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Operating System Concepts: Lecture 3

programs/processes and threads : from bios to application startup

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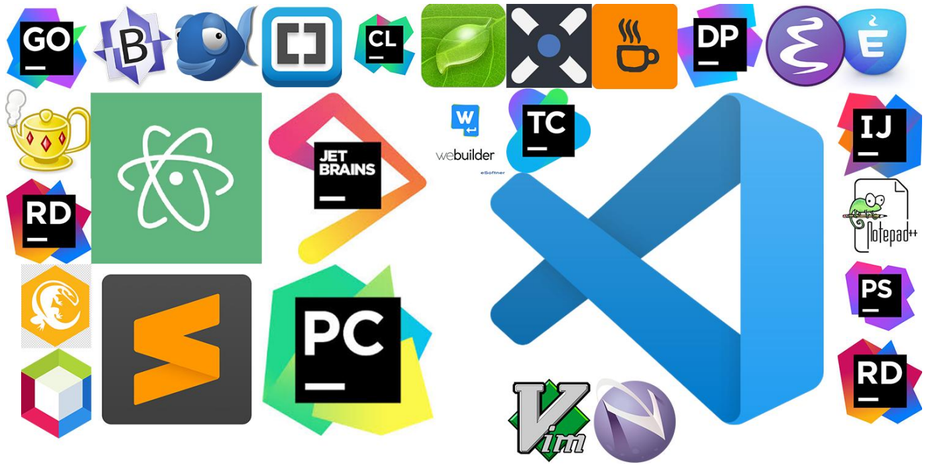
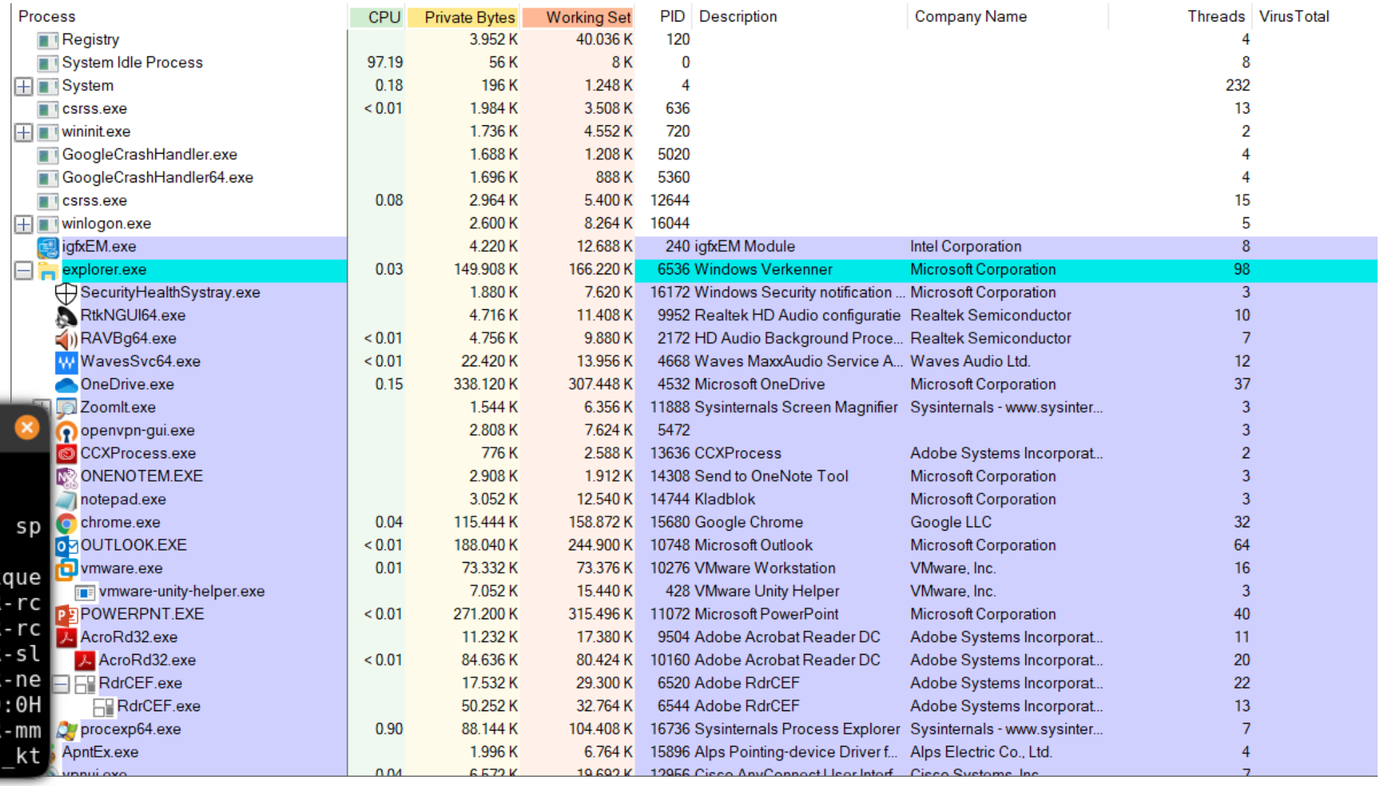
Processes

Processes: Building blocks of what we do on a computer



Job vs Process

- Job: slightly older term (used in batch systems) but still used in literature (“job scheduling”)
- Process: Actually the same thing
- View processes :
  - Windows
  - Linux : ps command



Process	CPU	Private Bytes	Working Set	PID	Description	Company Name	Threads	VirusTotal
Registry		3.952 K	40.036 K	120			4	
System Idle Process	97.19	56 K	8 K	0			8	
System	0.18	196 K	1.248 K	4			232	
csrss.exe	< 0.01	1.984 K	3.508 K	636			13	
wininit.exe		1.736 K	4.552 K	720			2	
GoogleCrashHandler.exe		1.688 K	1.208 K	5020			4	
GoogleCrashHandler64.exe		1.696 K	888 K	5360			4	
csrss.exe	0.08	2.964 K	5.400 K	12644			15	
winlogon.exe		2.600 K	8.264 K	16044			5	
igfxEM.exe		4.220 K	12.688 K	240	igfxEM Module	Intel Corporation	8	
explorer.exe	0.03	149.908 K	166.220 K	6536	Windows Verkenner	Microsoft Corporation	98	
SecurityHealthSystray.exe		1.880 K	7.620 K	16172	Windows Security notification ...	Microsoft Corporation	3	
RtkNGUI64.exe		4.716 K	11.408 K	9952	Realtek HD Audio configuratie	Realtek Semiconductor	10	
RAVBg64.exe	< 0.01	4.756 K	9.880 K	2172	HD Audio Background Proce...	Realtek Semiconductor	7	
WavesSvc64.exe	< 0.01	22.420 K	13.956 K	4668	Waves MaxxAudio Service A...	Waves Audio Ltd.	12	
OneDrive.exe	0.15	338.120 K	307.448 K	4532	Microsoft OneDrive	Microsoft Corporation	37	
ZoomIt.exe		1.544 K	6.356 K	11888	Sysinternals Screen Magnifier	Sysinternals - www.sysinter...	3	
openvpn-gui.exe		2.808 K	7.624 K	5472			3	
CCXProcess.exe		776 K	2.588 K	13636	CCXProcess	Adobe Systems Incorporat...	2	
ONENOTEM.EXE		2.908 K	1.912 K	14308	Send to OneNote Tool	Microsoft Corporation	3	
notepad.exe		3.052 K	12.540 K	14744	Kladblok	Microsoft Corporation	3	
chrome.exe	0.04	115.444 K	158.872 K	15680	Google Chrome	Google LLC	32	
OUTLOOK.EXE	< 0.01	188.040 K	244.900 K	10748	Microsoft Outlook	Microsoft Corporation	64	
vmware.exe	0.01	73.332 K	73.376 K	10276	VMware Workstation	VMware, Inc.	16	
vmware-unity-helper.exe		7.052 K	15.440 K	428	VMware Unity Helper	VMware, Inc.	3	
POWERPNT.EXE	< 0.01	271.200 K	315.496 K	11072	Microsoft PowerPoint	Microsoft Corporation	40	
AcroRd32.exe		11.232 K	17.380 K	9504	Adobe Acrobat Reader DC	Adobe Systems Incorporat...	11	
AcroRd32.exe	< 0.01	84.636 K	80.424 K	10160	Adobe Acrobat Reader DC	Adobe Systems Incorporat...	20	
RdrCEF.exe		17.532 K	29.300 K	6520	Adobe RdrCEF	Adobe Systems Incorporat...	22	
RdrCEF.exe		50.252 K	32.764 K	6544	Adobe RdrCEF	Adobe Systems Incorporat...	13	
procexp64.exe	0.90	88.144 K	104.408 K	16736	Sysinternals Process Explorer	Sysinternals - www.sysinter...	7	
ApntEx.exe		1.996 K	6.764 K	15896	Alps Pointing-device Driver f...	Alps Electric Co., Ltd.	4	

```
sagar@itsFOSS:~
sagar@itsFOSS:~$ ps -aux
USER         PID %CPU %MEM    VSZ   RSS TTY      STAT START   TIME COMMAND
root           1  0.0  0.0 166872 11456 ?        Ss   15:31   0:02 /sbin/init sp
root           2  0.0  0.0      0     0 ?        S    15:31   0:00 [kthreadd]
root           3  0.0  0.0      0     0 ?        S    15:31   0:00 [pool_workque
root           4  0.0  0.0      0     0 ?        I<   15:31   0:00 [kworker/R-rc
root           5  0.0  0.0      0     0 ?        I<   15:31   0:00 [kworker/R-rc
root           6  0.0  0.0      0     0 ?        I<   15:31   0:00 [kworker/R-sl
root           7  0.0  0.0      0     0 ?        I<   15:31   0:00 [kworker/R-ne
root           9  0.0  0.0      0     0 ?        I<   15:31   0:00 [kworker/0:0H
root          12  0.0  0.0      0     0 ?        I<   15:31   0:00 [kworker/R-mm
root          13  0.0  0.0      0     0 ?        I    15:31   0:00 [rcu_tasks_kt
```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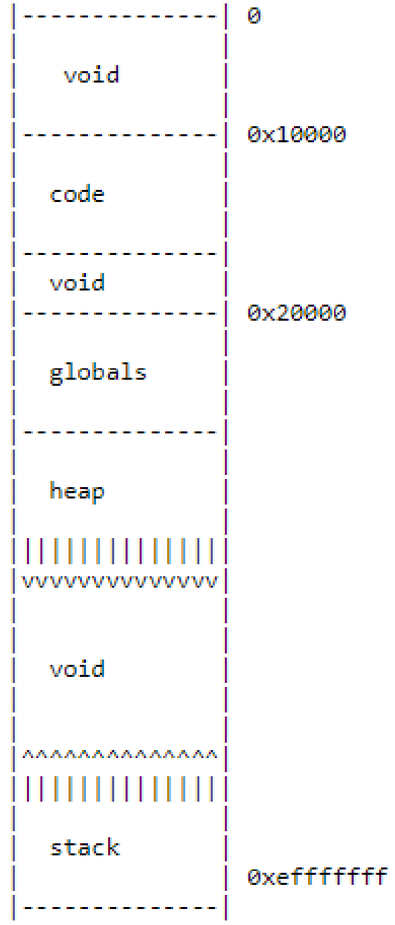
Process vs Program

- Program/Binary/Executable (/application/app):
  - passive
  - has no state
  - program code + initialized data
  - (= is not running!)
- Process:
  - active
  - has a state
  - program code + program counter + stack + data section + heap + …

If we view memory as a big array, the regions (or ``segments'') look as follows:



Process states

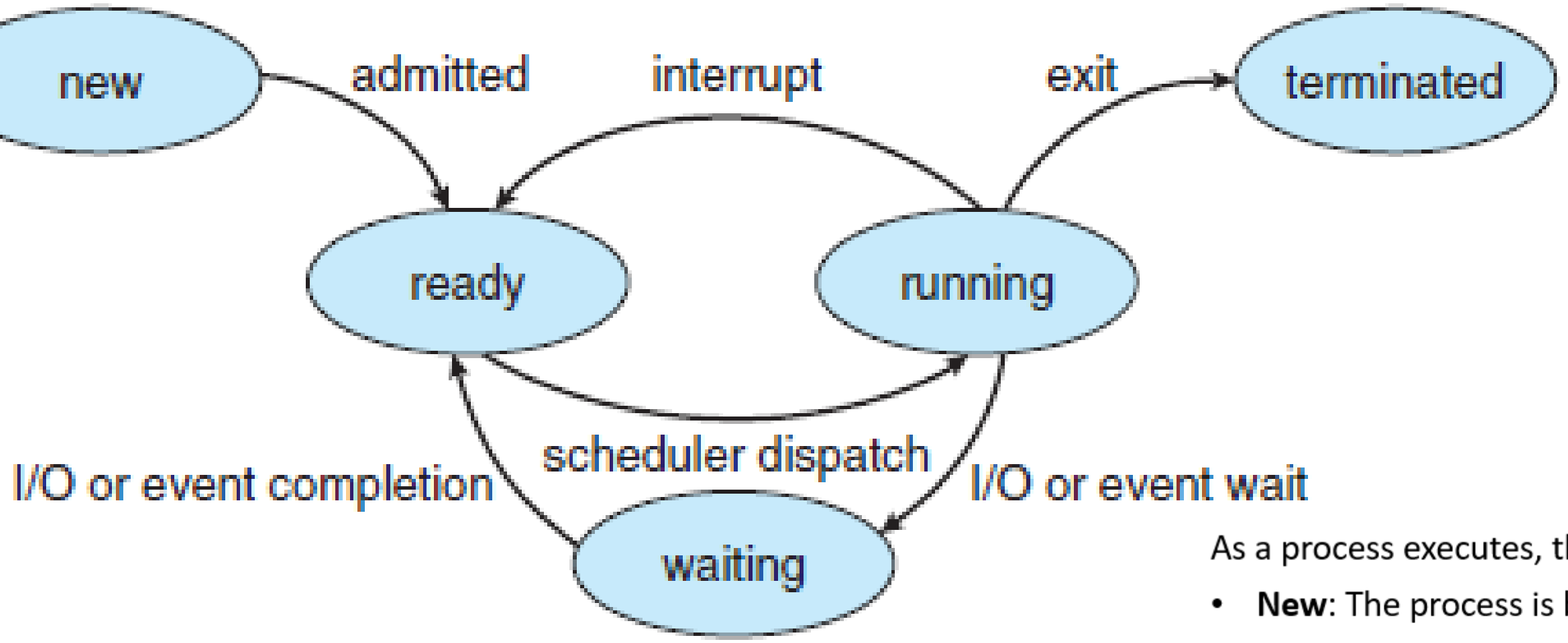


Figure 3.2 Diagram of process state.

