PART 1: Web Development & Automation

1)

A database model can be designed by an ER model. The machine can be model as strong entities since each one has a unique identifier, the MAC address. The process table and users tables are weak entities with cardinality 1:1 to the machines. Because they don't have an own description identifier. It's possible to list the most relevant attributes to store and monitor of each entity:

Machine

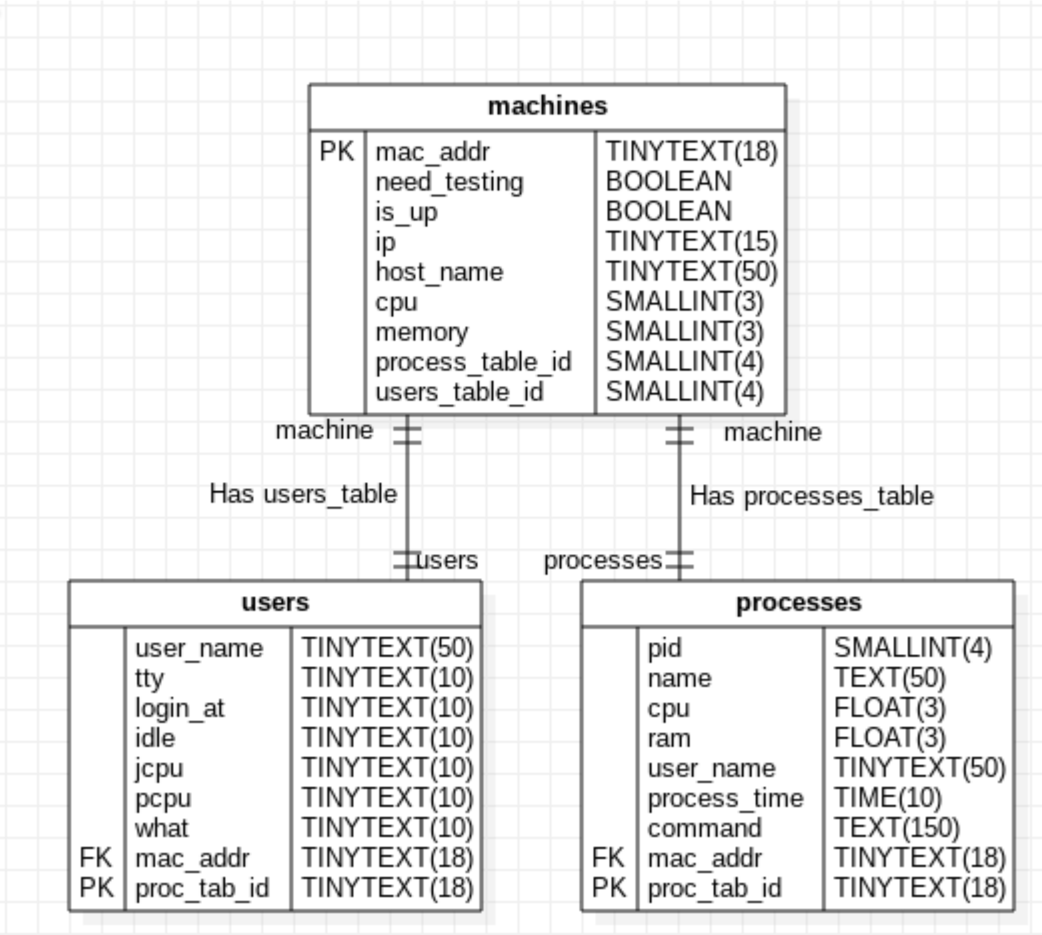
MAC addr, IP, hostName, Is up, Users table, Running Process table, total CPU usage, total Memory Usage.

Process table:

PID, Process name, CPU usage, Memory usage, CPU time usage by process, command, machine_id, process_table_id

User:

Username, CPU usage, login at the machine, idle, terminal/instance of access, users table id, machine id.



machines		
PK	mac_addr	TINYTEXT(18)
	need_testing	BOOLEAN
	is_up	BOOLEAN
	ip	TINYTEXT(15)
	host_name	TINYTEXT(50)
	cpu	SMALLINT(3)
	memory	SMALLINT(3)
	process_table_id	SMALLINT(4)
	users_table_id	SMALLINT(4)

users		
	user_name	TINYTEXT(50)
	tty	TINYTEXT(10)
	login_at	TINYTEXT(10)
	idle	TINYTEXT(10)
	jcpu	TINYTEXT(10)
	pcpu	TINYTEXT(10)
	what	TINYTEXT(10)
FK	mac_addr	TINYTEXT(18)
PK	proc_tab_id	TINYTEXT(18)

processes		
	pid	SMALLINT(4)
	name	TEXT(50)
	cpu	FLOAT(3)
	ram	FLOAT(3)
	user_name	TINYTEXT(50)
	process_time	TIME(10)
	command	TEXT(150)
FK	mac_addr	TINYTEXT(18)
PK	proc_tab_id	TINYTEXT(18)

