

Faculteit Bedrijf en Organisatie

Studie naar de performantie-impact van Spectre/Meltdown patches op Linux voor een typische workload van	an
een webserver	

Karel Willems

Scriptie voorgedragen tot het bekomen van de graad van professionele bachelor in de toegepaste informatica

Promotor: Karine Van Driessche Co-promotor: Bert Van Vreckem

Instelling: —

Academiejaar: 2017-2018

Tweede examenperiode

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.1 Bijlage Ansible

.1.1 Grub file voor het uitschakelen van Spectre/Meltdown patch

```
GRUB_DEFAULT=0
GRUB_HIDDEN_TIMEOUT=0
GRUB_HIDDEN_TIMEOUT_QUIET=true
GRUB_TIMEOUT=0
GRUB_DISTRIBUTOR='lsb_release -i -s 2> /dev/null || echo Debian'
GRUB_CMDLINE_LINUX_DEFAULT="console=tty1_console=tty0_spectre_v2=off_nopti"
GRUB_CMDLINE_LINUX="spectre_v2=off_nopti"
```

.1.2 Configureren van grub

```
#copy /etc/default/grub
- name: copy grub config
become: yes
copy:
src: files/grub
dest: /etc/default/grub
owner: root
group: root
mode: 0644
- name: update grub
become: yes
command: update-grub
– name: Restart server
become: yes
command: reboot
ignore_errors: true
```

.1.3 Setup Apache en Drupal

```
# tasks file for drupal.role
- include_tasks: "setup_apache.yml"
- include_tasks: "setup_php.yml"

- name: enable libapache2-mod-php5
become: yes
command: >
a2enmod php5
notify: restart apache

- name: Install drush
```

```
become: yes
apt: "name=drush_state=installed"
- name: Install php gd
become: yes
apt: "name=php5-gdustate=installed"
- name: downloading the last version of drupal into a
   folder
command: >
drush dl drupal -7.57
- name: Install Drupal with drush
ignore_errors: yes
command: >
sudo drush -y site-install --db-url=mysql://root
   :root@localhost:3306/drupaldb --root="/home/vagrant/
   drupal -7.57"
– name: Copy vhost
copy: src=files/000-default.conf dest=/etc/apache2/sites-
   available/000 - default.conf
#owner=root group=root mode=0644
- name: Copy ssl vhost
copy: src=files/default-ssl.conf dest=/etc/apache2/sites-
   available / default - ssl.conf
#owner=root group=root mode=0644
- name: reload apache.
command: >
service apache2 reload
become: yes
# enable clean urls
- name: enable apache rewrite mod
become: yes
command: >
a2enmod rewrite
notify: restart apache
```

.1.4 Setup MySQL

```
# tasks file for mysql.role
- include_tasks: "setup_mysql.yml"
- name: Copy my.cnf global MySQL configuration.
template:
src: my.cnf.j2
dest: "/etc/mysql/my.cnf"
owner: root
group: root
mode: 0644
notify: restart mysql
- name: root password is present
mysql_user: name=root host={{item}}} password={{
   mysql_root_password }} state=present
with_items:
- '::1'
- '127.0.0.1'
- 'localhost'
- name: install .my.cnf with credentials
template: src = .my. cnf. j2 dest = /root /.my. cnf
mode=0400
- name: Create the directory /etc/mysql/conf.d
file: path = /etc/mysql/conf.d state = directory
notify:

    restart mysql

- name: Start the mysql services
service: name=mysql state=started enabled=yes
- name: Create the database
become: yes
mysql_db: name=drupaldb state=present
- name: grant
mysql_user:
name: drupal
```

host: 192.168.33.1
password: 'drupal'
priv: '*.*:ALL,GRANT'
state: present

.1.5 Config redis

```
daemonize yes
pidfile /var/run/redis.pid
port {{ redis_port }}
bind {{ redis_bind }}
timeout 0
tcp-keepalive 0
loglevel notice
logfile ""
syslog-enabled {{ syslog_bool }}
databases {{ databases }}
save 900 1
save 300 10
save 60 10000
stop-writes-on-bgsave-error yes
rdbcompression yes
rdbchecksum yes
dbfilename {{ dbfilename }}
dir ./
slave-serve-stale-data yes
slave-read-only yes
repl-disable-tcp-nodelay no
slave-priority 100
{% if requirepass %}
requirepass {{ redis_pass }}
{% endif %}
appendonly no
appendfilename "appendonly.aof"
appendfsync everysec
no-appendfsync-on-rewrite no
auto-aof-rewrite-percentage 100
auto-aof-rewrite-min-size 64mb
lua-time-limit 5000
slowlog-log-slower-than 10000
slowlog-max-len 128
notify-keyspace-events ""
hash-max-ziplist-entries 512
hash-max-ziplist-value 64
list-max-ziplist-entries 512
list-max-ziplist-value 64
set-max-intset-entries 512
zset-max-ziplist-entries 128
```

```
zset-max-ziplist-value 64
activerehashing yes
client-output-buffer-limit normal 0 0 0
client-output-buffer-limit slave 256mb 64mb 60
client-output-buffer-limit pubsub 32mb 8mb 60
hz 10
aof-rewrite-incremental-fsync yes
```