As a process executes, the **state** changes:

- **New**: The process is being created
- **Running**: Instructions are being executed
- **Waiting**: The process is waiting for some event to occur
- **Ready**: The process is waiting to be assigned to a processor
- **Terminated**: The process has finished execution

Context Switch

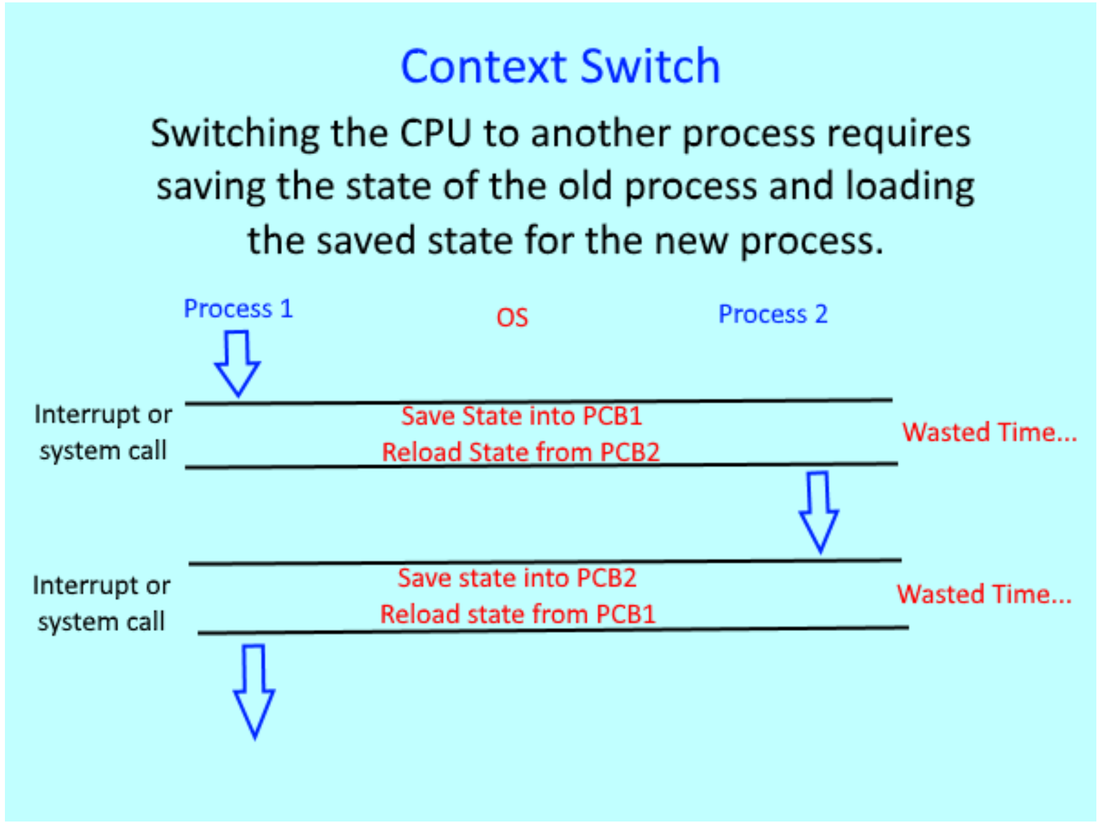
= Saving/storing the state of a process (or thread)

As a result a **single CPU** can **allow multiple processes** -> multitasking operating system!

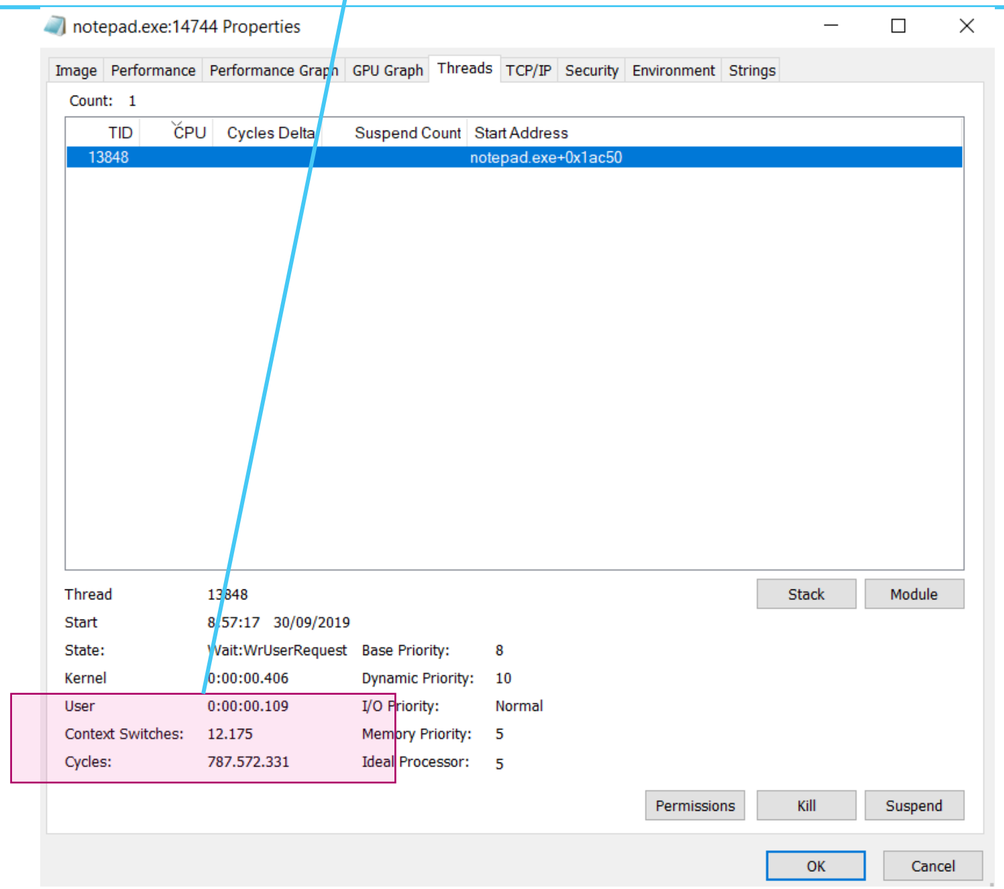
What actions the context switch performs depends on multiple things:

- Type of OS
- One or more register set
- Sometimes it is needed to go from user mode to kernel mode
- Sometimes as a result of interrupts
- …

Context Switch



Context Switches: 12 175



https://stackoverflow.com/questions/7439608/steps-in-context-switching

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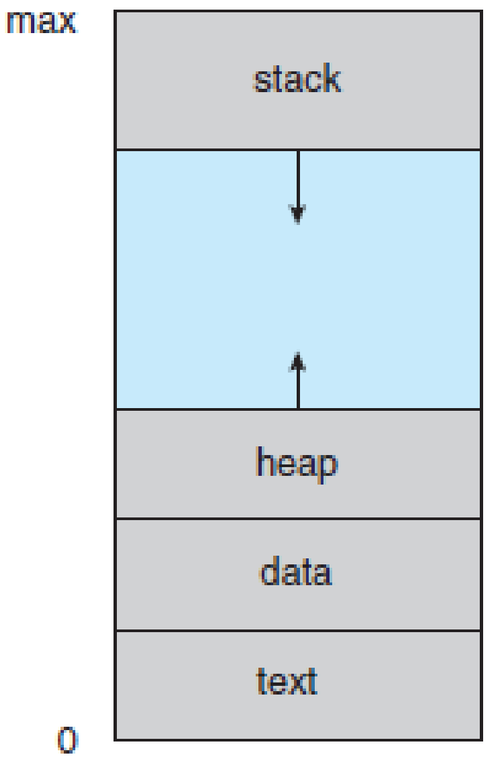
(OS) Stack vs Heap

Stack vs. Heap



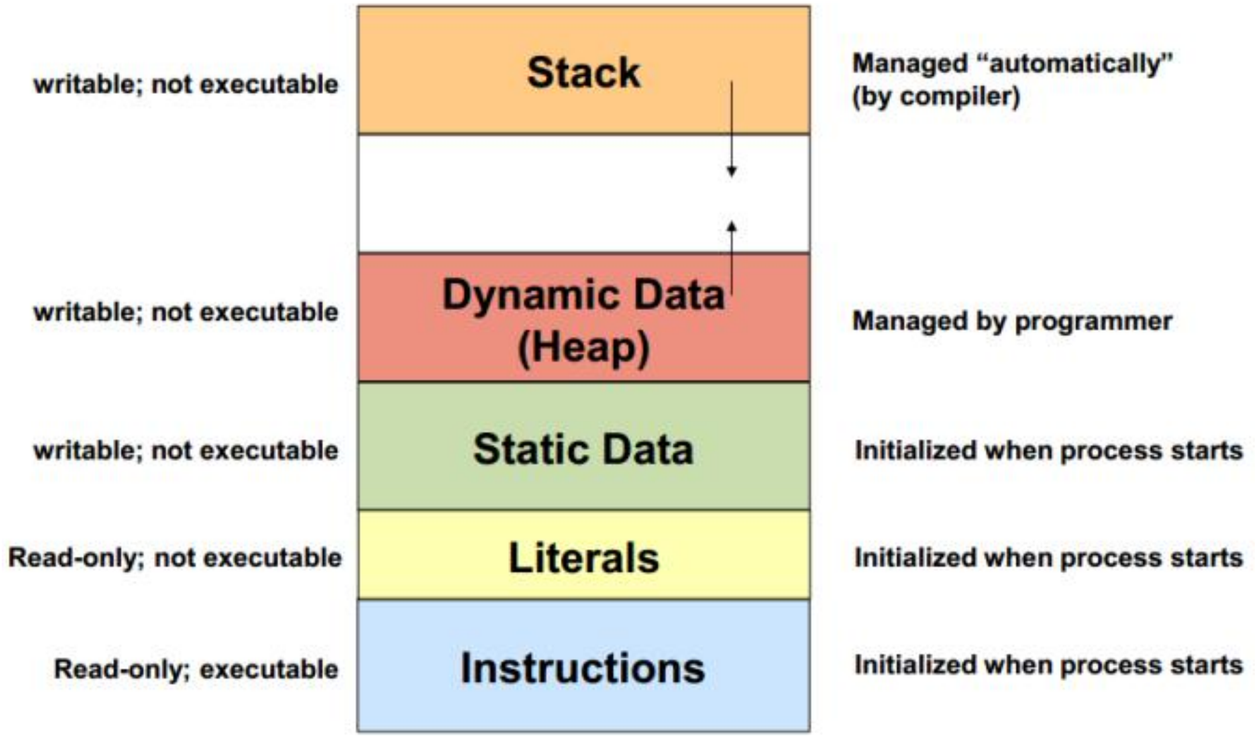
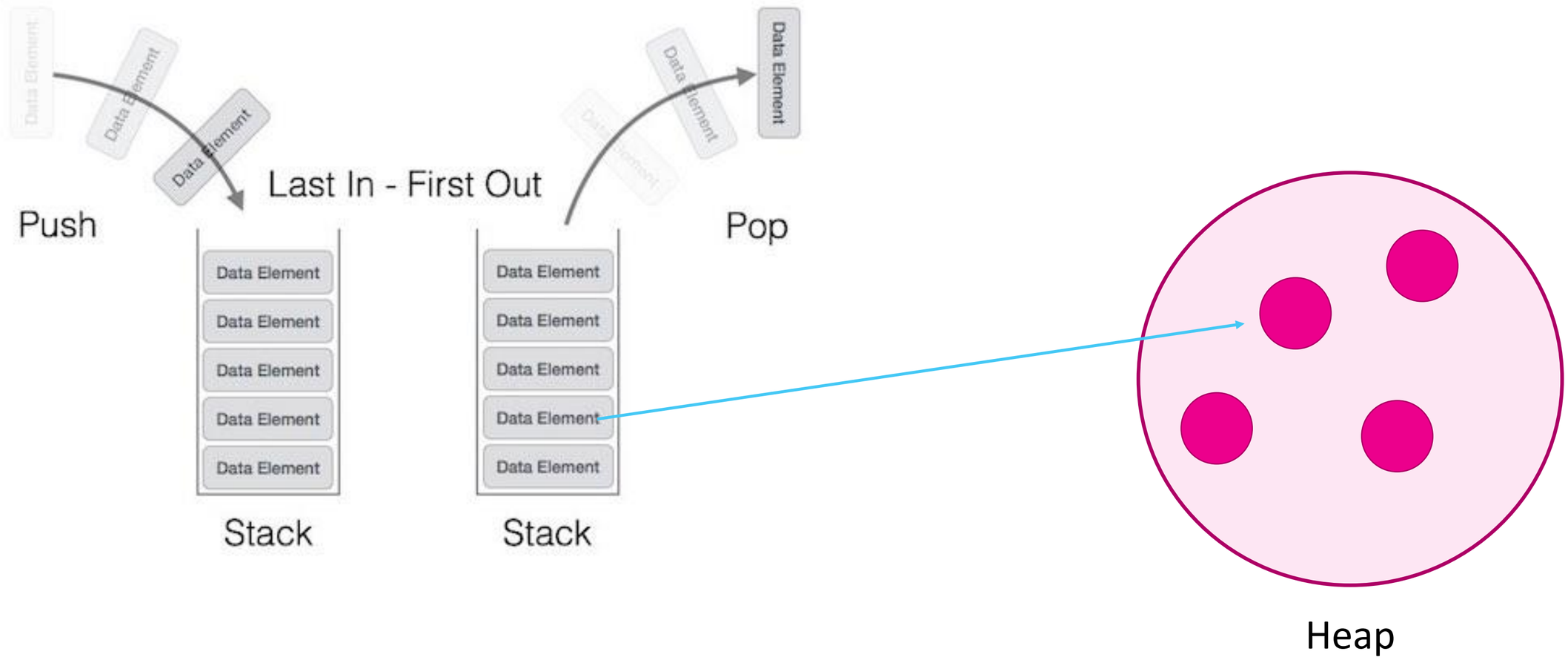


Figure 3.1 Process in memory.