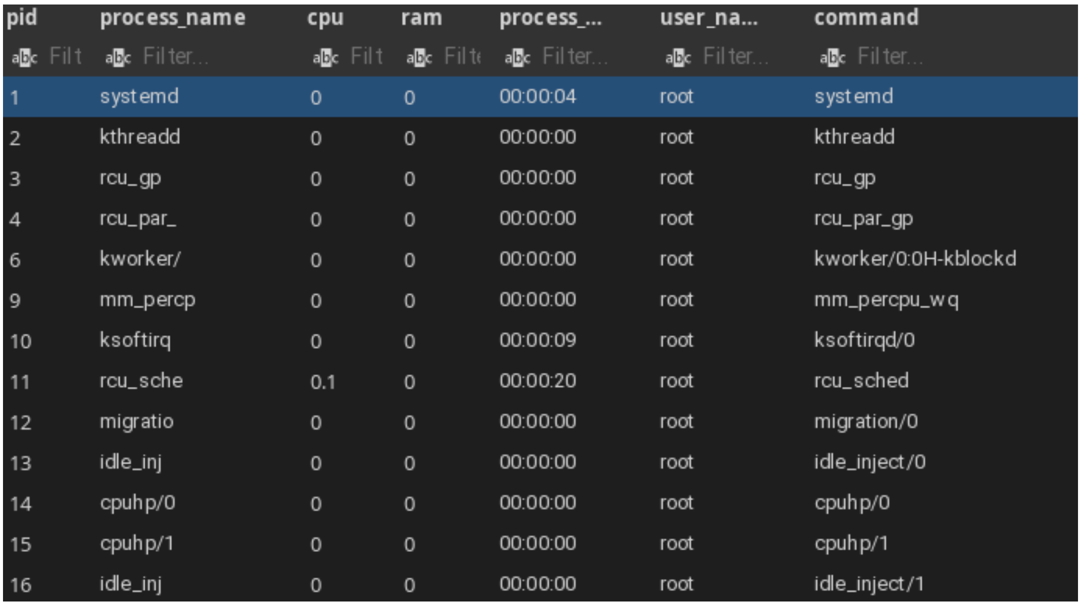
b) The machines will be inserted into the database by importing CSV files corresponding to each one of them. There will be 3 files: one retrieving data of a single machine, another retrieving its process, and the last one retrieving its users with statistics. Those CSV tables will be retrieved by a background process detailed ahead.

Sql scripit updates database with csv files data:

- /db/insert.sql

```
LOAD DATA LOCAL INFILE './machine_table.csv'
INTO TABLE machinesdb.machines
FIELDS TERMINATED BY ','
LINES TERMINATED BY '\n'
IGNORE 1 ROWS;


LOAD DATA LOCAL INFILE './process.csv'
INTO TABLE machinesdb.processes
FIELDS TERMINATED BY ','
LINES TERMINATED BY '\n'
IGNORE 1 ROWS;


LOAD DATA LOCAL INFILE './users.csv'
INTO TABLE machinesdb.users
FIELDS TERMINATED BY ','
LINES TERMINATED BY '\n'
IGNORE 1 ROWS;
```

- Database snapshot:



pid	process_name	cpu	ram	process_...	user_na...	command
1	systemd	0	0	00:00:04	root	systemd
2	kthreadd	0	0	00:00:00	root	kthreadd
3	rcu_gp	0	0	00:00:00	root	rcu_gp
4	rcu_par_	0	0	00:00:00	root	rcu_par_gp
6	kworker/	0	0	00:00:00	root	kworker/0:0H-kblockd
9	mm_percp	0	0	00:00:00	root	mm_percpu_wq
10	ksoftirq	0	0	00:00:09	root	ksoftirqd/0
11	rcu_sche	0.1	0	00:00:20	root	rcu_sched
12	migratio	0	0	00:00:00	root	migration/0
13	idle_inj	0	0	00:00:00	root	idle_inject/0
14	cpuhp/0	0	0	00:00:00	root	cpuhp/0
15	cpuhp/1	0	0	00:00:00	root	cpuhp/1
16	idle_inj	0	0	00:00:00	root	idle_inject/1

Machines monitor index page source code:

- /monitor_webpage/index.php:

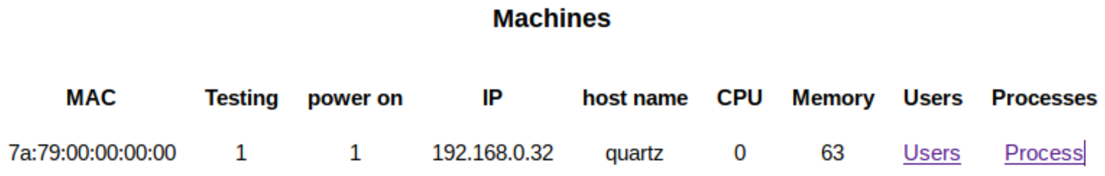
```
<?php
```

```
    $connection = mysqli_connect("localhost", "vektor", "");
    // prepare sql
    $sql = "SELECT * FROM machinesdb.machines";
    $result = mysqli_query($connection, $sql);
    // get number of rows in the table
    $rows_number = mysqli_num_rows($result);
    // fill the arrays with the rows data of stocks
    for ($i = 0; $i<$rows_number; $i++ )
    {
        $row = mysqli_fetch_array($result);
        $mac_array[$i] = $row["mac_addr"];
        $testing[$i] = $row["need_testing"];
        $is_up[$i] = $row["is_up"];
        $ip[$i] = $row["ip"];
        $name_array[$i] = $row["host_name"];
        $up_array[$i] = $row["is_up"];
        $cpu_array[$i] = $row["cpu"];
        $mem_array[$i] = $row["memory"];
    }
?>

<!DOCTYPE html>
<html>
  <head>
    <meta http-equiv="Content-Type" content="text/html;charset=utf-8">
    <link href="css/styles.css" rel="stylesheet" type="text/css">
    <title>Machines monitor</title>
  </head>
  <body>
    <div id="middle">
        <h3>Machines</h3>
        <table style =" border-spacing: 18px; clear:both;">
            <tr>
                <th>MAC</th>
                <th>Testing</th>
                <th>power on  </th>
                <th>IP</th>
                <th>host name </th>
                <th>CPU</th>
                <th>Memory</th>
                <th>Users</th>
                <th>Processes</th>
            </tr>
            <?php for ($i = 0; $i < $rows_number; $i++) : ?>
            <tr>
                <td> <?= $mac_array[$i]; ?> </td>
                <td> <?= $testing[$i]; ?> </td>
                <td> <?= $is_up[$i]; ?> </td>
                <td> <?= $ip[$i]; ?> </td>
                <td> <?= $name_array[$i]; ?> </td>
                <td> <?= $cpu_array[$i]; ?> </td>
                <td> <?= $mem_array[$i]; ?> </td>
                <td>  <a href="/users.php">Users</a>  </td>
                <td>  <a href="/processes.php">Process</a> </td>
            </tr>
            <?php endfor ?>
        </table>
    </div>
  </body>
</html>
```

- Query used to retrieve the machines Table:

```
    $sql = "SELECT * FROM machinesdb.machines";
```

Machines webpage:



Machines

MAC	Testing	power on	IP	host name	CPU	Memory	Users	Processes
7a:79:00:00:00:00	1	1	192.168.0.32	quartz	0	63	Users	Process

Process monitor page source code:

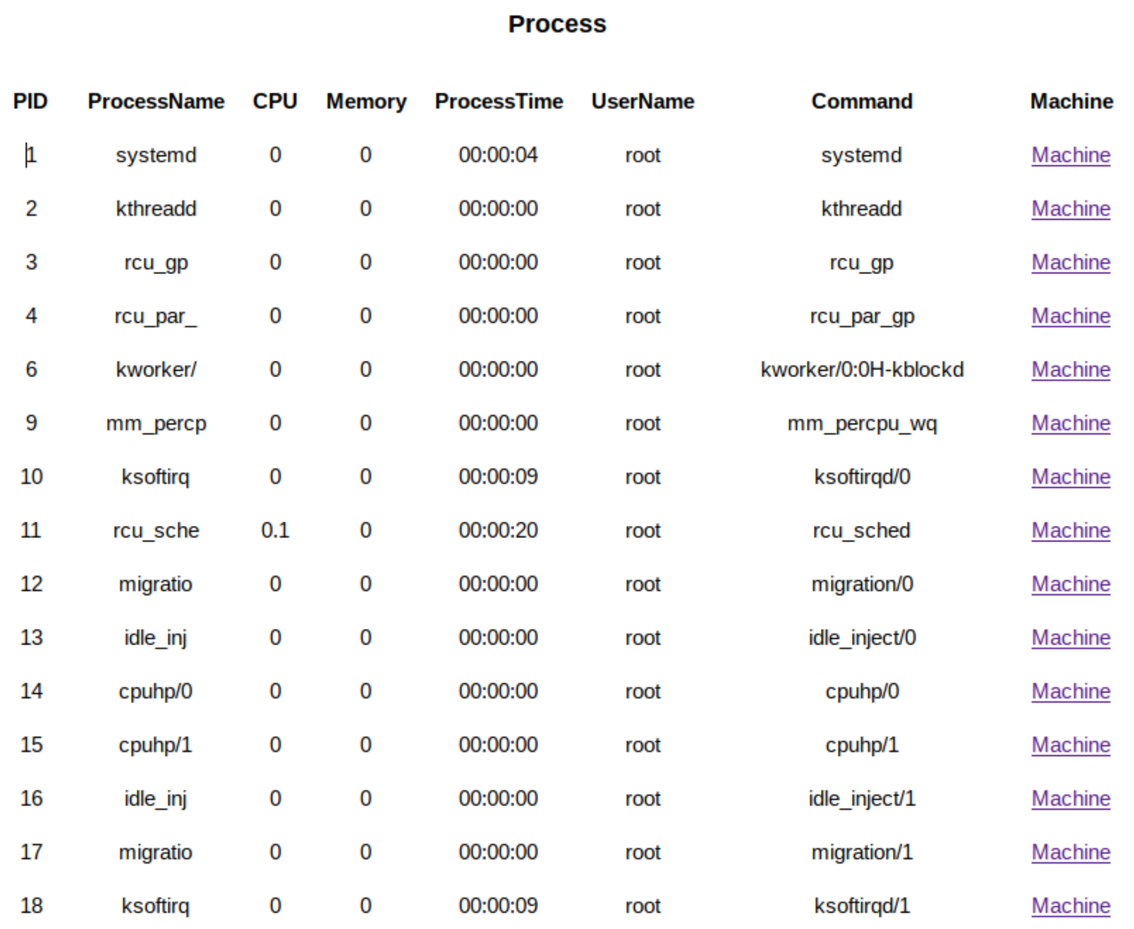
- /monitor_webpage/process.php:

```
<?php
    $connection = mysqli_connect("localhost", "vektor", "");
    // find username
    $result = mysqli_query($connection, "SELECT * FROM machinesdb.processes")
    // get number of rows in the table
    $rows_number = mysqli_num_rows($result);
    // fill the arrays with the rows data of stocks
    for ($i = 0; $i<$rows_number; $i++ )
    {
        $row = mysqli_fetch_array($result);
        $pid[$i] = $row["pid"];
        $process_name[$i] = $row["process_name"];
        $cpu[$i] = $row["cpu"];
        $ram[$i] = $row["ram"];
        $process_time[$i] = $row["process_time"];
        $user_name[$i] = $row["user_name"];
        $command[$i] = $row["command"];
    }
?>
<!DOCTYPE html>
<html>
  <head>
    <meta http-equiv="Content-Type" content="text/html;charset=utf-8">
    <link href="css/styles.css" rel="stylesheet" type="text/css">
    <title>Process monitor</title>
  </head>
  <body>
    <div id="middle">
        <h3>Process</h3>
        <table style =" border-spacing: 18px; clear:both;">
            <tr>
                <th>PID</th>
                <th>ProcessName</th>
                <th>CPU  </th>
                <th>Memory</th>
                <th>ProcessTime </th>
                <th>UserName</th>
                <th>Command</th>
                <th>Machine</th>
            </tr>
            <?php for ($i = 0; $i < $rows_number; $i++) : ?>
            <tr>
                <td> <?= $pid[$i]; ?> </td>
                <td> <?= $process_name[$i]; ?> </td>
                <td> <?= $cpu[$i]; ?> </td>
                <td> <?= $ram[$i]; ?> </td>
                <td> <?= $process_time[$i]; ?> </td>
                <td> <?= $user_name[$i]; ?> </td>
                <td> <?= $command[$i]; ?> </td>
                <td>  <a href="/index.php">Machine</a> </td>
            </tr>
            <?php endfor ?>
        </table>
    </div>
  </body>
</html>
```

- Query used to retrieve the machines Table:

```
$sql = "SELECT * FROM machinesdb.process";
```

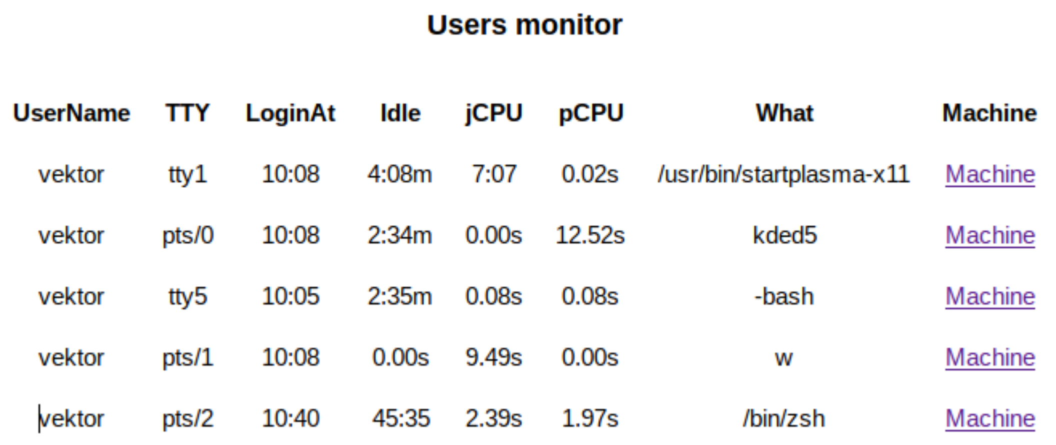
Process webpage:



Process

PID	ProcessName	CPU	Memory	ProcessTime	UserName	Command	Machine
1	systemd	0	0	00:00:04	root	systemd	Machine
2	kthreadd	0	0	00:00:00	root	kthreadd	Machine
3	rcu_gp	0	0	00:00:00	root	rcu_gp	Machine
4	rcu_par_	0	0	00:00:00	root	rcu_par_gp	Machine
6	kworker/	0	0	00:00:00	root	kworker/0:0H-kblockd	Machine
9	mm_percp	0	0	00:00:00	root	mm_percpu_wq	Machine
10	ksoftirq	0	0	00:00:09	root	ksoftirqd/0	Machine
11	rcu_sche	0.1	0	00:00:20	root	rcu_sched	Machine
12	migratio	0	0	00:00:00	root	migration/0	Machine
13	idle_inj	0	0	00:00:00	root	idle_inject/0	Machine
14	cpuhp/0	0	0	00:00:00	root	cpuhp/0	Machine
15	cpuhp/1	0	0	00:00:00	root	cpuhp/1	Machine
16	idle_inj	0	0	00:00:00	root	idle_inject/1	Machine
17	migratio	0	0	00:00:00	root	migration/1	Machine
18	ksoftirq	0	0	00:00:09	root	ksoftirqd/1	Machine

Users webpage:



Users monitor

UserName	TTY	LoginAt	Idle	jCPU	pCPU	What	Machine
vektor	tty1	10:08	4:08m	7:07	0.02s	/usr/bin/startplasma-x11	Machine
vektor	pts/0	10:08	2:34m	0.00s	12.52s	kded5	Machine
vektor	tty5	10:05	2:35m	0.08s	0.08s	-bash	Machine
vektor	pts/1	10:08	0.00s	9.49s	0.00s	w	Machine
vektor	pts/2	10:40	45:35	2.39s	1.97s	/bin/zsh	Machine

c)

A simpler implementation, but less scalable and works mostly to the local network: the monitor server fetches machines updates periodically by a poll. In each machine, is executed a bash script that connects by ssh, executes each command, and retrieves a CSV report file with each one of them. After getting all files, a parse must be done and then updating the DB. The pooling background process can be implemented by the following commands:

Local network machines:

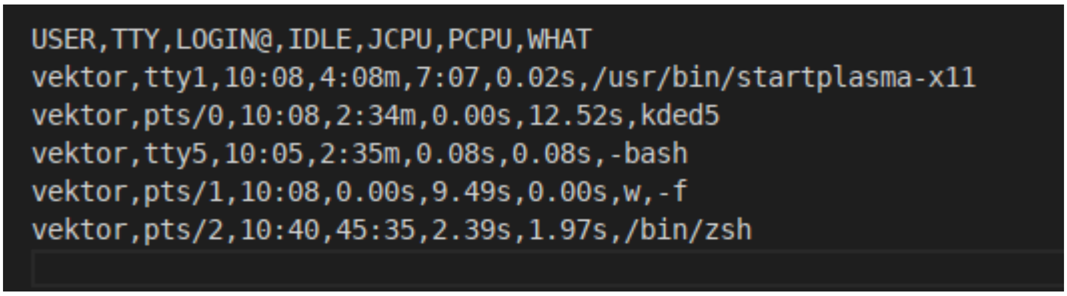
The list of current machines connected to the local network can be retrieved by:

```
arp -vn
```

Generating users table:

```
w -f| awk '(NR>1)' | tr -s '[:blank:]' ',' > users.csv
```