.2 Bijlage Vagrant

.2.1 Vagrantfile

```
\# -*- mode: ruby -*-
# vi: set ft = ruby:
serverpatched =
{ :hostname => 'webpatched', :ip => '192.168.33.100', :box
  => 'ubuntu/trusty64' }
servervulnerable =
{ :hostname => 'webvulnerable', :ip => '192.168.33.101', :
  box => 'ubuntu/trusty64' }
loadgenerator =
{ :hostname => 'loadgenerator', :ip => '192.168.33.102', :
  box => 'ubuntu/trusty64' }
Vagrant.configure ("2") do | config |
# The most common configuration options are documented and
  commented below.
# For a complete reference, please see the online
  documentation at
# https://docs.vagrantup.com.
# Every Vagrant development environment requires a box. You
   can search for
# boxes at https://vagrantcloud.com/search.
\#config.vm.box = "ubuntu/artful64"
config.vm.define serverpatched[:hostname] do |configpatched
        configpatched.vm.box = serverpatched[:box]
```

```
configpatched.vm.hostname = serverpatched[:hostname
        configpatched.vm.network : private_network , ip:
           serverpatched [: ip]
end
config.vm.define servervulnerable[:hostname] do |
   configvulnerable |
        configvulnerable.vm.box = servervulnerable[:box]
        configvulnerable.vm.hostname = servervulnerable[:
           hostname]
        configvulnerable.vm.network : private_network , ip:
           servervulnerable [: ip]
end
config.vm.define loadgenerator[:hostname] do |
   configloadgenerator
        configloadgenerator.vm.box = loadgenerator[:box]
        configloadgenerator.vm.hostname = loadgenerator[:
           hostname]
        configloadgenerator.vm.network : private_network , ip
           : loadgenerator [: ip]
end
# config.vm.network "forwarded_port", guest: 80, host:
  8080, host_ip: "127.0.0.1"
config.vm.provider "virtualbox" do |vb|
# Display the VirtualBox GUI when booting the machine
#vb.gui = true
# Customize the amount of memory on the VM:
vb.memory = "1024"
end
config.vm.provision "ansible" do |ansible|
```

```
ansible.compatibility_mode = 'auto'
#ansible.verbose = "vvvv"
ansible.playbook = "provisioning/playbook.yml"
ansible.inventory_path = "provisioning/inventory"
```

end

end

.3 Ruwe resultaten

.3.1 Apache benchmark van systeem met patches

Listing 1: Eerste 50 resultaten

	Listing 1.	Leiste 50	resurtaten	L			
seco	onds ctime	dtime	ttime	wait			
13:44:42	2018	15253550	082	0	14	14	14
13:44:35	2018	15253550)75	0	14	14	14
13:44:35	2018	15253550)75	0	14	14	14
13:44:40	2018	15253550	080	0	14	14	14
13:44:45	2018	15253550)85	0	14	14	14
13:44:46	2018	15253550)86	0	14	14	14
13:44:39	2018	15253550)79	0	14	14	14
13:44:45	2018	15253550)85	0	14	14	14
13:44:39	2018	15253550)79	0	14	14	14
13:44:46	2018	15253550)86	0	14	14	14
13:44:45	2018	15253550)85	0	14	14	14
13:44:37	2018	15253550)77	0	14	14	14
13:44:42	2018	15253550)82	0	14	14	14
13:44:37	2018	15253550)77	0	14	14	14
13:44:45	2018	15253550)85	0	14	14	14
13:44:38	2018	15253550)78	0	14	14	14
13:44:36	2018	15253550)76	0	14	14	14
13:44:33	2018	15253550)73	0	14	14	14
13:44:40	2018	15253550	080	0	14	14	14
13:44:46	2018	15253550)86	0	14	14	14
13:44:40	2018	15253550	080	0	14	14	14
13:44:45	2018	15253550)85	0	14	14	14
13:44:45	2018	15253550)85	0	14	14	14
13:44:36	2018	15253550)76	0	14	14	14
13:44:33	2018	15253550)73	0	14	14	14
13:44:40	2018	15253550	080	0	14	14	14
13:44:40	2018	15253550	080	0	14	14	14
13:44:46	2018	15253550)86	0	14	15	14
13:44:35	2018	15253550)75	0	14	15	14
13:44:45	2018	15253550)85	0	14	15	14
13:44:47	2018	15253550)87	0	14	15	14
13:44:45	2018	15253550)85	0	14	15	14
13:44:36	2018	15253550)76	0	14	15	14
13:44:35	2018	15253550)75	0	14	15	14
13:44:43	2018	15253550)83	0	14	15	14
13:44:45	2018	15253550)85	0	14	15	14
13:44:37	2018	15253550)77	0	14	15	14
13:44:35	2018	15253550)75	0	14	15	14
13:44:41	2018	15253550	081	0	14	15	14
	13:44:42 13:44:35 13:44:45 13:44:45 13:44:45 13:44:45 13:44:45 13:44:45 13:44:45 13:44:45 13:44:45 13:44:37 13:44:45 13:44:40 13:44:40 13:44:45	seconds ctime 13:44:42 2018 13:44:35 2018 13:44:40 2018 13:44:45 2018 13:44:45 2018 13:44:45 2018 13:44:45 2018 13:44:45 2018 13:44:45 2018 13:44:45 2018 13:44:45 2018 13:44:45 2018 13:44:45 2018 13:44:45 2018 13:44:45 2018 13:44:45 2018 13:44:45 2018 13:44:45 2018 13:44:45 2018 13:44:46 2018 13:44:46 2018 13:44:46 2018 13:44:40 2018 13:44:40 2018 13:44:45 2018 13:44:45 2018 13:44:45 2018 13:44:45 2018 13:44:45 2018 13:44:45 2018 13:44:46 2018 13:44:46 2018 13:44:46 2018 13:44:45 2018 13:44:46 2018 13:44:45 2018 13:44:35 2018 13:44:35 2018 13:44:35 2018	seconds ctime dtime 13:44:42 2018 15253550 13:44:35 2018 15253550 13:44:35 2018 15253550 13:44:40 2018 15253550 13:44:45 2018 15253550 13:44:46 2018 15253550 13:44:39 2018 15253550 13:44:45 2018 15253550 13:44:45 2018 15253550 13:44:47 2018 15253550 13:44:47 2018 15253550 13:44:48 2018 15253550 13:44:49 2018 15253550 13:44:49 2018 15253550 13:44:40 2018 15253550 13:44:40 2018 15253550 13:44:40 2018 15253550 13:44:40 2018 15253550 13:44:45 2018 15253550 13:44:45 2018 15253550 13:44:45 2018 15253550 13:44:45 2018 15253550 13:44:46 2018 15253550 13:44:45 2018 15253550 13:44:45 2018 15253550 13:44:45 2018 15253550 <	seconds ctime dtime ttime 13:44:42 2018 1525355082 13:44:35 2018 1525355075 13:44:35 2018 1525355080 13:44:40 2018 1525355085 13:44:45 2018 1525355086 13:44:49 2018 1525355085 13:44:49 2018 1525355079 13:44:49 2018 1525355085 13:44:49 2018 1525355085 13:44:40 2018 1525355085 13:44:47 2018 1525355085 13:44:47 2018 1525355085 13:44:45 2018 1525355085 13:44:43 2018 1525355085 13:44:43 2018 1525355085 13:44:45 2018 1525355085 13:44:45 2018 1525355085 13:44:40 2018 1525355085 13:44:40 2018 1525355086 13:44:45 2018 1525355085 13:44:45 2	13:44:42 2018 1525355082 0 13:44:35 2018 1525355075 0 13:44:35 2018 1525355085 0 13:44:40 2018 1525355080 0 13:44:45 2018 1525355085 0 13:44:46 2018 1525355086 0 13:44:45 2018 1525355085 0 13:44:45 2018 1525355086 0 13:44:49 2018 1525355086 0 13:44:45 2018 1525355086 0 13:44:46 2018 1525355086 0 13:44:45 2018 1525355086 0 13:44:47 2018 1525355085 0 13:44:42 2018 1525355087 0 13:44:43 2018 1525355085 0 13:44:35 2018 1525355085 0 13:44:43 2018 1525355085 0 13:44:36 2018 1525355085 0 13:44:33 2018 1525355085 0 1	Seconds ctime	Seconds ctime Seconds Seconds