Stack vs. Heap



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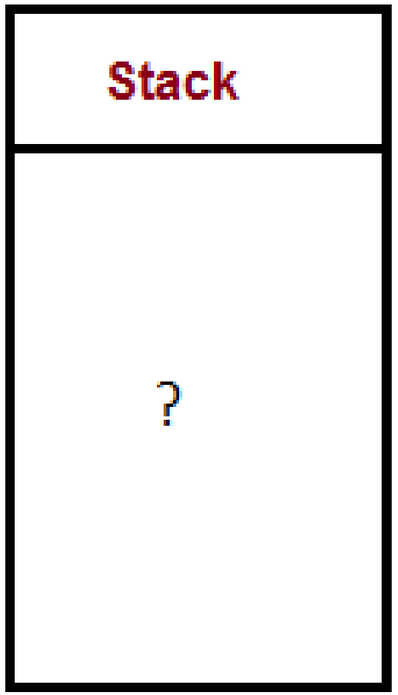
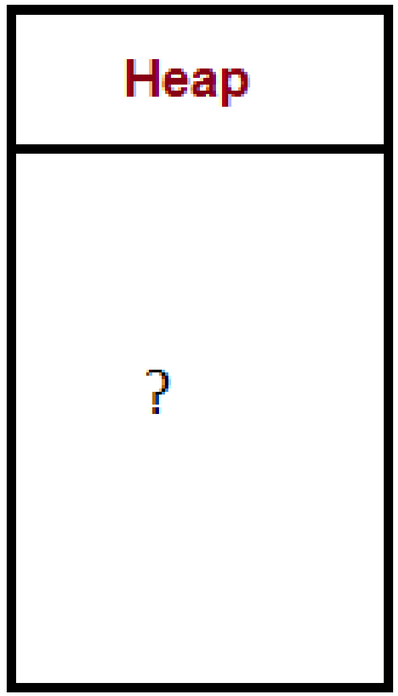
Stack vs. Heap



int x=1

int y = 2

Form1 frm = new Form1()



Stack or heap?

- X?
- Y?
- Frm-object?
- Pointer/reference to Frm-object?

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Memzoom

https://justine.lol/memzoom/index.html

Linear Memory Order

Renders memory bytes using traditional left-to-right ordering.

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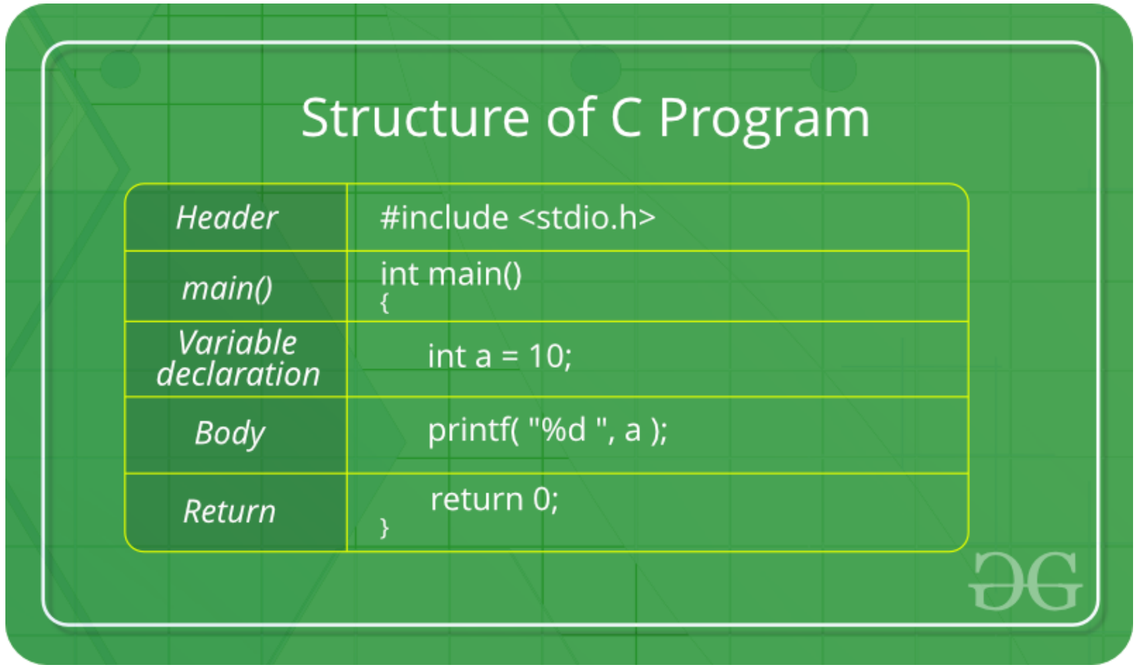
“Low” level programming

Introduction to C

- Pretty old language (1972-1973)
- Was created to make UNIX !
- Interesting in this module because it is low-level
- Needs a Compiler (gcc for linux)
- Benefits from a make/builder (gmake)



Introduction to C

To **Build** a c program from source you can either use:

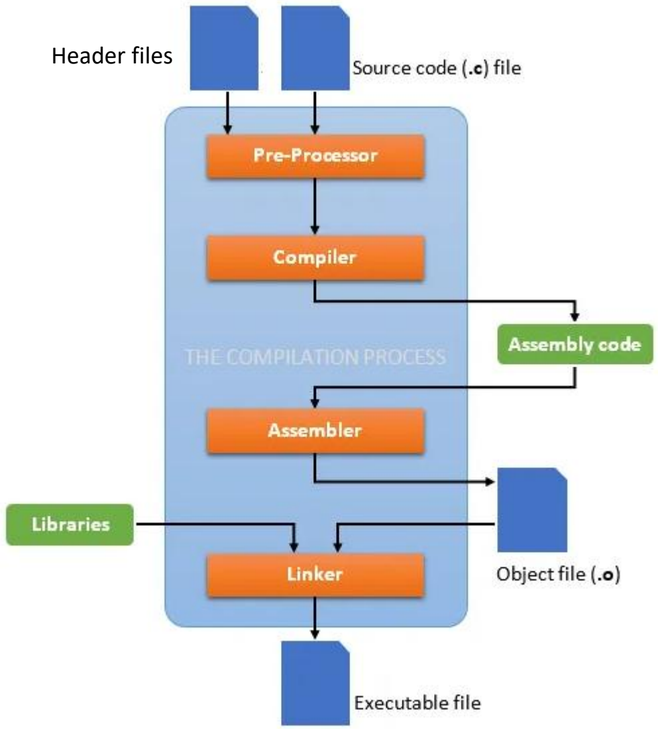
gcc hello.c -o hello

Or

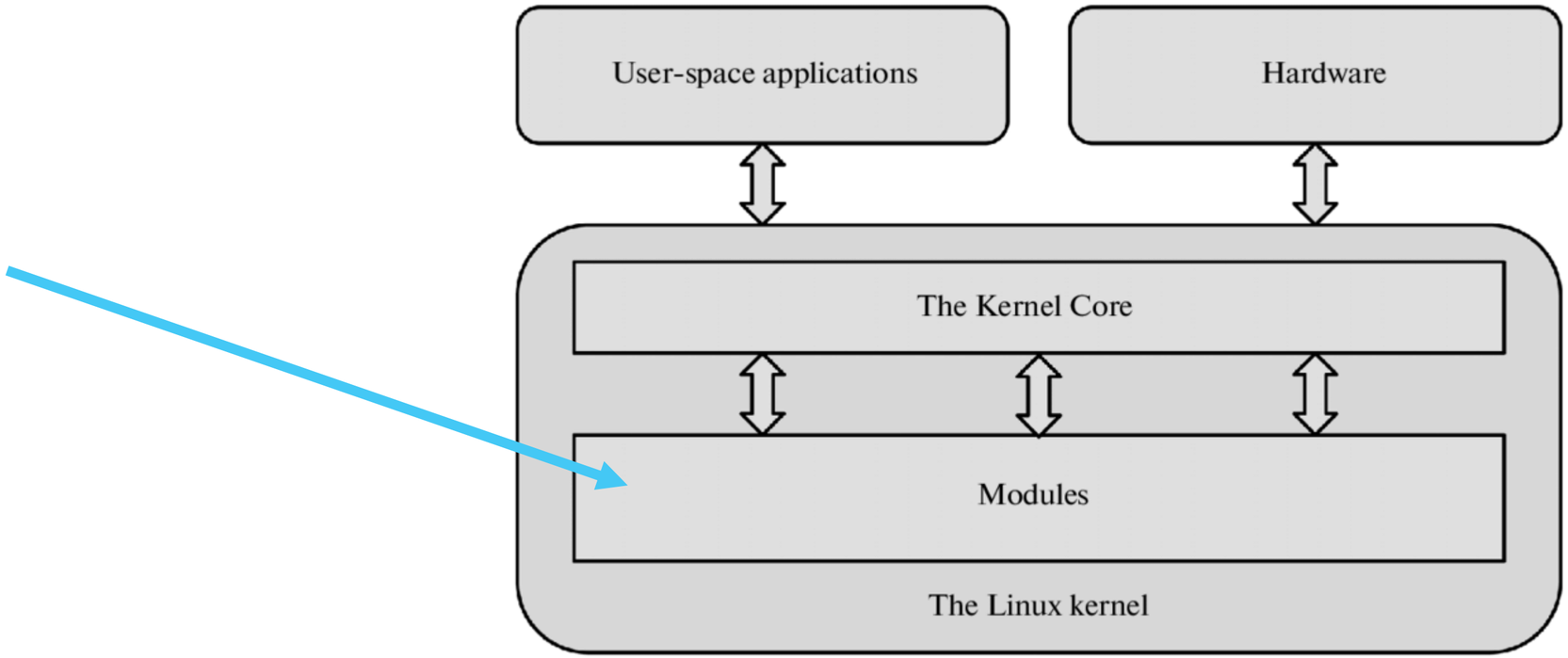
make hello

This will generate an exectuable.

Makefiles exist to make the life of a C programmer easier.



Kernel module



C can do low level things if run in kernel mode ! (i.e. wreck your system)

Pass by value vs. Pass by reference intermezzo

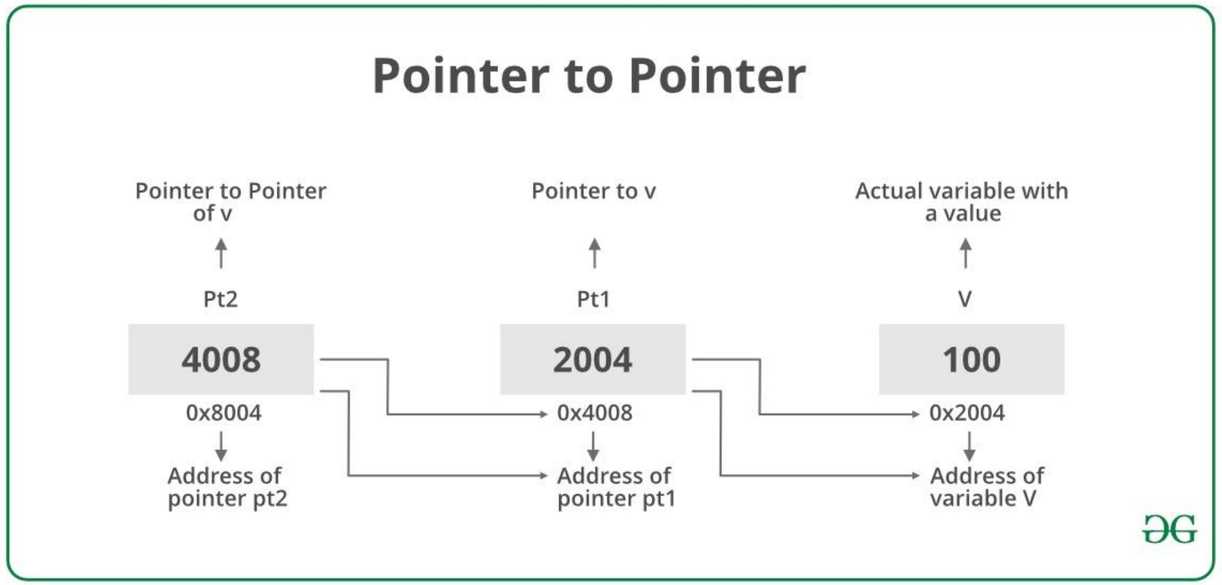
Nice visual representation: https://www.mathwarehouse.com/programming/passing-by-value-vs-by-reference-visual-explanation.php

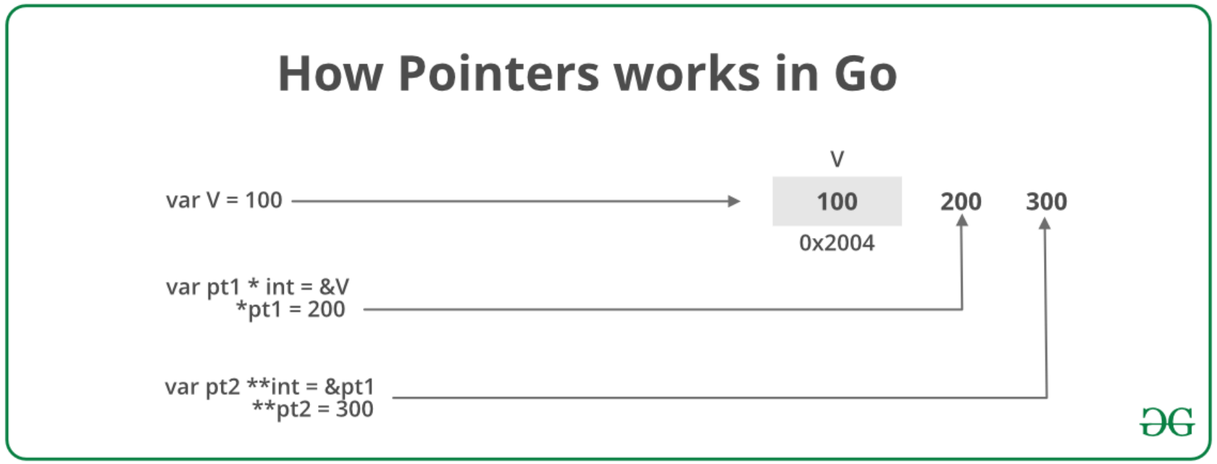
Authentic definition:

- When a parameter is **passed by reference**, the caller and the called **use the same variable** for the parameter. If the called modifies the parameter variable, the effect is visible to the caller's variable.
- When a parameter is **passed by value**, the caller and called have **two independent variables** with the same value. If the called modifies the parameter variable, the effect is not visible to the caller.