- Generated user csv file

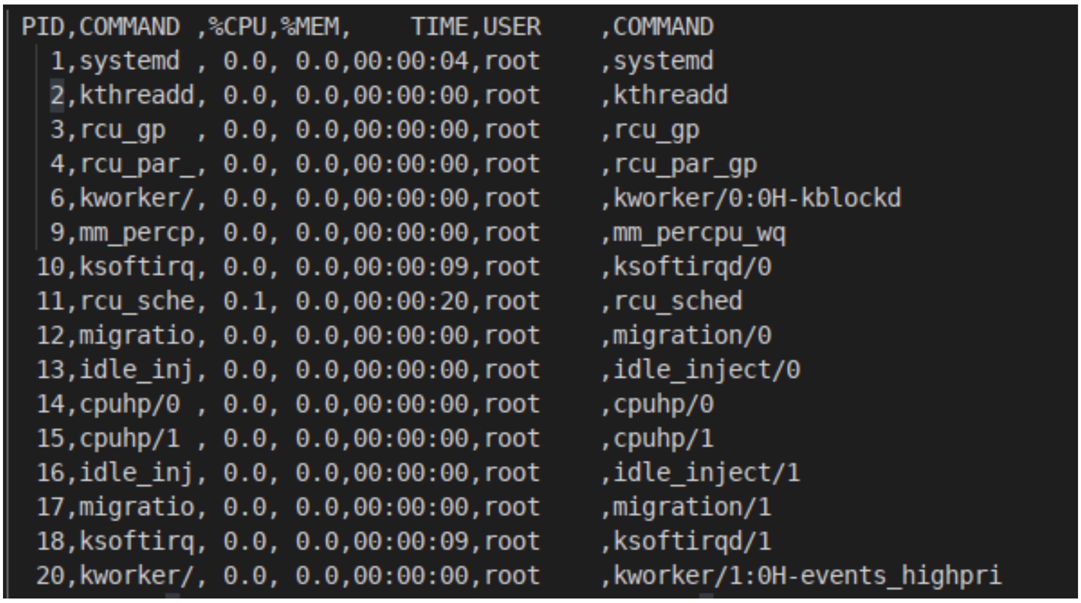


```
USER,TTY,LOGIN@,IDLE,JCPU,PCPU,WHAT
vektor,tty1,10:08,4:08m,7:07,0.02s,/usr/bin/startplasma-x11
vektor,pts/0,10:08,2:34m,0.00s,12.52s,kded5
vektor,tty5,10:05,2:35m,0.08s,0.08s,-bash
vektor,pts/1,10:08,0.00s,9.49s,0.00s,w,-f
vektor,pts/2,10:40,45:35,2.39s,1.97s,/bin/zsh
```

Generating process table:

```
ps -e -o %p, -o fname -o,%C, -o %mem, -o ,%x -o,%U, -o %c | sed 's/^.//g' > p
```

- Generated process csv file



```
PID,COMMAND ,%CPU,%MEM,    TIME,USER     ,COMMAND
  1,systemd , 0.0, 0.0,00:00:04,root     ,systemd
  2,kthreadd, 0.0, 0.0,00:00:00,root     ,kthreadd
  3,rcu_gp  , 0.0, 0.0,00:00:00,root     ,rcu_gp
  4,rcu_par_, 0.0, 0.0,00:00:00,root     ,rcu_par_gp
  6,kworker/, 0.0, 0.0,00:00:00,root     ,kworker/0:0H-kblockd
  9,mm_percp, 0.0, 0.0,00:00:00,root     ,mm_percpu_wq
 10,ksoftirq, 0.0, 0.0,00:00:09,root     ,ksoftirqd/0
 11,rcu_sche, 0.1, 0.0,00:00:20,root     ,rcu_sched
 12,migratio, 0.0, 0.0,00:00:00,root     ,migration/0
 13,idle_inj, 0.0, 0.0,00:00:00,root     ,idle_inject/0
 14,cpuhp/0 , 0.0, 0.0,00:00:00,root     ,cpuhp/0
 15,cpuhp/1 , 0.0, 0.0,00:00:00,root     ,cpuhp/1
 16,idle_inj, 0.0, 0.0,00:00:00,root     ,idle_inject/1
 17,migratio, 0.0, 0.0,00:00:00,root     ,migration/1
 18,ksoftirq, 0.0, 0.0,00:00:09,root     ,ksoftirqd/1
 20,kworker/, 0.0, 0.0,00:00:00,root     ,kworker/1:0H-events_highpri
```

Current machine statistics:

- Total CPU usage:

```
cpu_usage=$(awk -F"," '{x+=$2}END{print x}' ./process.csv)
```

- Current machine total MEM usage:

```
mem_usage=$(awk -F"," '{x+=$3}END{print x}' ./process.csv)
```

- MAC address:

```
mac_addr=$(ifconfig | grep -m1 -o -E '([[:xdigit:]]{1,2}:){5}[[:xdigit:]]{1,2
```

- IP address:

```
ip_addr=$(ifconfig | grep -A 3 "wlp2s0" |grep -m2 -o -E "\b([0-9]{1,3}\.){3}[
```

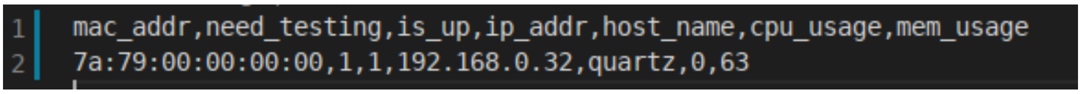
- HostName:

```
host_name=$(cat /proc/sys/kernel/hostname)
```