Thu	May	03	13:44:43	2018	1525355083	0	14	15	14
Thu	May	03	13:44:47	2018	1525355087	0	14	15	14
Thu	May	03	13:44:43	2018	1525355083	0	14	15	14
Thu	May	03	13:44:38	2018	1525355078	1	14	15	14
Thu	May	03	13:44:45	2018	1525355085	0	14	15	14
Thu	May	03	13:44:37	2018	1525355077	0	14	15	14
Thu	May	03	13:44:47	2018	1525355087	0	14	15	14
Thu	May	03	13:44:34	2018	1525355074	0	14	15	14
Thu	May	03	13:44:47	2018	1525355087	0	14	15	14
Thu	May	03	13:44:37	2018	1525355077	0	14	15	14
Thu	May	03	13:44:45	2018	1525355085	0	14	15	14

.3.2 Apache benchmark van systeem zonder patches

Listing 2: Eerste 50 resultaten

	Listing 2.	Leibte 50	resurtater				
seco	onds ctime	dtime	ttime	wait			
13:44:52	2018	15253550)92	0	10	11	10
13:44:49	2018	15253550)89	0	12	12	12
13:44:55	2018	15253550)95	0	13	13	13
13:44:51	2018	15253550)91	0	13	13	13
13:44:48	2018	15253550	88(0	13	13	13
13:44:53	2018	15253550)93	0	13	13	13
13:44:52	2018	15253550)92	0	13	13	13
13:44:59	2018	15253550)99	0	13	13	13
13:44:53	2018	15253550)93	0	13	13	13
13:44:51	2018	15253550)91	0	13	13	13
13:45:02	2018	15253551	102	0	13	13	13
13:44:52	2018	15253550)92	0	13	13	13
13:44:58	2018	15253550)98	0	13	13	13
13:44:52	2018	15253550)92	0	13	13	13
13:44:49	2018	15253550)89	0	13	13	13
13:44:59	2018	15253550)99	0	13	13	13
13:44:52	2018	15253550)92	0	13	13	13
13:45:01	2018	15253551	101	0	13	13	13
13:44:53	2018	15253550)93	0	13	13	13
13:44:55	2018	15253550)95	0	13	13	13
13:44:59	2018	15253550)99	0	13	13	13
13:44:48	2018	15253550	88(0	13	13	13
13:44:54	2018	15253550)94	0	13	13	13
13:44:52	2018	15253550)92	0	13	13	13
13:44:55	2018	15253550)95	0	13	13	13
13:44:52	2018	15253550)92	0	13	13	13
13:44:59	2018	15253550)99	0	13	13	13
13:44:51	2018	15253550)91	0	13	13	13
13:44:59	2018	15253550)99	0	13	13	13
13:44:54	2018	15253550)94	0	13	13	13
13:45:02	2018	15253551	102	0	13	13	13
13:44:49	2018	15253550)89	0	13	13	13
13:44:52	2018	15253550)92	0	13	13	13
13:44:59	2018	15253550)99	0	13	13	13
13:44:53	2018	15253550)93	0	13	13	13
13:44:52	2018	15253550)92	0	13	13	13
13:44:48	2018	15253550	88(0	13	13	13
13:44:56	2018	15253550)96	0	13	13	13
13:44:53	2018	15253550)93	0	13	13	13
	13:44:52 13:44:51 13:44:53 13:44:53 13:44:59 13:44:51 13:44:51 13:44:52 13:44:52 13:44:52 13:44:59 13:44:53 13:44:53 13:44:55 13:44:55 13:44:55 13:44:55 13:44:55 13:44:55 13:44:55 13:44:55 13:44:55 13:44:55 13:44:55 13:44:55 13:44:55 13:44:55 13:44:59 13:44:59 13:44:59 13:44:59 13:44:59 13:44:59 13:44:59 13:44:59 13:44:59 13:44:59 13:44:59 13:44:59 13:44:59 13:44:59 13:44:59 13:44:59 13:44:59 13:44:55 13:44:59 13:44:59 13:44:59 13:44:59 13:44:55	seconds ctime 13:44:52 2018 13:44:49 2018 13:44:55 2018 13:44:51 2018 13:44:53 2018 13:44:59 2018 13:44:51 2018 13:44:51 2018 13:44:52 2018 13:44:52 2018 13:44:52 2018 13:44:52 2018 13:44:52 2018 13:44:52 2018 13:44:59 2018 13:44:59 2018 13:44:59 2018 13:44:59 2018 13:44:59 2018 13:44:55 2018 13:44:55 