Pointers in low level programming languages

https://www.geeksforgeeks.org/go-pointer-to-pointer-double-pointer/





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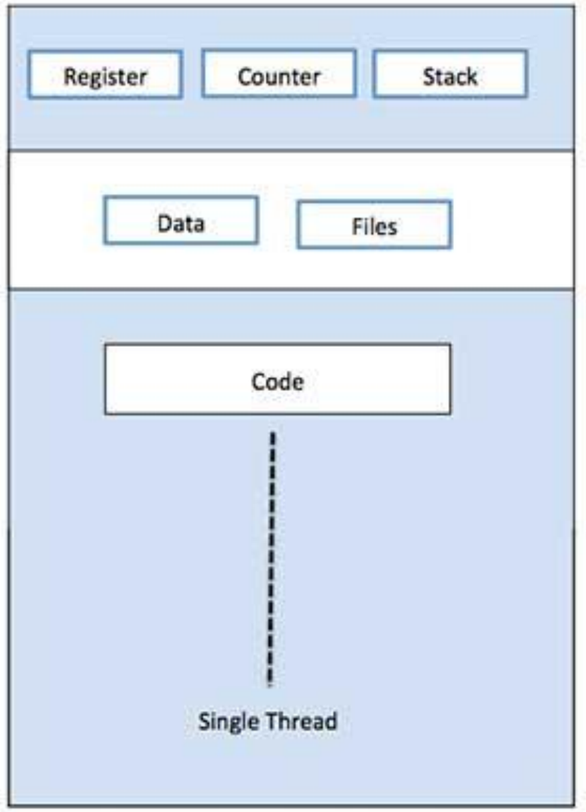
Threading

What is a “Thread”

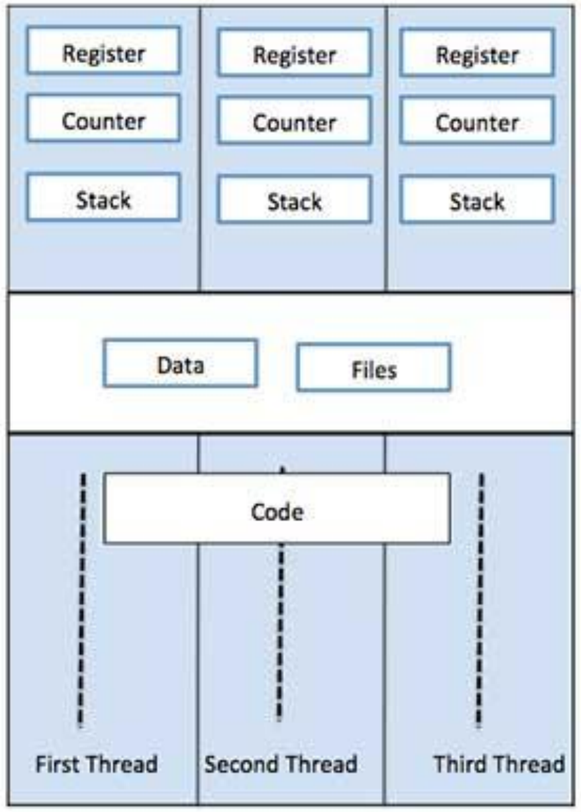
Often called a “**lightweight process**”

→ Minimize **context switching** time
→ A “blocking” thread does not block other threads

Question: We know that switching between processes requires interaction from the OS. Is this also the case for threading (thread switching)?



Single Process P with single thread

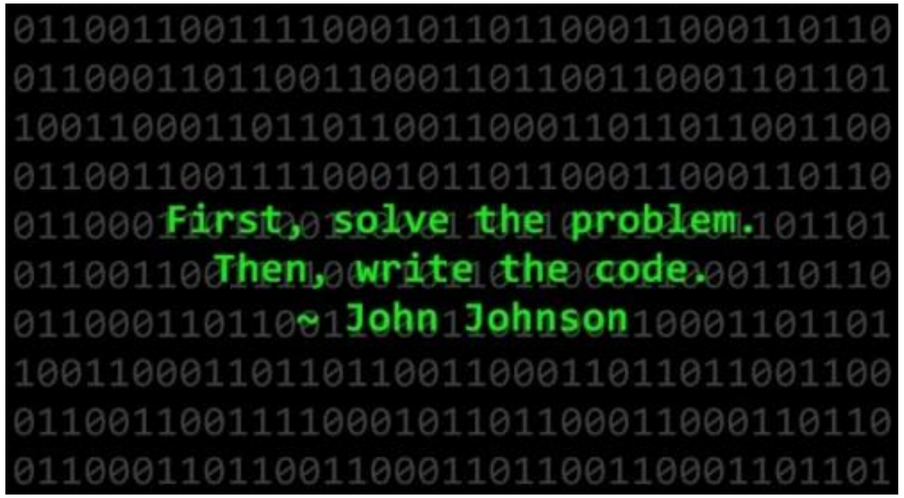


Single Process P with three threads

Img src: https://www.tutorialspoint.com/operating_system/os_multi_threading.htm

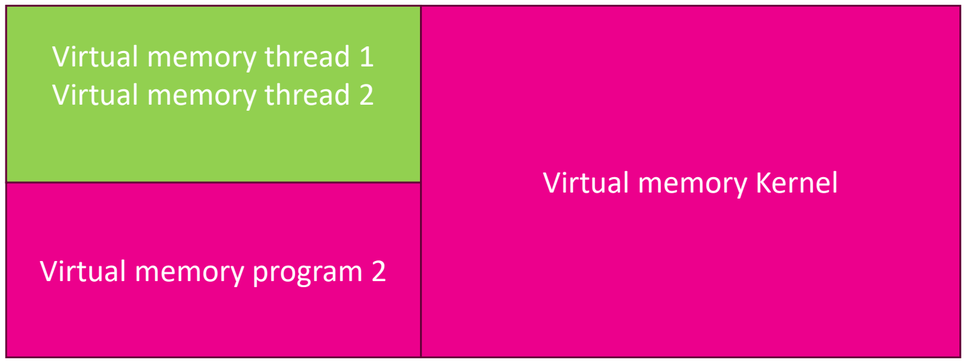
Threads vs Processes

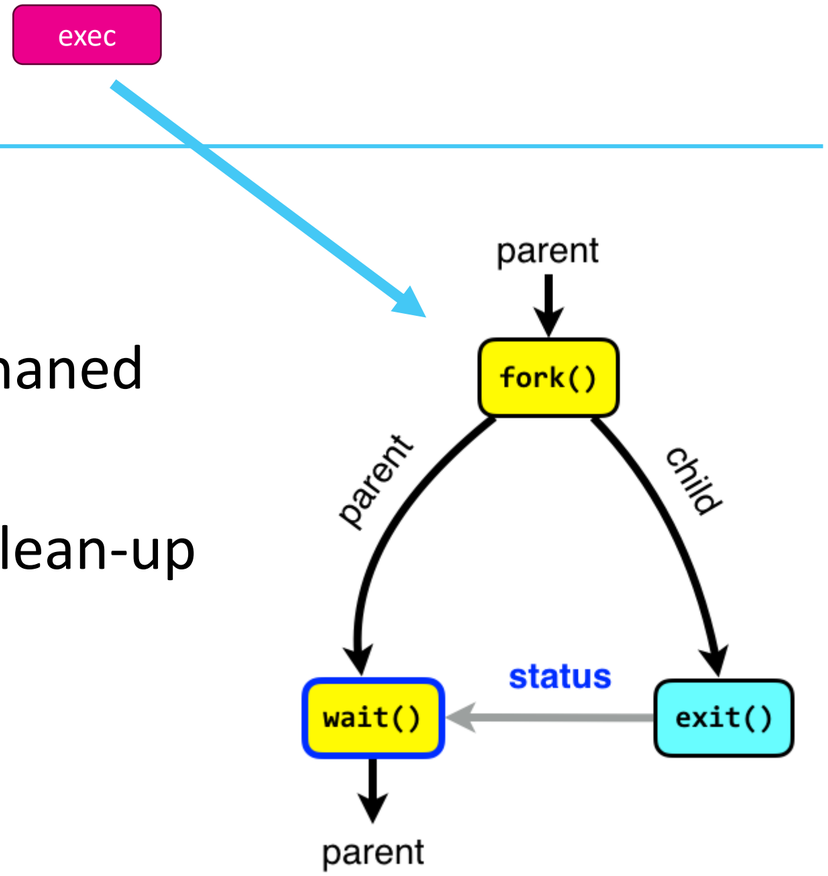
- Processes & scheduling
  - Responsibility with the OS -> CPU scheduling
- Threads & scheduling
  - Responsability with the application / program designer



Threads vs forks (in c)

- Fork -> System call that creates a new child **process**
  - If parent ends before child, the child becomes orphaned
- Pthread_create -> All “part of” the same process
  - There is no exit as virtual memory does not need clean-up





Fork example

How many times will “hello” be printed?

File: hello.c

```c
#include <stdio.h>
#include <sys/types.h>
int main()
{
    fork();
    fork();
    fork();
    printf("hello\n");
    return 0;
}
```

```
fork ();   // Line 1
fork ();   // Line 2
fork ();   // Line 3
       L1       // There will be 1 child process
    /     \     // created by line 1.
  L2      L2    // There will be 2 child processes
 /  \    /  \   //  created by line 2
L3  L3  L3  L3  // There will be 4 child processes
                // created by line 3
```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Child processes vs Parent processes

Why is this important?

- What happens with the parent process if a child process gets killed?
- **What happens with the child process if a parent process gets killed?**
  - → Actually OS dependend

    Multiple options are possible:

    → Child process gets killed as soon as parent gets killed (behind the scenes “kill” signals are send to the child process)

    → Child becomes an “orphan”

    → Child gets to live on without any issues

    → Etc.

Attention: Sometimes it gets tricky!

Example 1:

→ Typically (on Unix/Linux)

if a parent dies before the child process. The child becomes an orphan and get's a new parent process (init/systemd (= one of the first processes that starts with the OS)).

Example 2:

→ If the parent process receives proper exit signals – and it is able to send signals to its children – child behaviour depends on what the programmer implemented.

→ Example: SSH into a linux machine, issue a ping and in another session kill the SSH connection. Is your ping still going?

Thread example

File: printthread.c

```c
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>  //Header file for sleep(). man 3 sleep for details.
#include <pthread.h>

// A normal C function that is executed as a thread
// when its name is specified in pthread_create()
void *myThreadFun(void *vargp)
{
    sleep(1);
    printf("Printing GeeksQuiz from Thread \n");
    sleep(200);
    return NULL;
}

int main()
{
    pthread_t thread_id;
    printf("Before Thread\n");
    pthread_create(&thread_id, NULL, myThreadFun, NULL);
    pthread_join(thread_id, NULL);
    printf("After Thread\n");

    exit(0);
}
```

```
936   943   1   943 debian   20   0  8836  5576  3820 S  0.0  0.1  0:00.14   -bash
943  1379   2  1379 debian   20   0 10648   540   464 S  0.0  0.0  0:00.00     ./printthread
943  1379   2  1380 debian   20   0 10648   540   464 S  0.0  0.0  0:00.00       printthread
```

```
debian@debian:~/threads$ gcc printthread.c -lpthread -o printthread
```


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Java example

File: HelloWorld.java

```java
import java.util.*;

public class HelloWorld {
    public static void main(String[] args) {
        System.out.println("Hello World");
        Scanner sc= new Scanner(System.in);
        System.out.print("Enter a string: ");
        String str= sc.nextLine();
    }
}
```

How many threads ?

```
  936     943     1      943 debian     20   0   8820   5800   3884 S   0.0   0.1   0:00.18          └─ -bash
  943    1486    12     1486 debian     20   0 2957M 40664 25396 S   0.7   1.0   0:00.13             └─ java HelloWorld
  943    1486    12     1487 debian     20   0 2957M 40664 25396 S   0.0   1.0   0:00.04                ├─ java
  943    1486    12     1488 debian     20   0 2957M 40664 25396 S   0.0   1.0   0:00.00                ├─ VM Thread
  943    1486    12     1489 debian     20   0 2957M 40664 25396 S   0.0   1.0   0:00.00                ├─ Reference Handl
  943    1486    12     1490 debian     20   0 2957M 40664 25396 S   0.0   1.0   0:00.00                ├─ Finalizer
  943    1486    12     1491 debian     20   0 2957M 40664 25396 S   0.0   1.0   0:00.00                ├─ Signal Dispatch
  943    1486    12     1492 debian     20   0 2957M 40664 25396 S   0.0   1.0   0:00.00                ├─ Service Thread
  943    1486    12     1493 debian     20   0 2957M 40664 25396 S   0.0   1.0   0:00.01                ├─ C2 CompilerThre
  943    1486    12     1494 debian     20   0 2957M 40664 25396 S   0.0   1.0   0:00.02                ├─ C1 CompilerThre
  943    1486    12     1495 debian     20   0 2957M 40664 25396 S   0.0   1.0   0:00.00                ├─ Sweeper thread
  943    1486    12     1496 debian     20   0 2957M 40664 25396 S   0.0   1.0   0:00.03                ├─ VM Periodic Tas
  943    1486    12     1497 debian     20   0 2957M 40664 25396 S   0.0   1.0   0:00.00                └─ Common-Cleaner
```


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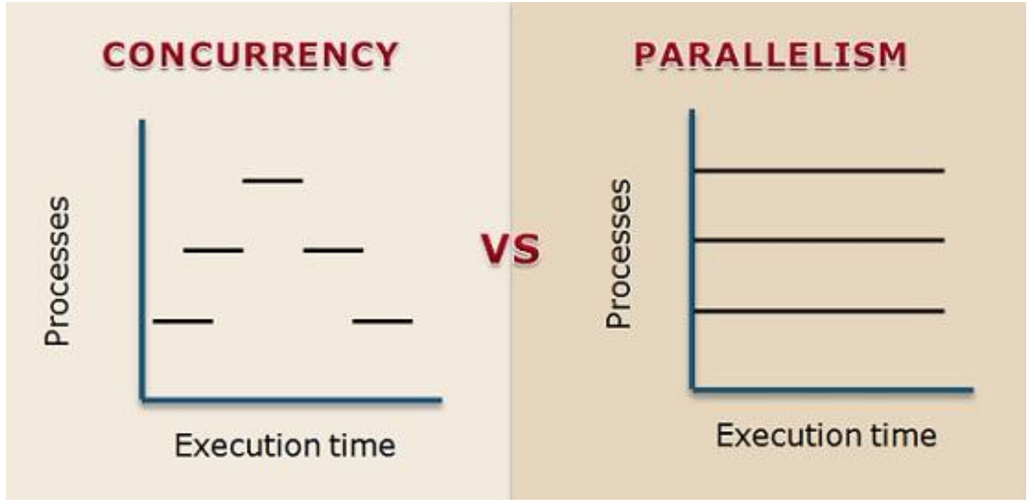
Example : where do we use threads?