- Store machines table:

```
echo mac_addr,need_testing,is_up,ip_addr,host_name,cpu_usage,mem_usage > mach
echo $mac_addr,$need_testing,$is_up,$ip_addr,$host_name,$cpu_usage,$mem_usage
```

- Generated machine csv file:



```
mac_addr,need_testing,is_up,ip_addr,host_name,cpu_usage,mem_usage
7a:79:00:00:00:00,1,1,192.168.0.32,quartz,0,63
```

d) Background process

The background process required is stored at background_process.sh. It uses ssh to connect to each machine, execute the formerly listed commands and retrieve the respective table of the machine, using ssh copy "scp":

- /background_process.sh

```
#!/bin/bash

# Exit trap:

function trap_ctrlc() {

    exit 2
}

# Initialize tables:
mysql -u vektor < machinesdb_table_drop.sql
mysql -u vektor < machinesdb_table_create.sql

machines_list={192.168.1.32, 192.168.1.52}
```

```
while :
do

wait(60)

for machine in {machines_list}:
ssh -i "{machine}_key.pem" $machine /bin/bash << EOF
    # Get process table:
    ps -e -o %p, -o fname -o,%C, -o %mem, -o ,%x -o,%U, -o %c | sed 's/^.//g'

    # Get users stats
    w -f| awk '(NR>1)' | tr -s '[:blank:]' ',' > users.csv

    # Get machine stats

    mac_addr=$(ifconfig | grep -m1 -o -E '([[:xdigit:]]{1,2}:){5}[[:xdigit:]]

    ip_addr=$(ifconfig | grep -A 3 "wlp2s0" |grep -m2 -o -E "\b([0-9]{1,3}\.)

    mem_usage=$(awk -F"," '{x+=$3}END{print x}' ./process.csv)

    cpu_usage=$(awk -F"," '{x+=$2}END{print x}' ./process.csv)
    need_testing=1
    is_up=1
    ps_id=32
    users_table_id=2
    host_name=$(cat /proc/sys/kernel/hostname)

    echo mac_addr,need_testing,is_up,ip_addr,host_name,cpu_usage,mem_usage >
    echo $mac_addr,$need_testing,$is_up,$ip_addr,$host_name,$cpu_usage,$mem_u
EOF
scp -i "key_file.pem" $machine_addr: ~/machine_table.csv machine_table_${mach
scp -i "key_file.pem" $machine_addr: ~/process.csv process_${machine}.csv
scp -i "key_file.pem" $machine_addr: ~/users.csv users_${machine}.csv

mysql -u vektor  < insert.sql

done
```

Another important statistics

- The statistic that was also stored is the CPU time consumption of each process. It's important to monitor remote machines lefted at a prolonged processing job.

Alternative implementation

A second implementation not detailed here but with higher scalability and robustness could be implemented by 2 modules: a centralized DB, which runs at the monitor server; and a daemon running in each client machine to be monitored. The last one waits for a GET request. When it's signalized it answers, by DB machine/API, posting a JSON with the previously listed information.

2)

To know whether the decision must be automated or not relies on the difference of time cost to automate it versus the accumulated time consumed on repeating this task. If a task isn't usual or doesn’t consume much time users can even choose not to use the automation. So, when working with a daily scheduled task that spends more than 1 minute, 5 times is enough to decide whether implement automation or not.

3) Containers

I would proceed using containers to encapsulate the application to the compatible kernel. The migration plan would be installing docker, setting up MySQL8 in the container. The former database needs to be backed-up, exporting all the data to inside the database inside the container. Backing up the production machine and then updating its OS is also an alternative.

PART 2: Python

4)

A password validator was implemented to find all the matching characters to the pattern, corresponding to input requirements. After filter characters, join all of them and check if it matches with the specified length. The source code and unit tests are at the pass validator directory.

/pass_validator/pass_validator.py:

```
#!/usr/bin/python3
# -*- coding: utf-8 -*-

import sys
import re

def validator_regex(password, requirements):
    """
    Find all the characters who match the pattern
    corresponding to input requirements.
    After filter characters, join all of them,
    and check if it matches the specified length.



    Args:
        password (str): Password to be validated.
        requirements (List[tuple]): List of rules.

    Returns:
        [bool]: True if password satisfies requirements.
    """
    does_pass=True
    for n_req in requirements:
        (operation, comparation, length) = n_req
        size = {
            '<': r"{,"+rf"{length-1}" + r"}",
            '>': r"{"+ rf"{length+1}"+ r",}",
            '=': r"{"+ rf"{length},"+f"{length}"+r"}"
        }
        req_dict = {
            "LEN": r".",
            "SPECIALS": r"[^a-zA-Z0-9]",
            "LETTERS": r"[a-zA-Z]",
            "NUMBERS": r"[0-9]",
        }
        rule_char = "("+req_dict[operation]+")"
        rule_size = (
            "("+req_dict[operation]+size[comparation]+")")
        match = ''.join(re.findall(rule_char,password))
        match = re.fullmatch(rule_size,match)
        match = "" if match == None else match.string
        does_pass = (does_pass
            and match != None and match != "")

    return does_pass
```