2018 13:44:55 2018 13:44:55 2018 13:44:55 2018 13:44:55 2018 13:44:55 2018 13:44:55 2018 13:44:55 2018 13:44:55 2018 13:44:55 2018 13:44:55 2018 13:44:55 2018 13:44:59 2018	seconds ctime dtime 13:44:52 2018 15253550 13:44:49 2018 15253550 13:44:55 2018 15253550 13:44:51 2018 15253550 13:44:48 2018 15253550 13:44:53 2018 15253550 13:44:59 2018 15253550 13:44:59 2018 15253550 13:44:51 2018 15253550 13:44:52 2018 15253550 13:44:52 2018 15253550 13:44:59 2018 15253550 13:44:59 2018 15253550 13:44:59 2018 15253550 13:44:59 2018 15253550 13:44:59 2018 15253550 13:44:59 2018 15253550 13:44:59 2018 15253550 13:44:59 2018 15253550 13:44:59 2018 15253550 13:44:59 2018 15253550 13:44:59 2018 15253550 13:44:59 2018 15253550 13:44:59 2018 15253550 13:44:59 2018 15253550 13:44:59 2018 15253550 <	seconds ctime dtime ttime 13:44:52 2018 1525355092 13:44:49 2018 1525355089 13:44:55 2018 1525355095 13:44:51 2018 1525355091 13:44:48 2018 1525355093 13:44:52 2018 1525355092 13:44:59 2018 1525355092 13:44:51 2018 1525355093 13:44:52 2018 1525355093 13:44:52 2018 1525355092 13:44:52 2018 1525355093 13:44:52 2018 1525355092 13:44:52 2018 1525355092 13:44:52 2018 1525355092 13:44:59 2018 1525355092 13:44:59 2018 1525355092 13:44:50 2018 1525355092 13:44:50 2018 1525355092 13:44:50 2018 1525355093 13:44:50 2018 1525355093 13:44:52 2	seconds ctime dtime ttime wait 13:44:52 2018 1525355092 0 13:44:49 2018 1525355089 0 13:44:55 2018 1525355095 0 13:44:51 2018 1525355091 0 13:44:48 2018 1525355093 0 13:44:52 2018 1525355092 0 13:44:59 2018 1525355099 0 13:44:51 2018 1525355099 0 13:44:52 2018 1525355099 0 13:44:51 2018 1525355091 0 13:44:52 2018 1525355092 0 13:44:52 2018 1525355092 0 13:44:52 2018 1525355092 0 13:44:54 2018 1525355092 0 13:44:59 2018 1525355092 0 13:44:50 2018 1525355099 0 13:44:59 2018 1525355099 0 <td>13:44:52 2018 1525355092 0 10 13:44:49 2018 1525355089 0 12 13:44:51 2018 1525355095 0 13 13:44:51 2018 1525355091 0 13 13:44:53 2018 1525355088 0 13 13:44:53 2018 1525355092 0 13 13:44:59 2018 1525355099 0 13 13:44:51 2018 1525355093 0 13 13:44:52 2018 1525355099 0 13 13:44:51 2018 1525355093 0 13 13:44:52 2018 1525355091 0 13 13:44:52 2018 1525355092 0 13 13:44:52 2018 1525355092 0 13 13:44:59 2018 1525355092 0 13 13:44:59 2018 1525355092 0 13 13:44:50 2018 1525355099 0 13 13:44:50 2018<td> Seconds ctime</td></td>	13:44:52 2018 1525355092 0 10 13:44:49 2018 1525355089 0 12 13:44:51 2018 1525355095 0 13 13:44:51 2018 1525355091 0 13 13:44:53 2018 1525355088 0 13 13:44:53 2018 1525355092 0 13 13:44:59 2018 1525355099 0 13 13:44:51 2018 1525355093 0 13 13:44:52 2018 1525355099 0 13 13:44:51 2018 1525355093 0 13 13:44:52 2018 1525355091 0 13 13:44:52 2018 1525355092 0 13 13:44:52 2018 1525355092 0 13 13:44:59 2018 1525355092 0 13 13:44:59 2018 1525355092 0 13 13:44:50 2018 1525355099 0 13 13:44:50 2018 <td> Seconds ctime</td>	Seconds ctime

