ビルド 19045.2965)

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HP Inc.

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最終更新: 2021 年 6 月

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→→→ more restrictions →→→

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WTFPL

CC0

M.I.T

Apache

Mozilla

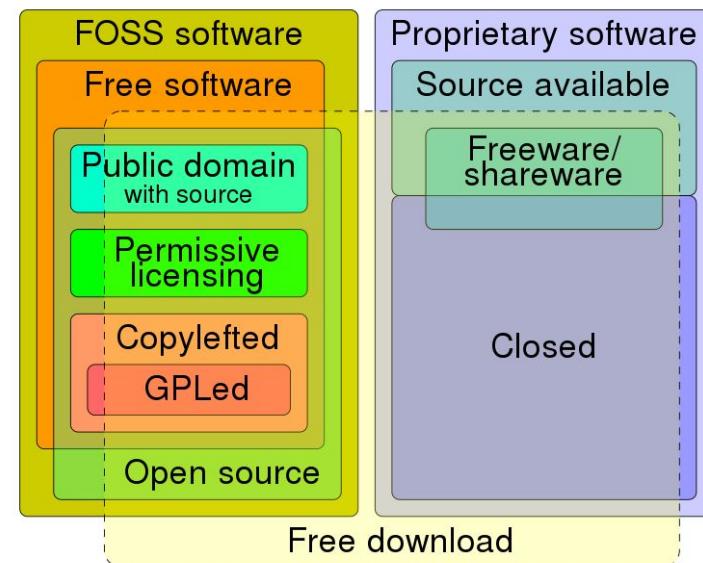
BSD

GNU GPL

GNU LGPL

GNU AGPL

CC-BY-SA



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Need to disclose source code: GNU GPL, GNU AGPL, ...

Need to disclose source code except used as library: GNU LGPL, ...

GNU GPL: distribute (modified) source code, under the same license

# Copyleft "debate"

"This viral aspect of the GPL poses a threat to the intellectual property of any organization making use of it." (Microsoft vice-president Craig Mundie 2005)

"code released under GPL is useless to the commercial sector" "a cancer that attaches itself in an intellectual property sense to everything it touches"  
(Microsoft CEO Steve Ballmer 2001)

# "自由4原則" (Free Software Definition)

Freedom 0 - the freedom to use the work

Freedom 1 - the freedom to study the work

Freedom 2 - the freedom to copy and share the work with others

Freedom 3 - the freedom to modify the work, and the freedom to distribute modified and therefore derivative works

# Unix/GNU/Linux philosophy

The radical concept of equality:

"treats everyone equally and allows everyone the maximum amount of power"

Use the force, Luke

→ sudo rm -rf /

This is the Unix philosophy (Peter H. Salus. A Quarter-Century of Unix. Addison-Wesley. 1994.):

- Write programs that do one thing and do it well.
- Write programs to work together.
- Write programs to handle text streams, because that is a universal interface.

etc.

# Another philosophy

- Uninstall Microsoft Edge / Internet Explorer\*?
- Uninstall Cortana?
- Stop Windows Update?
- Secure boot

"Users know nothing and they are afraid of technologies"

- Locks bootloader
- No jailbreak, no third party apps

enohPi

# Homework

1. 日本語、中国語入力方法のインストール。
2. (bonus) mount SFTP over CLI