- “Everywhere”?!
- “We don’t want clients to wait!”
  - Parallellism vs concurrency?
  - Race conditions



Process vs. Thread

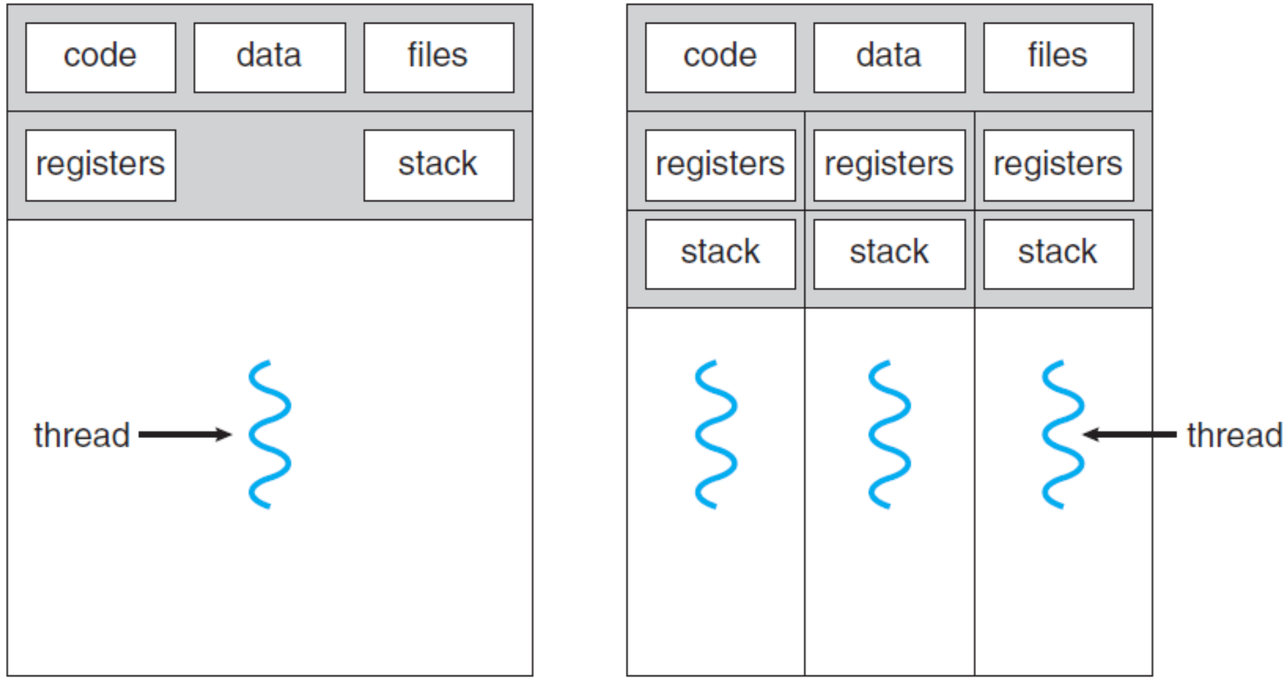


Figure 4.1 Single-threaded and multithreaded processes.

Kernel vs user-level threads

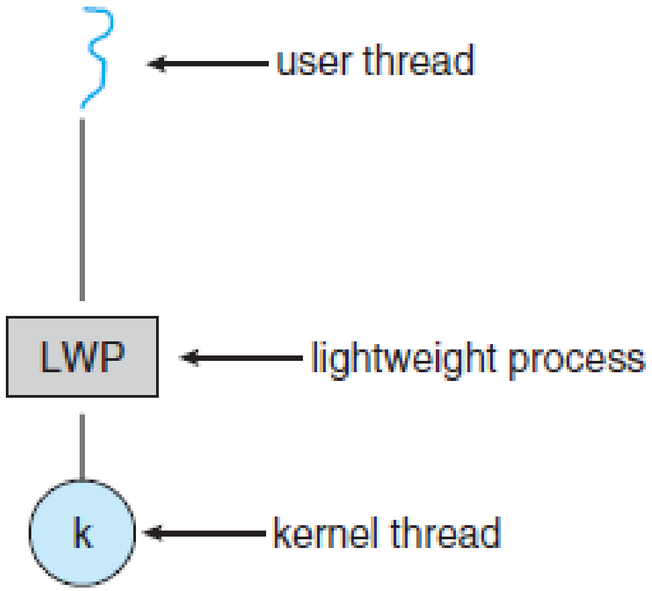


Figure 4.13 Lightweight process (LWP).

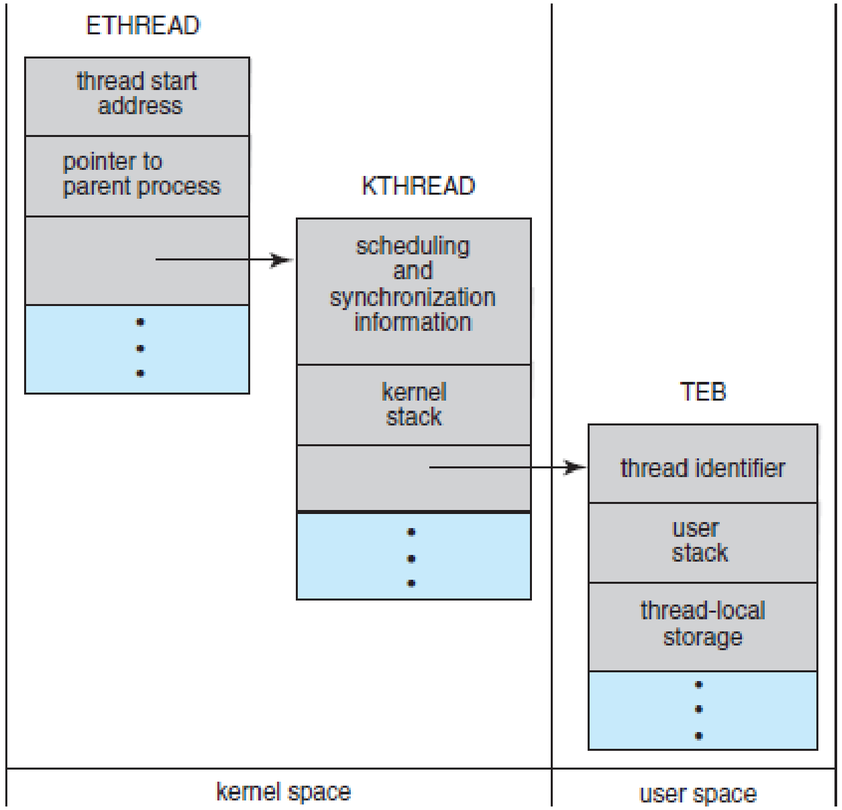


Figure 4.14 Data structures of a Windows thread.

Kernel vs user-level threads & multithreading models

User-level threads

All **code** and **data structures** for the library exist in user space.

Invoking a function in the API results in a **local function call** in user **space** and not a system call.

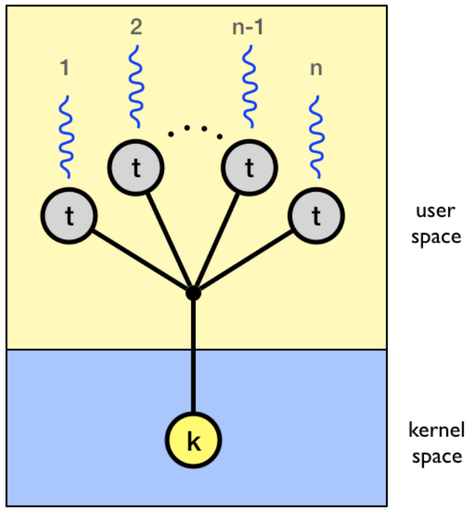
user mode

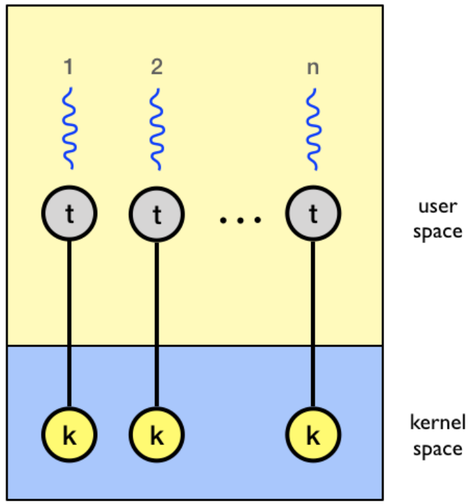
Kernel-level threads

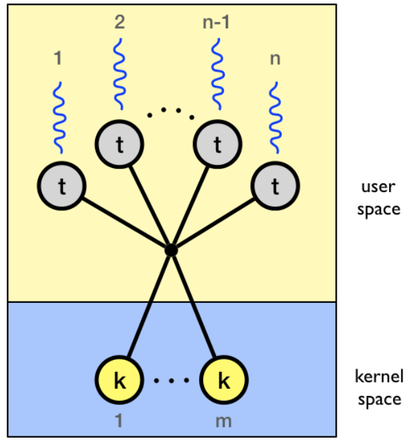
All **code** and **data structures** for the library exists in **kernel space**.

Invoking a function in the API typically results in a **system call** to the kernel.

kernel mode







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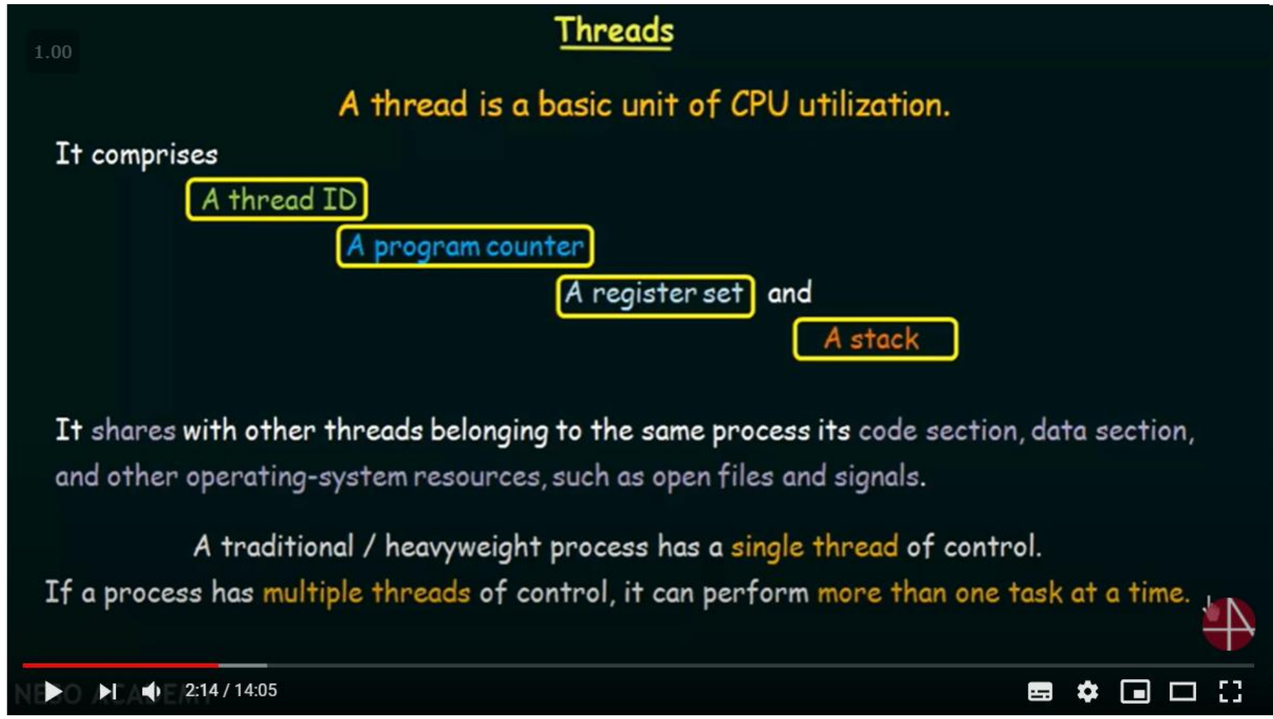
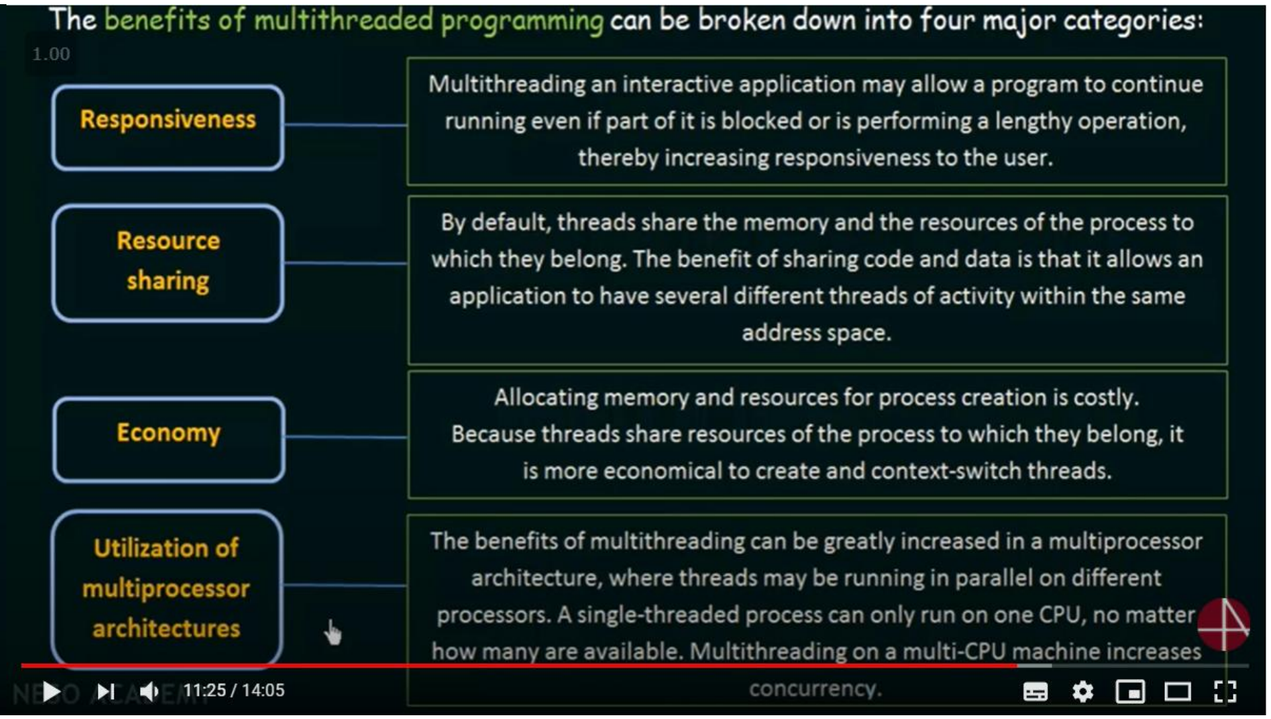
Kernel vs user-level threads