Thu	May	03	13:44:48	2018	1525355088	0	13	13	13
Thu	May	03	13:44:52	2018	1525355092	0	13	13	13
Thu	May	03	13:44:54	2018	1525355094	0	13	13	13
Thu	May	03	13:44:57	2018	1525355097	0	13	13	13
Thu	May	03	13:44:51	2018	1525355091	0	13	13	13
Thu	May	03	13:44:54	2018	1525355094	0	13	13	13
Thu	May	03	13:44:58	2018	1525355098	0	13	13	13
Thu	May	03	13:44:59	2018	1525355099	0	13	13	13
Thu	May	03	13:44:52	2018	1525355092	0	13	13	13
Thu	May	03	13:44:54	2018	1525355094	0	13	13	13
Thu	May	03	13:44:52	2018	1525355092	0	13	13	13

.3.3 Autobench benchmark van systeem met patches

Listing 3: Eerste 50 resultaten

			8 - 1						
dem_req									_rate_192.168.3
20	20.3	20.3	0.0	0.0	0.0	0.0	454.6	158.0	0
22	22.3	22.3	0.0	0.0	0.0	0.0	16.7	173.8	0
24	24.3	24.3	0.0	0.0	0.0	0.0	16.3	189.4	0
26	26.3	26.3	0.0	0.0	0.0	0.0	14.4	204.8	0
28	28.3	28.3	0.0	0.0	0.0	0.0	15.6	220.7	0
30	30.3	30.3	0.0	0.0	0.0	0.0	14.9	236.3	0
32	32.3	32.3	0.0	0.0	0.0	0.0	14.7	251.9	0
34	34.3	34.3	0.0	0.0	0.0	0.0	14.9	267.4	0
36	36.3	36.3	0.0	0.0	0.0	0.0	14.9	283.2	0
38	38.3	38.3	0.0	0.0	0.0	0.0	14.9	298.4	0
40	40.1	40.1	0.0	0.0	0.0	0.0	14.5	312.7	0
42	42.3	42.3	0.0	0.0	0.0	0.0	14.5	329.7	0
44	44.3	44.3	0.0	0.0	0.0	0.0	15.1	345.3	0
46	46.3	46.3	0.0	0.0	0.0	0.0	15.1	360.9	0
48	48.3	48.3	0.0	0.0	0.0	0.0	15.0	376.5	0
50	50.2	50.2	0.0	0.0	0.0	0.0	14.7	391.5	0
52	52.2	52.2	0.0	0.0	0.0	0.0	14.5	406.9	0
54	54.2	54.2	0.0	0.0	0.0	0.0	14.6	422.7	0
56	56.1	56.1	0.0	0.0	0.0	0.0	14.6	437.5	0
58	58.2	58.2	0.0	0.0	0.0	0.0	14.9	453.3	0
60	60.1	60.1	0.0	0.0	0.0	0.0	14.8	468.4	0
62	60.2	60.2	0.0	0.0	0.0	0.0	35.8	469.5	0
64	59.8	59.8	0.0	0.0	0.0	0.0	92.6	466.2	0
66	60.8	60.8	0.0	0.0	0.0	0.0	83.5	474.0	0
68	59.7	59.7	0.0	0.0	0.0	0.0	110.2	465.6	0
70	57.4	57.4	0.0	0.0	0.0	0.0	144.9	447.0	0
72	54.6	54.6	0.0	0.0	0.0	0.0	166.4	425.8	0
74	54.9	54.9	0.0	0.0	0.0	0.0	180.3	427.7	0
76	52.6	52.6	0.0	0.0	0.0	0.0	344.9	409.8	0
78	41.8	41.8	0.0	0.0	0.0	0.0	637.4	326.1	0
80	56.2	56.2	0.0	0.0	0.0	0.0	330.3	437.9	0
82	57.7	57.7	0.0	0.0	0.0	0.0	317.0	449.4	0
84	56.8	56.8	0.0	0.0	0.0	0.0	351.7	442.5	0
86	56.1	56.1	0.0	0.0	0.0	0.0	374.2	437.4	0
88	57.0	57.0	0.0	0.0	0.0	0.0	366.0	444.0	0
90	57.6	57.6	0.0	0.0	0.0	0.0	363.0	448.7	0
92	56.6	56.6	0.0	0.0	0.0	0.0	375.1	441.2	0
94	55.0	55.0	0.0	0.0	0.0	0.0	388.3	428.7	0
96	52.9	52.9	0.0	0.0	0.0	0.0	454.6	412.0	0
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									_
98	53.7	53.7	0.0	0.0	0.0	0.0	504.9	418.3	0
98	33.1	33.1	0.0	0.0	0.0	0.0	304.9	410.3	0
100	49.7	49.7	0.0	0.0	0.0	0.0	597.0	387.4	0
102	57.0	57.0	0.0	0.0	0.0	0.0	476.2	444.1	0
104	57.9	57.9	0.0	0.0	0.0	0.0	469.7	451.5	0
106	58.0	58.0	0.0	0.0	0.0	0.0	489.1	452.2	0
108	57.3	57.3	0.0	0.0	0.0	0.0	503.6	446.6	0
110	57.2	57.2	0.0	0.0	0.0	0.0	503.1	445.9	0
112	56.4	56.4	0.0	0.0	0.0	0.0	506.0	439.6	0
114	57.7	57.7	0.0	0.0	0.0	0.0	511.0	450.1	0
116	55.9	55.9	0.0	0.0	0.0	0.0	556.6	435.4	0
118	56.9	56.9	0.0	0.0	0.0	0.0	537.6	443.4	0