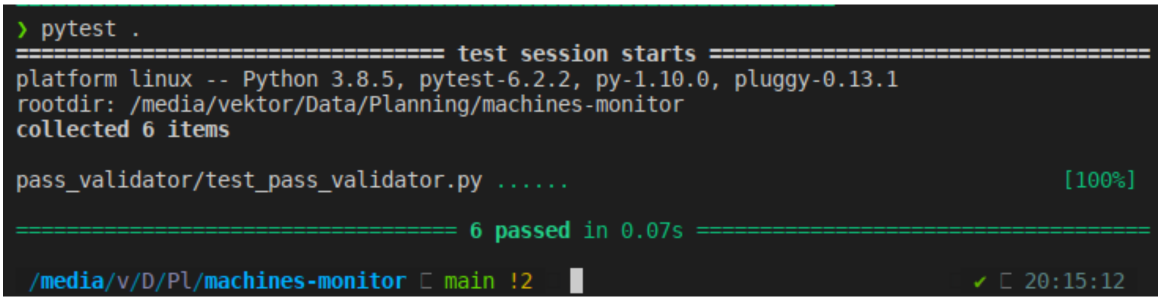
Unit tests:

- /pass_validator/test_pass_validator.py

```
import pytest
from pass_validator import validator_regex
validator=validator_regex

def test_len_gt_fail():
    req = [('LEN', '=', 8), ('SPECIALS', '>', 1)]
    assert validator("12345678!@", req) == False

def test_validator_len_eq_ok():
    req = [('LEN', '=', 8), ('SPECIALS', '>', 1)]
    assert validator("@23a567!", req) == True

def test_spectial_count():
    req = [('LEN', '>', 8), ('SPECIALS', '>', 1), ('LEN', '<', 10)]
    assert validator("123@4567!", req) == True
```

```
def test_validator_gtr():
    req = [('LEN', '>', 8), ('SPECIALS', '>', 1), ('LEN', '<', 10)]
    assert validator("1234567981!", req) == False

def test_validator_eq():
    req = [('LEN', '>', 8), ('SPECIALS', '>', 1), ('LEN', '<', 10)]
    assert validator("123@567!81", req) == False

def test_validator_letters():
    req = [('LETTERS', '>', 2), ('SPECIALS', '>', 1), ('LEN', '<', 10)]
    assert validator("1abc@567!", req) == True
```

Validated behavior:



```
❯ pytest .
=================================== test session starts ====================================
platform linux -- Python 3.8.5, pytest-6.2.2, py-1.10.0, pluggy-0.13.1
rootdir: /media/vektor/Data/Planning/machines-monitor
collected 6 items

pass_validator/test_pass_validator.py ......                                         [100%]

==================================== 6 passed in 0.07s =====================================

 /media/v/D/Pl/machines-monitor  main !2   █                                 ✔  20:15:12
```

PART 3: Quality Assurance

5.)

The main way to guarantee that no new code cannot affect already implemented features is by using automated tests. They can be unit tests or automated structural tests. They must be executed whenever a new commit is done to the main branch.

PART 4: Logic, Common Sense and Scripting

6.)

A simple algorithm was chosen to control the elevator. It assumes an uniform distribution of requests and destinations between the floors:

- The elevator has a capacity of X people.
- As long as there’s someone inside the elevator or in its direction, who wants to go in the current direction, keep heading in that direction.

- Once the elevator has exhausted the requests in its current direction, switch directions if there’s a request in the other direction, if it's not completely loaded yet. Otherwise, stop and wait for a call.

Test 0: No one requested. Stay on the current floor.
Test 1: One person requesting elevator. The elevator is idle, then it must go immediately to the requested floor. Test 2: One person requesting an elevator already in use. The elevator is on the way to the requested floor, it must stop at the requested floor.
Test 3: One person requesting an elevator already in use. If the elevator is NOT in the way of the requested floor, so it must switch direction to the requested floor.
Test 4: X+1 people requesting elevator to go to the first floor. It must attend X peoples and then fetch the last one.
Test 5: X people currently in the elevator. It must stop whenever it reaches a requested destination floor.

7.)

a) It's an implementation of the insertion sort algorithm. It sorts in crescent order and returns the sorted array.

b) Output:

```
5  6  8  12  34  35  38  44  55
```

c) The while loop shifts a large amount of the array whenever it finds a smaller $val. It has a complexity order of O(n²) of swaps and comparisons. It can be improved in the inner loop, thats compares each element with the selected element by the outer loop $var. Since the inner loop covers the sorted section of the list, it's possible to replace this linear search with a binary search method.