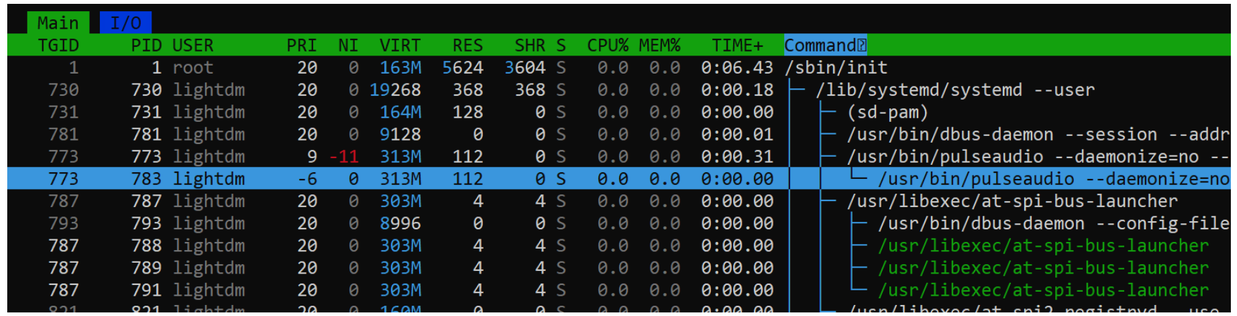


Src: https://www.youtube.com/watch?v=LOfGJcVnvAk

On Linux

Some interesting things:

- htop
  - nlwp via f2 setup, add tgid
- ps –e –T
- /proc/<nr>/status
- pstree –p



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Process vs. Thread (generally speaking)

- A **thread** is a basic unit of CPU utilization; each thread has a:
  - Thread ID
  - Program Counter
  - Register set
  - Stack
- It **shares** with other threads (belonging to the **same process**):
  - Code section
  - Data section
  - Other OS-resources such as “Open-files”

Why would we want to use threads? - Motivation

- Imagine a browser tab “being stuck” while downloading a file?
  - Other examples?
- **Advantages** of **multithreaded** programming
  - Responsiveness
  - Resource sharing
  - Economy

    (it is less costly to manage threads than processes)
  - Scalability

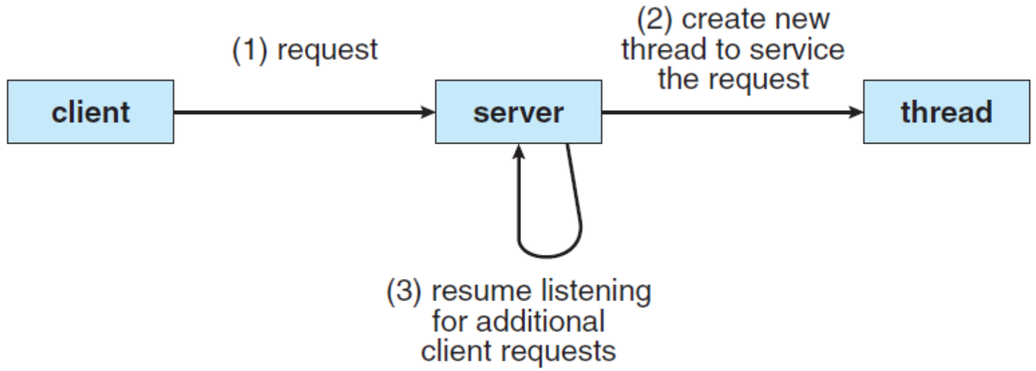
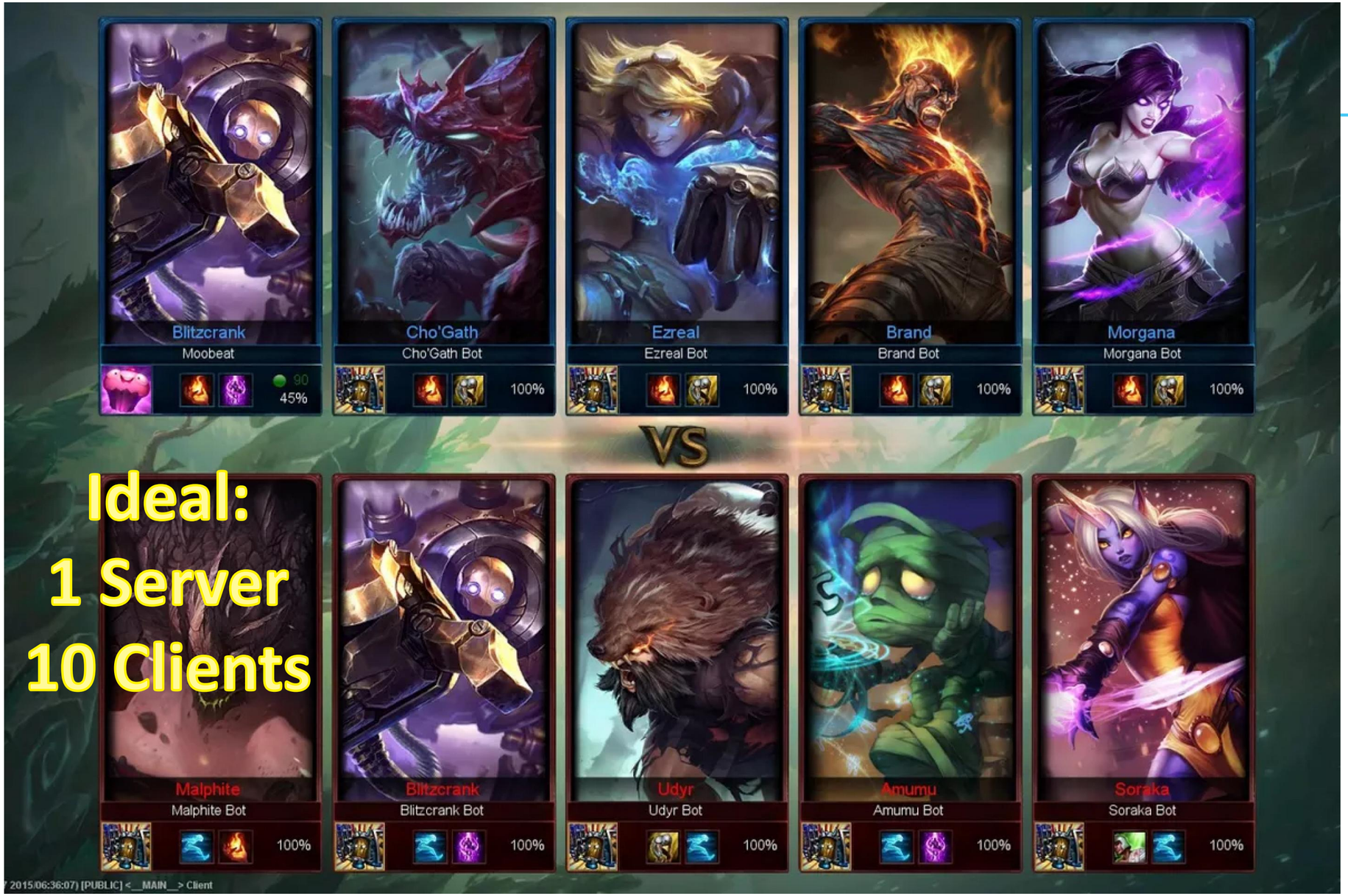


Figure 4.2 Multithreaded server architecture.



Without threads

- leagueserver.exe
- league_accept_client.exe (for every client)
- leagueclient.exe

With threads

- leagueserver.exe
- leagueclient.exe

Server creates a thread for each client

Disadvantages?

- **Programming** (harder to write, harder to debug, harder to manage)
- **Concurrency issues with shared resources**
  - Similar problems with transactions in databases!
    - Dirty read
    - Loss update
    - Phantom read
- It is never set in stone that a “Java thread” is always mapped to an “OS thread”.
  - You have to trust the libraries/frameworks or write everything yourself if you want that.
  - Luckily we rarely have to worry about that as a programmer ☺
  - -> User and kernel threads

Disadvantages? – Race Conditions

Thread 1	Thread 2		Integer value
			0
read value		←	0
increase value			0
write back		→	1
	read value	←	1
	increase value		1
	write back	→	2

Thread 1	Thread 2		Integer value
			0
read value		←	0
	read value	←	0
increase value			0
	increase value		0
write back		→	1
	write back	→	1

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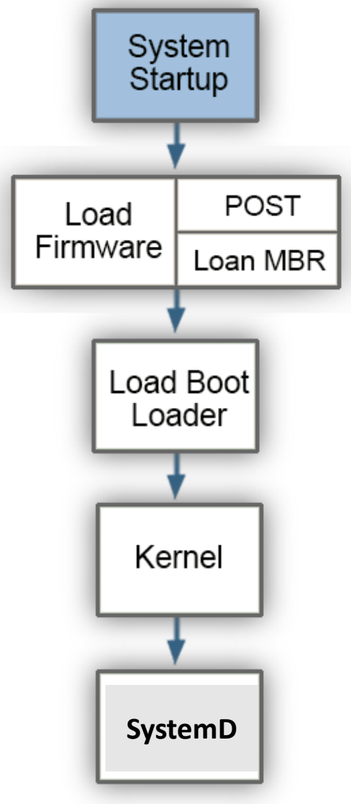
The boot process

Boot Process Overview

- Four main stages
- Some stages can be modified by administrators



Firmware Stage

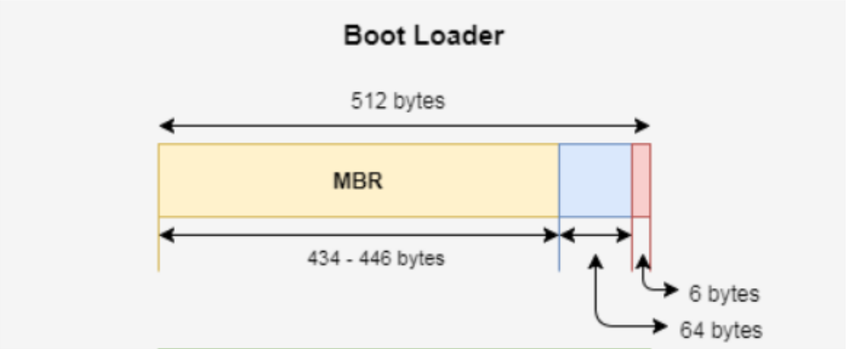
- Firmware is referred to as the BIOS (Basic Input Output System)
- UEFI (Unified Extensible Firmware Interface) has replaced the BIOS on most systems but typically still referred to as “BIOS”

Firmware Stage

- Two primary jobs in this stage:
  1) Power-On Self Test (POST) – ensures system hardware (CPU, RAM, peripherals, etc.) is functioning properly
  2) Load Master Boot Record (MBR) – contains drive partition table and loads *first stage bootloader* whose purpose is to load the *second stage booloader* (next stage)

First Stage Boot Loader

BIOS looks for Master Boot Record (MBR) on first found hdd or equivalent – finds partition table and loads*first stage bootloader*



- *Max 446 bytes!*
- *64 bytes Partition Table, 6 bytes crc*
- *That bootloader will load the second stage bootloader, who lies elsewhere*

* (exceptionally this First stage bootloader loads kernel directly)

Bootloaders

- Most common bootloaders
  - LILO - Linux Loader
    *Supports systems with BIOS
    *ELILO – Efi Linux Loader supports systems with UEFI
  - GRUB - Grand Unified Bootloader
    *Supports systems with UEFI
    *Supports Kernel Flavor choice