.3.4 Autobench benchmark van systeem zonder patches

Listing 4: Eerste 50 resultaten

			_	Leiste 30					
dem_req		-						-	_rate_192.168.3
20	20.3	20.3	0.0	0.0	0.0	0.0	435.2	158.0	0
22	22.3	22.3	0.0	0.0	0.0	0.0	13.9	173.9	0
24	24.3	24.3	0.0	0.0	0.0	0.0	14.0	189.5	0
26	26.3	26.3	0.0	0.0	0.0	0.0	13.7	204.9	0
28	28.3	28.3	0.0	0.0	0.0	0.0	14.4	220.9	0
30	30.3	30.3	0.0	0.0	0.0	0.0	14.2	236.3	0
32	32.4	32.4	0.0	0.0	0.0	0.0	14.4	252.3	0
34	34.3	34.3	0.0	0.0	0.0	0.0	13.7	267.6	0
36	36.2	36.2	0.0	0.0	0.0	0.0	14.0	282.0	0
38	38.4	38.4	0.0	0.0	0.0	0.0	13.6	298.9	0
40	40.4	40.4	0.0	0.0	0.0	0.0	13.7	314.5	0
42	42.3	42.3	0.0	0.0	0.0	0.0	13.6	330.0	0
44	44.3	44.3	0.0	0.0	0.0	0.0	13.9	345.3	0
46	46.3	46.3	0.0	0.0	0.0	0.0	14.0	360.9	0
48	48.2	48.2	0.0	0.0	0.0	0.0	13.9	376.0	0
50	50.2	50.2	0.0	0.0	0.0	0.0	14.0	391.2	0
52	52.3	52.3	0.0	0.0	0.0	0.0	14.1	407.5	0
54	54.1	54.1	0.0	0.0	0.0	0.0	14.1	421.5	0
56	56.2	56.2	0.0	0.0	0.0	0.0	14.1	437.9	0
58	58.1	58.1	0.0	0.0	0.0	0.0	13.9	452.8	0
60	60.1	60.1	0.0	0.0	0.0	0.0	14.5	468.5	0
62	62.1	62.1	0.0	0.0	0.0	0.0	15.2	484.1	0
64	64.1	64.1	0.0	0.0	0.0	0.0	13.8	499.7	0
66	66.1	66.1	0.0	0.0	0.0	0.0	13.9	515.0	0
68	68.0	68.0	0.0	0.0	0.0	0.0	14.2	530.2	0
70	64.9	64.9	0.0	0.0	0.0	0.0	61.1	505.6	0
72	64.7	64.7	0.0	0.0	0.0	0.0	83.3	504.5	0
74	63.0	63.0	0.0	0.0	0.0	0.0	148.9	490.9	0
76	64.8	64.8	0.0	0.0	0.0	0.0	126.7	504.7	0
78	62.1	62.1	0.0	0.0	0.0	0.0	158.6	483.9	0
80	62.2	62.2	0.0	0.0	0.0	0.0	166.7	484.7	0
82	63.3	63.3	0.0	0.0	0.0	0.0	179.2	493.2	0
84	60.6	60.6	0.0	0.0	0.0	0.0	252.4	471.9	0
86	62.5	62.5	0.0	0.0	0.0	0.0	221.0	487.1	0
88	61.6	61.6	0.0	0.0	0.0	0.0	237.4	480.4	0
90	61.2	61.2	0.0	0.0	0.0	0.0	249.3	476.9	0
92	63.0	63.0	0.0	0.0	0.0	0.0	249.1	491.2	0
94	59.7	59.7	0.0	0.0	0.0	0.0	324.4	465.2	0
96	62.9	62.9	0.0	0.0	0.0	0.0	290.8	490.2	0

98	58.1	58.1	0.0	0.0	0.0	0.0	342.8	452.5	0
100	58.6	58.6	0.0	0.0	0.0	0.0	337.0	456.5	0
102	57.0	57.0	0.0	0.0	0.0	0.0	348.4	443.9	0
104	59.8	59.8	0.0	0.0	0.0	0.0	358.2	465.9	0
106	61.5	61.5	0.0	0.0	0.0	0.0	355.1	479.1	0
108	61.0	61.0	0.0	0.0	0.0	0.0	361.7	475.4	0
110	63.3	63.3	0.0	0.0	0.0	0.0	340.2	493.2	0
112	61.8	61.8	0.0	0.0	0.0	0.0	355.8	481.3	0
114	62.2	62.2	0.0	0.0	0.0	0.0	363.2	484.5	0
116	60.4	60.4	0.0	0.0	0.0	0.0	396.0	470.7	0
118	61.8	61.8	0.0	0.0	0.0	0.0	377.5	481.8	0

.3.5 Redis benchmark van systeem met patches

```
"PING_INLINE","5688.28"
```

.3.6 Redis benchmark van systeem zonder patches

```
"PING_INLINE","6729.48"
```

[&]quot;SET","5740.53"

[&]quot;GET", "5561.74"

[&]quot;INCR","5399.57"

[&]quot;LPUSH","5875.44"

[&]quot;LPOP","7434.94"

[&]quot;SADD","10928.96"

[&]quot;SPOP","11389.52"

[&]quot;SET","6798.10"

[&]quot;GET","6684.49"

[&]quot;INCR","6920.42"

[&]quot;LPUSH","6891.80"

[&]quot;LPOP","6988.12"

[&]quot;SADD", "6770.48"

[&]quot;SPOP","6281.41"

.3.7 Vmstat tool van systeem met patches

Listing 5: Eerste 50 resultaten

nr	ncs -		me							_ s v s	tem —			cn11	
r	b		free		cache		so so			in				id wa	
11	0		334156		382460	0	0	697	511		5 2578				3.0
3	0				, 202.00	Ü	Ü	0,7	011					, 00	
3	0	0	325904	25420	382460	0	0	0	0	927	6921	59	28	13	
0	0		,												
3	0	0	330268	25428	382456	0	0	0	120	807	5900	41	20	40	
0	0														
3	0	0	335052	25428	382468	0	0	0	0	812	5871	42	16	42	
0	0														
2	0	0	339792	25428	382472	0	0	0	0	844	5891	40	17	43	
0	0														
1	0	0	339848	25428	382476	0	0	0	0	824	5864	43	17	40	
0	0														
0	0	0	339848	25428	382480	0	0	0	0	796	5805	42	14	44	
0	0														
0	0	0	339848	25436	382476	0	0	0	12	827	5851	40	17	43	
0	0														
0	0	0	339848	25436	382488	0	0	0	0	784	5835	44	13	44	
0	0														
1	0	0	339848	25436	382492	0	0	0	0	836	5874	40	20	39	
0	0														
0	0	0	339848	25436	382496	0	0	0	0	803	5820	42	14	44	
0	0														
0	0	0	339848	25436	382500	0	0	0	0	803	5826	40	16	44	
0	0														
0	0	0	339848	25444	382492	0	0	0	12	821	5869	46	11	43	
0	0	0	220040	25111	202504	0	0	0	0	0.02	50.40	4.0	1.0	4.0	
0	0	U	339848	25444	382504	0	0	0	0	802	5842	40	18	42	
0	0	0	220044	25111	202500	0	0	0	0	0.46	5061	20	1.0	10	
0	0	U	339844	25444	382508	0	0	0	0	846	5864	39	19	42	
0	0	0	220040	25444	382512	0	0	0	0	021	5827	20	10	12	
0	0	U	339848	23444	382312	0	0	0	0	034	3821	39	10	43	
0	0	0	339848	25444	382516	0	0	0	0	822	5839	28	10	13	
0	0	U	337040	23444	362310	U	U	U	U	022	3639	30	19	43	
0	0	0	339848	25452	382512	0	0	0	12	827	5852	40	10	42	
0	0	U	337040	23732	302312	U	O	U	12	021	3632	70	1)	72	
0	0	0	339848	25452	382524	0	0	0	0	849	5848	42	17	42	
0	0	Ü	557010	20 102	30232.	Ü	Ü	Ü	Ü	017	20.0		• ′		
0	0	0	339848	25452	382528	0	0	0	0	806	5832	40	18	42	
0	0	Ü	0000.0	20.02	002020	Ü	Ü	Ü		000	2002		- 0		
0	0	0	339848	25452	382532	0	0	0	0	833	5870	38	20	42	
0	0														
0	0	0	339848	25452	382536	0	0	0	0	813	5860	42	17	42	
0	0														
0	0	0	339848	25460	382532	0	0	0	116	839	5857	39	19	42	
0	0														
0	0	0	339848	25460	382544	0	0	0	0	835	5833	40	19	42	
0	0														
0	0	0	339848	25460	382548	0	0	0	0	842	5857	38	19	43	
0	0														
0	0	0	339848	25460	382548	0	0	0	0	822	5849	40	19	40	