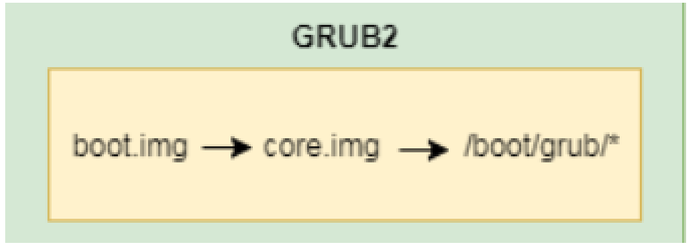
Bootloaders

- Other bootloaders
  - SILO – SPARC Improved bootLoader
    *Supports Linux on Sun SPARC hardware
  -YABOOT – Yet Another Bootloader
  - Supports PowerPC hardware
- Network booting
  - PXE– Preboot Execution Environment
    *For hardware that supports TFTP used to download the bootloader from a server

Bootloaders

- Windows
  - BOOTMGR (can be chainloaded from GRUB)
- MacOS
  -IBOOT for INTEL
  -LLB for ARM (Low-Level Bootloader)
  -Can be used alongside GRUB

GRUB2



- Boot.img (1st stage bootloader)
  - <512 bytes on MBR
  - Points to location of core.img
- Core.img (2nd stage | 1,5th stage bootloader)
  - Chosen Kernel image + generic modules to
    - Access files in /boot/grub (the REAL 2nd stage ?)
  - Loads other (kernel) modules at runtime

Kernel phase

- GRUB2 loads the chosen kernel in memory and passes control to it using the files in
- the /boot directory :
  - An initial RAM disk image (initrd / initramfs)
    - temporary / as tmpfs ←!!!
  - the kernel files (vmlinuz) with basic devices
  - Kernel start up : SystemD becomes active

SystemD phase

- Set kernel options using /etc/sysctl.conf
- Starts udevd daemon to detect all (other) devices
- Imports network configuration
- file system check (fsck) the root file system if necessary

SystemD phase

- Decrypts filesystems if encrypted.
- Mount filesystems according to /etc/fstab
- the REAL (root) / is mounted
- Enable swap devices
- Eventually
  - The system boots in a specific target mode
- SystemD is managed by systemctl

dmesg Command

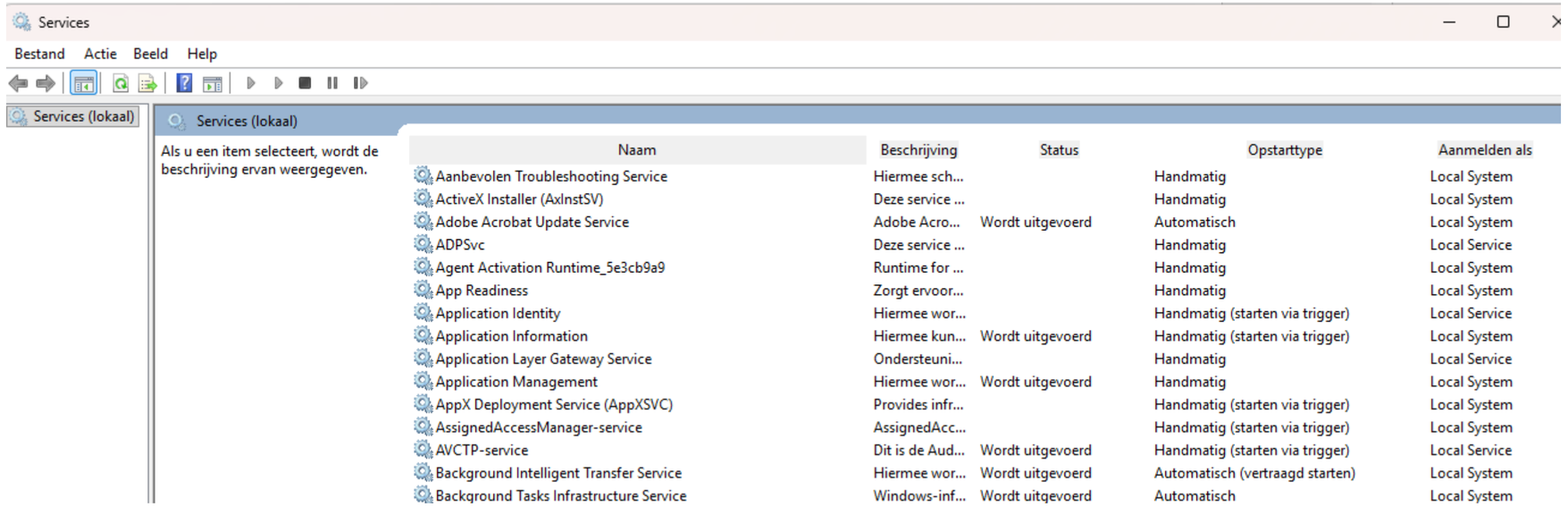
- Executed after boot to view messages generated by the kernel during the boot process
  - Useful for troubleshooting boot issues
- Also executed upon connecting a new device to see device pathname

Daemons

- The administrator can control which services will be provided by the various *daemons*
- A daemon is a running program that provides a service

No Daemons in Windows

- A daemon in windows is called a service



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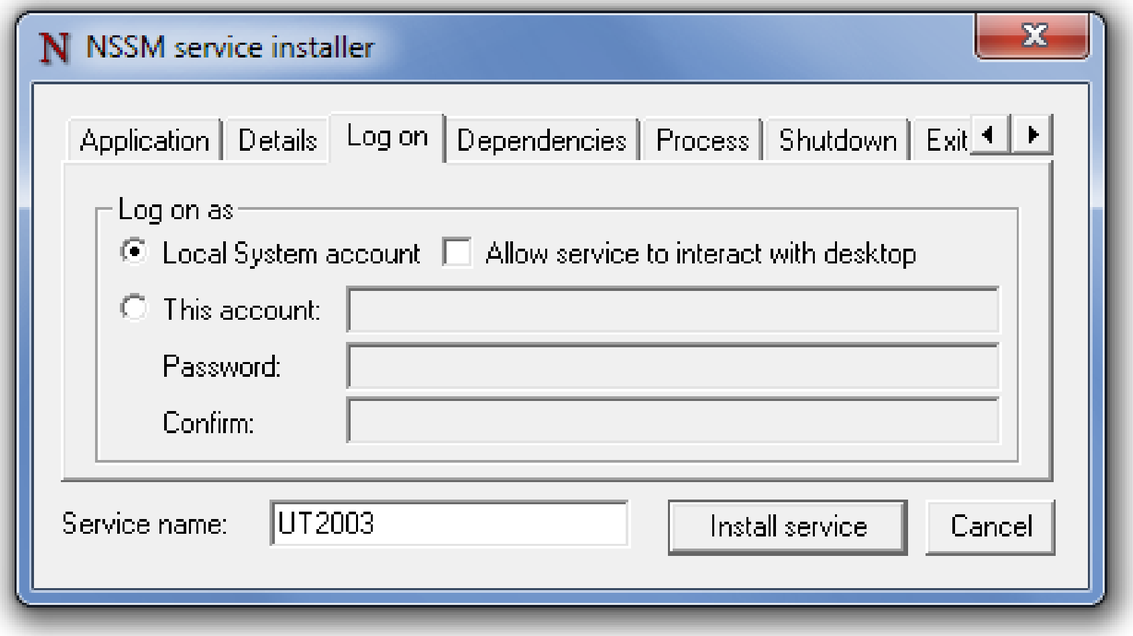
No Daemons in Windows

- Limited wrapping of executables into services is possible
- Need Admin powers
- E.g.
  - sc create ServiceName binPath= "C:\Path\To\YourExecutable.exe“
  - sc start ServiceName

  - New-Service -Name "ServiceName" -BinaryPathName "C:\Path\To\YourExecutable.exe" -DisplayName "My Service" -StartupType Automatic
  - Start-Service -Name "ServiceName"

No Daemons in Windows

- NSSM (third party open source tool)



Systemctl controls the daemons

- The `systemctl` command is used in systems that have Systemd
- Services are found in
  - /etc/systemd/system
  - They are formal configuration files
- To start a service:

```
#systemctl start httpd.service
```

- To stop a service:

```
#systemctl stop httpd.service
```

The systemctl command

- To start check the state of a service:

```
#systemctl status httpd.service
```

- To view all running services:

```
#systemctl -a
```

- To configure a service to start automatically:

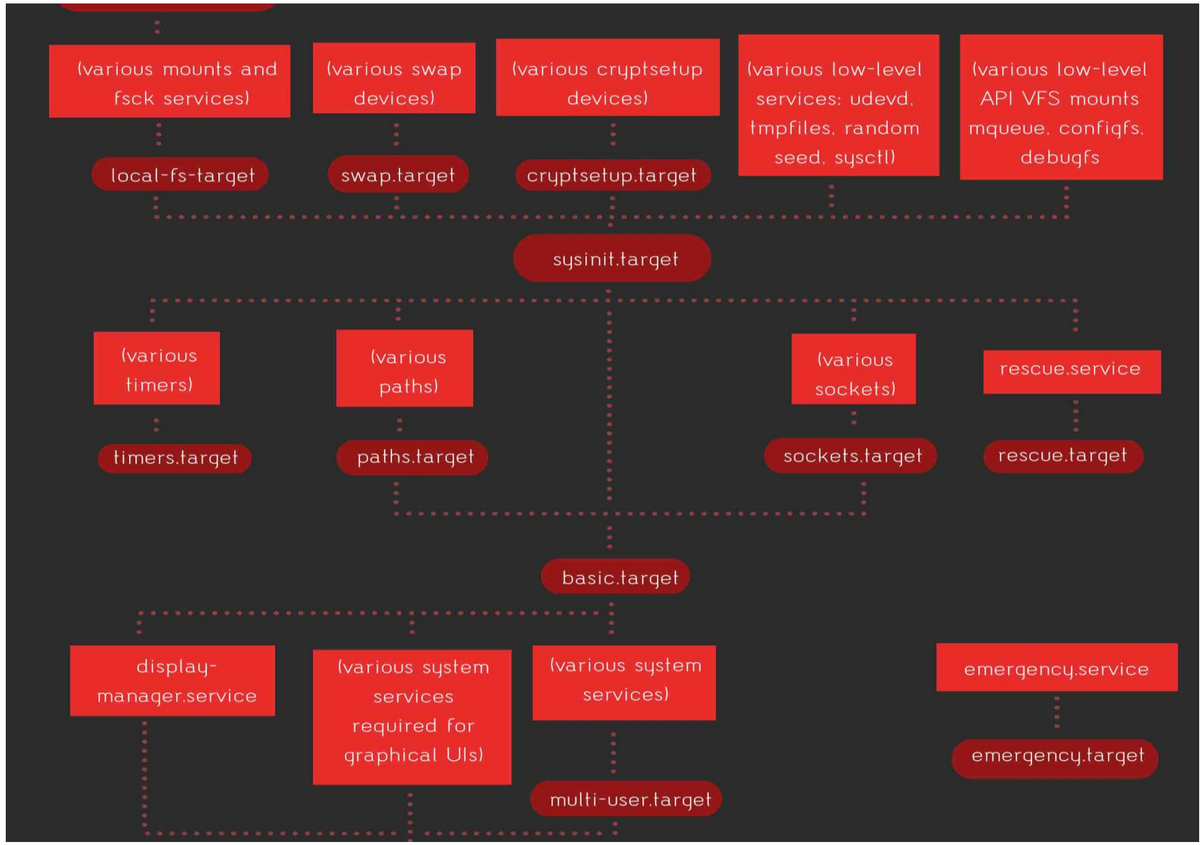
```
#systemctl enable httpd.service
```

Targets

A Target is a state where a consistent number of services are running

A target has

- Required dependencies
- Parallel dependencies
- Conflicting dependencies
- Sequential dependencies (Before / After)



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The systemctl command

- To change the current target state

```
#systemctl isolate graphical-
 target
```

- To change the default target state

```
#systemctl set-default multi-
 user.target
```

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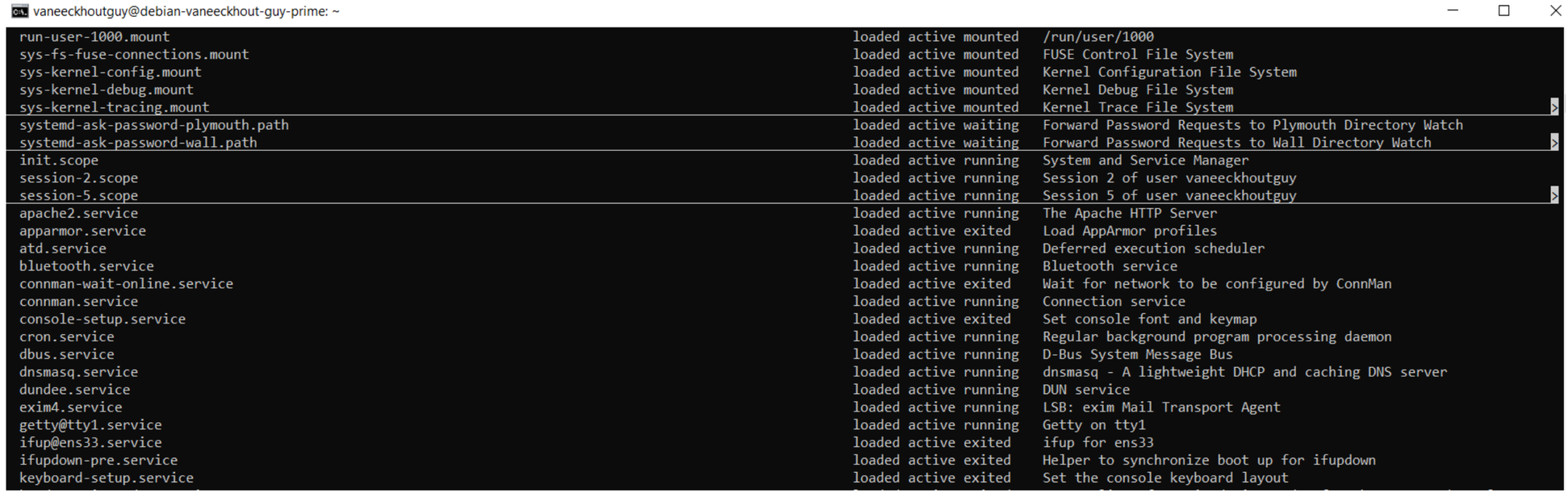
SYSTEMD

In Linux, SYSTEMD is in control

SystemD is in Control

It determines which daemons are running

Consult it using systemctl command (no args)



.service ?