0	0													
1	0	0	339848	25460	382552	0	0	0	0	847	5858	40	21	39
0	0													
1	0	0	339848	25468	382548	0	0	0	12	840	5874	35	23	42
0	0	0	339840	25468	382560	0	0	0	0	830	5881	22	23	44
0	0	U	339040	23400	362300	U	U	U	U	830	3001	33	23	44
3	0	0	339848	25468	382564	0	0	0	0	830	5911	38	21	41
0	0													
2	0	0	339848	25468	382568	0	0	0	0	831	5957	39	21	40
0	0													
1	0	0	339848	25468	382572	0	0	0	0	857	5863	38	21	41
0	0	0	220040	25.456	202560	0	0	0	200	0.60	5050	2.6	2.2	4.1
0	0	0	339848	25476	382568	0	0	0	280	868	5873	36	23	41
0	0	0	339848	25476	382580	0	0	0	0	960	5905	<i>1</i> 1	18	42
0	0	U	339040	23470	302300	U	U	U	U	800	3903	41	10	42
0	0	0	339848	25476	382584	0	0	0	0	851	5883	41	19	41
0	0	Ü	227010	25 . 7 0	30230.	Ü	Ü	Ü	Ü	001	2002			
0	0	0	339848	25476	382588	0	0	0	0	876	5943	42	21	37
0	0													
0	0	0	339848	25476	382592	0	0	0	0	832	5876	41	19	41
0	0													
2	0	0	339724	25484	382584	0	0	0	36	870	5879	40	24	37
0	0	0	220724	25101	202506	0	0	0	0	0.64	7000	4.0	20	2.7
0	0	0	339724	25484	382596	0	0	0	0	864	5908	43	20	37
0	0	0	339724	25484	382600	0	0	0	0	867	5916	11	1 Q	38
0	0	U	339124	23404	362000	U	U	U	U	807	3910	44	10	30
0	0	0	339724	25484	382604	0	0	0	0	840	5904	40	18	41
0	0													
0	0	0	339724	25484	382608	0	0	0	0	857	5889	43	18	39
0	0													
0	0	0	339832	25492	382604	0	0	0	12	870	5923	40	19	40
0	0	_					_	_						
0	0	0	339852	25492	382616	0	0	0	0	838	5888	40	19	41
0	0	0	220052	25402	292620	0	0	0	0	0.62	5000	40	22	20
0	0	U	339852	23492	382020	0	0	0	U	803	5909	40	22	38
$0 \\ 0$	0	0	339852	25492	382624	0	0	0	0	857	5897	42	21	37
0	0	U	337032	23772	302024	U	U	O	U	037	3071	72	21	31
0	0	0	339852	25492	382628	0	0	0	0	897	5891	43	18	39
0	0													
0	0	0	339848	25500	382624	0	0	0	12	878	5909	41	18	40
0	0													
0	0	0	339836	25500	382636	0	0	0	0	854	5881	39	20	41
0	0													

.3.8 Vmstat tool van systeem zonder patches

Listing 6: Eerste 50 resultaten

					\mathcal{C}				•						
	ocs -			nory——			_		io ——	-				cpu-	
r	b	swpd		buff	cache		so	bi	bo	in			•	id wa	s t
0	0	0	829484	6836	88892	0	0	2562	13	335	1107	9	6	85	
0	0														
0	0	0	829220	6836	88896	0	0	0	0	717	1299	26	22	52	
0	0														
0	0	0	829220	6836	88900	0	0	0	0	663	1209	30	16	5.2	
_		U	029220	0030	88900	U	U	U	U	003	1209	30	10	33	
0	0														
0	0	0	829220	6844	88904	0	0	0	92	735	1336	37	16	47	
0	0														
0	0	0	829296	6844	88904	0	0	0	0	703	1275	28	22	49	
0	0														
0	0	0	829400	6844	88908	0	0	0	0	703	1293	28	19	53	
	0	U	027400	0044	00700	U	U	U	U	703	1275	20	1)	33	
0		0	020420	6044	00012	0	0	0	0	720	1222	20	1.0	<i>-</i> 1	
1	0	0	829420	6844	88912	0	0	0	0	729	1323	30	19	51	
0	0														
1	0	0	829416	6844	88916	0	0	0	0	687	1265	28	18	54	
0	0														
1	0	0	829060	6852	88920	0	0	0	16	710	1297	29	14	57	
0	0														
0	0	0	829420	6852	88924	0	0	0	0	715	1296	28	1 2	5.4	
		U	029420	0032	00924	U	U	U	U	/13	1290	20	10	34	
0	0											• •			
1	0	0	829344	6852	88928	0	0	0	0	713	1278	29	14	57	
0	0														
0	0	0	829344	6852	88932	0	0	0	0	704	1286	33	17	50	
0	0														
0	0	0	829360	6852	88936	0	0	0	0	700	1279	26	17	58	
0	0	O	027300	0032	00750	O	O	O	O	700	12//	20	1,	30	
		0	920264	6960	99040	0	0	0	1.6	720	1227	20	10	50	
1	0	U	829364	6860	88940	0	0	0	16	128	1327	29	10	32	
0	0														
0	0	0	829348	6860	88944	0	0	0	0	726	1270	25	18	57	
0	0														
0	0	0	829348	6860	88948	0	0	0	0	727	1296	27	16	56	
0	0														
0	0	0	829240	6860	88952	0	0	0	80	715	1247	31	11	58	
0	0	U	027240	0000	00732	U	U	U	00	713	127/	31	11	30	
		0	020220	(0(0	0.0052	0	0	0	0	717	1206	20	1.5	<i></i>	
3	0	U	829220	6860	88952	0	0	0	0	/1/	1306	29	13	33	
0	0														
2	0	0	829004	6868	88956	0	0	0	16	726	1295	29	19	53	
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