.service

Configured in a .service file !

Constructed so SystemD knows what (you want it) to do

Selecteren vaneeckhoutguy@debian-vaneeckhout-guy-prime: ~

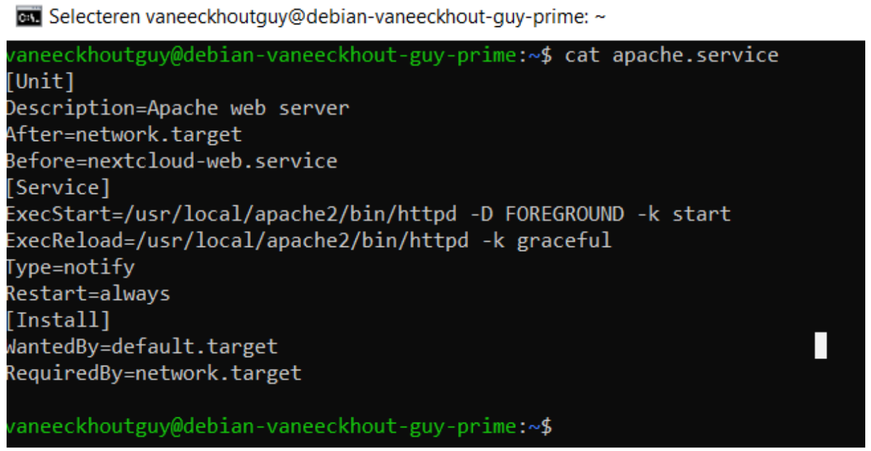
```
vaneeckhoutguy@debian-vaneeckhout-guy-prime:~$ cat apache.service
[Unit]
Description=Apache web server
After=network.target
Before=nextcloud-web.service
[Service]
ExecStart=/usr/local/apache2/bin/httpd -D FOREGROUND -k start
ExecReload=/usr/local/apache2/bin/httpd -k graceful
Type=notify
Restart=always
[Install]
WantedBy=default.target
RequiredBy=network.target

vaneeckhoutguy@debian-vaneeckhout-guy-prime:~$
```

The Unit Section

DESCRIPTION :- Human-readable title of the systemd service.

AFTER :- Set dependency on a service. (I want the server to start after the network is online. This typically includes targets or other services.)

BEFORE :- Start current service before specified service. (I want Apache web server running before the service for Nextcloud is started).



The Service Section

ExecStart:- The command that needs to be executed when the service starts

ExecReload:- (optional).

how a service is restarted. Use this field in case you wish to have a specific restart mechanism.

Type:- start-up type of a process for a given systemd service. Options are simple, exec, forking, oneshot, dbus, notify and idle.

Restart:- (optional)

specifies if/when a service should be restarted or not.

options are no, on-success, on-failure, on-abnormal, on-watchdog, on-abort and always.

The Install Section

is used when you run either systemctl enable and systemctl disable command for enabling or disabling a service.

WantedBy:

similar to the After and Before fields

used to specify systemd-equivalent "runlevels".

The default.target is when all the system initialization is complete (when the user is asked to log in. user-facing services (like Apache, cron, GNOME-stuff, etc.) use this target.)

RequiredBy:

similar to WantedBy

specifies hard dependencies.

(if a dependency, this service will fail).

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Take control

Create/start/Stop/Manage your own service

Creating a root service

Start with a (root) script **update-on-boot.sh**

```
#!/usr/bin/env bash

if [ ${EUID} -ne 0 ]
then
    exit 1 # this is meant to be run as root
fi

apt-get update 1>/dev/null 2>>/root/sys-update.log
```

Put it in /root/ directory
Make sure root can execute this script
Test it !

```
./update-on-boot.sh
```

Turning your script into a service

cd to /etc/systemd/system

create a file ***update-on-boot.service***

[Unit]
Description=Keeping my sources minty fresh
After=multi-user.target

[Service]
ExecStart=/usr/bin/bash /root/update-on-boot.sh
Type=simple

[Install]
WantedBy=multi-user.target

Enabling the service

sudo systemctl daemon-reload

makes the systemD daemon aware of the new service

sudo systemctl enable update-on-boot.service

```
root@debian-vaneeckhout-guy-prime:/etc/systemd/system# sudo systemctl enable update-on-boot.service
Created symlink /etc/systemd/system/multi-user.target.wants/update-on-boot.service → /etc/systemd/system/update-on-boot.service.
root@debian-vaneeckhout-guy-prime:/etc/systemd/system#
```

This creates a symlink in the multi-user.target.wants (remember the targets ?)

How to check if it is enabled ?

```
root@debian-vaneeckhout-guy-prime:/etc/systemd/system# sudo systemctl is-enabled update-on-boot.service
enabled
```

So every time a system enters this target, the script will be executed !

Creating a USER script

Create a script keep-uptime.sh to keep the time your system is up

```
#!/usr/bin/env bash
uptime | tee -a ${HOME}/uptime.log
```

Make it executable

Test it !

Creating a service for a regular user

Make another .service file ☺

cd to /etc/systemd/system ?

~/.config/systemd/user/ !

Directory not present by default

mkdir -p

cd to ~/.config/systemd/user/

Creating a service for a regular user

Create a file keep-uptime.service in ~/.config/systemd/user/

Content :

```
[Unit]
Description=Log uptime in scoreboard
DefaultDependencies=no
Before=shutdown.target
[Service]
Type=oneshot
ExecStart=/usr/bin/bash %h/keep-uptime.sh
TimeoutStartSec=0
[Install]
WantedBy=shutdown.target
```

Enabling your user service

makes the systemD daemon aware of the new service

No sudo necessary !

systemctl --user daemon-reload

systemctl --user enable keep-uptime.service

```
vaneeckhoutguy@debian-vaneeckhout-guy-prime:~$ systemctl --user enable keep-uptime.service
Created symlink /home/vaneeckhoutguy/.config/systemd/user/shutdown.target.wants/keep-uptime.service → /home/vaneeckhoutguy/.config/system
d/user/keep-uptime.service.
vaneeckhoutguy@debian-vaneeckhout-guy-prime:~$
```

Start & Check your user service

Start it !

systemctl --user start keep-uptime

Check what happened (log)

systemctl --user status keep-uptime

```
vaneeckhoutguy@debian-vaneeckhout-guy-prime:~$ systemctl --user status keep-uptime
● keep-uptime.service - Log uptime in scoreboard
     Loaded: loaded (/home/vaneeckhoutguy/.config/systemd/user/keep-uptime.service; enabled; vendor preset: enabled)
     Active: inactive (dead) since Wed 2022-11-16 13:41:28 CET; 4s ago
    Process: 3108 ExecStart=/usr/bin/bash /home/vaneeckhoutguy/keep-uptime.sh (code=exited, status=0/SUCCESS)
   Main PID: 3108 (code=exited, status=0/SUCCESS)
        CPU: 9ms

Nov 16 13:41:28 debian-vaneeckhout-guy-prime systemd[1206]: Starting Log uptime in scoreboard...
Nov 16 13:41:28 debian-vaneeckhout-guy-prime bash[3110]:  13:41:28 up  3:18,  1 user,  load average: 0.13, 0.15, 0.12
Nov 16 13:41:28 debian-vaneeckhout-guy-prime systemd[1206]: keep-uptime.service: Succeeded.
Nov 16 13:41:28 debian-vaneeckhout-guy-prime systemd[1206]: Finished Log uptime in scoreboard.
vaneeckhoutguy@debian-vaneeckhout-guy-prime:~$
```

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Want more

Let’s build a true server service

Chatbot 1.0

Dumb chatbot.php that answers anything you type in gibberese

```
<?php
$sock = socket_create(AF_INET, SOCK_DGRAM, SOL_UDP);
socket_bind($sock, '0.0.0.0', 10000);
for (;;) {
    socket_recvfrom($sock, $message, 1024, 0, $ip, $port);
    $reply = str_rot13($message);
    socket_sendto($sock, $reply, strlen($reply), 0, $ip, $port);
}
```

Run it !

Php chatbot.php

Test it in another terminal

nc -u 127.0.0.1 10000

CTRL + C
Kill chatbot

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Turning Chatbot 1.0 into a service

Let's create a chatbot.service file for our service

```
[Unit]
Description=Dumb chat service
After=network.target
StartLimitIntervalSec=0
[Service]
Type=simple
Restart=always
RestartSec=1
ExecStart=/usr/bin/env php %h/chatbot.php
[Install]
WantedBy=default.target
```

What steps do you need to get it running ?

Examine your service process

systemctl --user status chatbot

```
vaneeckhoutguy@debian-vaneeckhout-guy-prime:~/.config/systemd/user$ systemctl --user status chatbot
● chatbot.service - Dumb chat service
     Loaded: loaded (/home/vaneeckhoutguy/.config/systemd/user/chatbot.service; enabled; vendor preset: enabled)
     Active: active (running) since Wed 2022-11-16 14:27:27 CET; 3s ago
   Main PID: 3494 (php)
      Tasks: 1 (limit: 2284)
     Memory: 5.2M
        CPU: 20ms
     CGroup: /user.slice/user-1000.slice/user@1000.service/app.slice/chatbot.service
             └─3494 php /home/vaneeckhoutguy/chatbot.php

Nov 16 14:27:27 debian-vaneeckhout-guy-prime systemd[1206]: Started Dumb chat service.
vaneeckhoutguy@debian-vaneeckhout-guy-prime:~/.config/systemd/user$ nc -u 127.0.0.1 10000
Hi Daemon
Uv Qnrzba
^C
```

Examine your service process

ps -ef | grep php

```
vaneeckhoutguy@debian-vaneeckhout-guy-prime:~/.config/systemd/user$ ps -ef | grep php
vaneeck+    3494    1206  0 14:27 ?        00:00:00 php /home/vaneeckhoutguy/chatbot.php
vaneeck+    3505    3222  0 14:28 pts/1    00:00:00 grep php
vaneeckhoutguy@debian-vaneeckhout-guy-prime:~/.config/systemd/user$ systemctl --user stop chatbot
vaneeckhoutguy@debian-vaneeckhout-guy-prime:~/.config/systemd/user$ ps -ef | grep php
vaneeck+    3508    3222  0 14:28 pts/1    00:00:00 grep php
vaneeckhoutguy@debian-vaneeckhout-guy-prime:~/.config/systemd/user$ systemctl --user start chatbot
vaneeckhoutguy@debian-vaneeckhout-guy-prime:~/.config/systemd/user$ ps -ef | grep php
vaneeck+    3510    1206  0 14:28 ?        00:00:00 php /home/vaneeckhoutguy/chatbot.php
vaneeck+    3512    3222  0 14:28 pts/1    00:00:00 grep php
```

Examine your service process

Try and kill your server process !

Kill pid_of_chatbot

```
vaneeckhoutguy@debian-vaneeckhout-guy-prime:~/.config/systemd/user$ ps -ef | grep php
vaneeck+    3494    1206  0 14:27 ?        00:00:00 php /home/vaneeckhoutguy/chatbot.php
vaneeck+    3505    3222  0 14:28 pts/1    00:00:00 grep php
vaneeckhoutguy@debian-vaneeckhout-guy-prime:~/.config/systemd/user$ systemctl --user stop chatbot
vaneeckhoutguy@debian-vaneeckhout-guy-prime:~/.config/systemd/user$ ps -ef | grep php
vaneeck+    3508    3222  0 14:28 pts/1    00:00:00 grep php
vaneeckhoutguy@debian-vaneeckhout-guy-prime:~/.config/systemd/user$ systemctl --user start chatbot
vaneeckhoutguy@debian-vaneeckhout-guy-prime:~/.config/systemd/user$ ps -ef | grep php
vaneeck+    3510    1206  0 14:28 ?        00:00:00 php /home/vaneeckhoutguy/chatbot.php
vaneeck+    3512    3222  0 14:28 pts/1    00:00:00 grep php
```

Examine your service process

Your chatbot gets respawned automatically !

```
vaneeckhoutguy@debian-vaneeckhout-guy-prime:~/.config/systemd/user$ ps -ef | grep chat
vaneeck+    3530    1206  0 14:30 ?        00:00:00 php /home/vaneeckhoutguy/chatbot.php
vaneeck+    3532    3222  0 14:30 pts/1    00:00:00 grep chat
vaneeckhoutguy@debian-vaneeckhout-guy-prime:~/.config/systemd/user$ kill 3530
vaneeckhoutguy@debian-vaneeckhout-guy-prime:~/.config/systemd/user$ ps -ef | grep chat
vaneeck+    3533    1206  0 14:30 ?        00:00:00 php /home/vaneeckhoutguy/chatbot.php
vaneeck+    3535    3222  0 14:30 pts/1    00:00:00 grep chat
vaneeckhoutguy@debian-vaneeckhout-guy-prime:~/.config/systemd/user$ systemctl --user status chatbot
● chatbot.service - Dumb chat service
     Loaded: loaded (/home/vaneeckhoutguy/.config/systemd/user/chatbot.service; enabled; vendor preset: enabled)
     Active: active (running) since Wed 2022-11-16 14:30:39 CET; 20s ago
   Main PID: 3533 (php)
      Tasks: 1 (limit: 2284)
     Memory: 5.2M
        CPU: 22ms
     CGroup: /user.slice/user-1000.slice/user@1000.service/app.slice/chatbot.service
             └─3533 php /home/vaneeckhoutguy/chatbot.php

Nov 16 14:30:39 debian-vaneeckhout-guy-prime systemd[1206]: chatbot.service: Scheduled restart job, restart counter is at 1.
Nov 16 14:30:39 debian-vaneeckhout-guy-prime systemd[1206]: Stopped Dumb chat service.
Nov 16 14:30:39 debian-vaneeckhout-guy-prime systemd[1206]: Started Dumb chat service.
vaneeckhoutguy@debian-vaneeckhout-guy-prime:~/.config/systemd/user$
```