Управление внешними устройствами и модулями ядра в операционной системе GNU Linux

Отчет по лабораторной работе 4

по дисциплине «**Системное программное обеспечение**»

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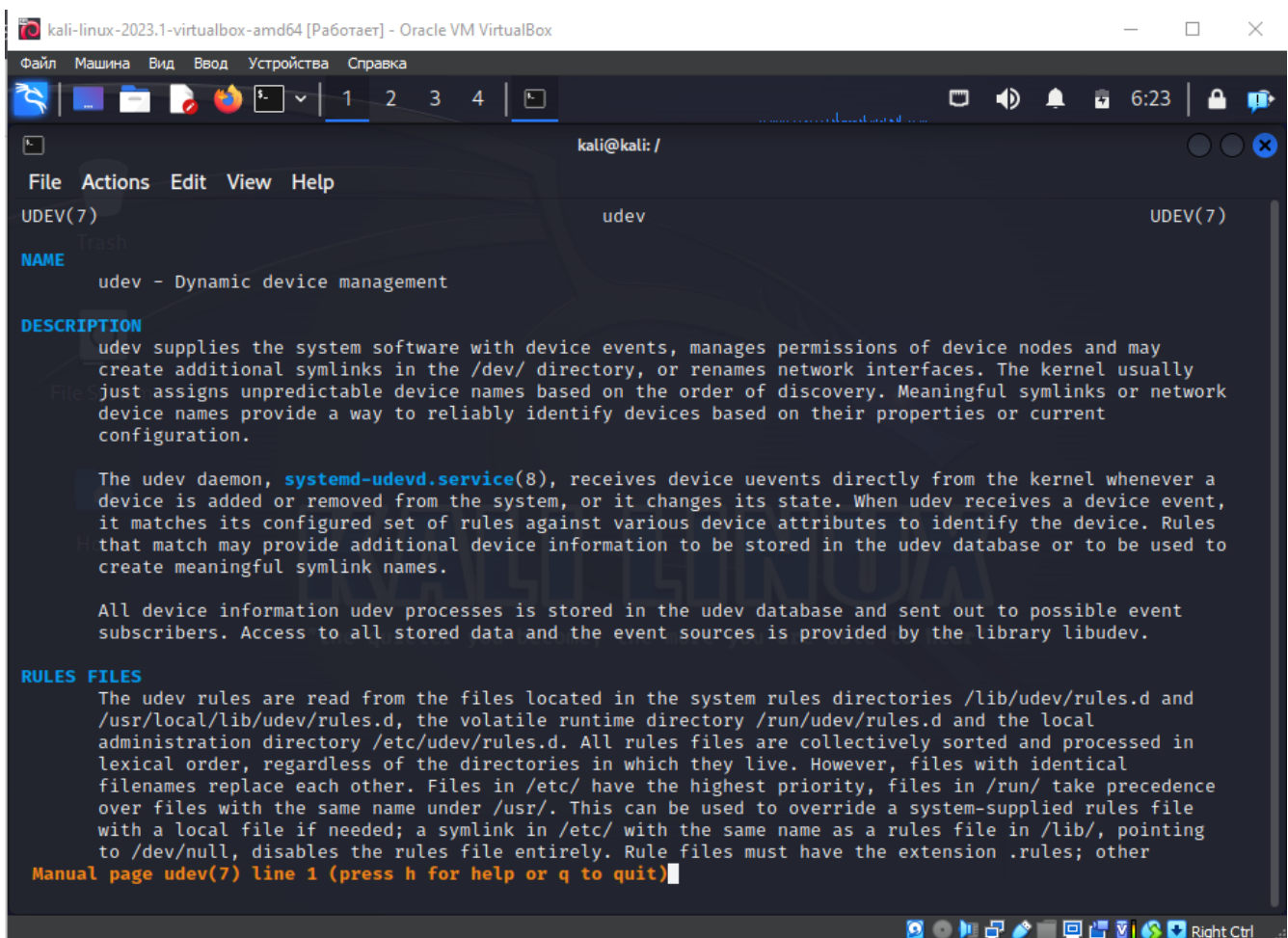
Направления подготовки 09.03.01«Информатика и вычислительная техника»

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Лабораторная работа №4. Управление внешними устройствами и модулями ядра в операционной системе GNU Linux

Цель работы: Получение сведений о средствах управления внешними устройствами в ОС Linux

1. Запуск установки
2. Изучить udev

3. Udevadm monitor

```
┌──(aqua㉿kali)-[~]
└─$ udevadm monitor
monitor will print the received events for:
UDEV - the event which udev sends out after rule processing
KERNEL - the kernel uevent

KERNEL[526.257798] add        /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4 (usb)
KERNEL[526.257903] add        /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0 (usb)
KERNEL[526.258071] add        /devices/virtual/workqueue/scsi_tmf_2 (workqueue)
KERNEL[526.258167] add        /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0/host2 (scsi)
KERNEL[526.258182] add        /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0/host2/scsi_host/ho
st2 (scsi_host)
KERNEL[526.258197] bind       /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0 (usb)
KERNEL[526.258215] bind       /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4 (usb)
UDEV  [526.270015] add        /devices/virtual/workqueue/scsi_tmf_2 (workqueue)
UDEV  [526.271783] add        /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4 (usb)
UDEV  [526.272739] add        /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0 (usb)
UDEV  [526.273509] add        /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0/host2 (scsi)
UDEV  [526.274412] add        /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0/host2/scsi_host/ho
st2 (scsi_host)
UDEV  [526.275044] bind       /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0 (usb)
UDEV  [526.277755] bind       /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4 (usb)
KERNEL[527.283782] add        /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0/host2/target2:0:0
(scsi)
KERNEL[527.283813] add        /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0/host2/target2:0:0/
2:0:0:0 (scsi)
KERNEL[527.283825] add        /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0/host2/target2:0:0/
2:0:0:0/scsi_device/2:0:0:0 (scsi_device)
KERNEL[527.283914] add        /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0/host2/target2:0:0/
2:0:0:0/scsi_generic/sg0 (scsi_generic)
KERNEL[527.283931] add        /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0/host2/target2:0:0/
2:0:0:0/scsi_disk/2:0:0:0 (scsi_disk)
KERNEL[527.283987] add        /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0/host2/target2:0:0/
2:0:0:0/bsg/2:0:0:0 (bsg)
UDEV  [527.284951] add        /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0/host2/target2:0:0
(scsi)
UDEV  [527.285831] add        /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0/host2/target2:0:0/
2:0:0:0 (scsi)
UDEV  [527.286743] add        /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0/host2/target2:0:0/
2:0:0:0/scsi_device/2:0:0:0 (scsi_device)
KERNEL[527.287036] add        /devices/virtual/bdi/8:0 (bdi)
UDEV  [527.288004] add        /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0/host2/target2:0:0/
2:0:0:0/scsi_generic/sg0 (scsi_generic)
UDEV  [527.288921] add        /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0/host2/target2:0:0/
2:0:0:0/bsg/2:0:0:0 (bsg)
UDEV  [527.289124] add        /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0/host2/target2:0:0/
2:0:0:0/scsi_disk/2:0:0:0 (scsi_disk)
UDEV  [527.299587] add        /devices/virtual/bdi/8:0 (bdi)
KERNEL[527.303331] add        /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0/host2/target2:0:0/
2:0:0:0/block/sda (block)
KERNEL[527.303384] add        /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0/host2/target2:0:0/
2:0:0:0/block/sda/sda1 (block)
KERNEL[527.303418] bind       /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0/host2/target2:0:0/
2:0:0:0 (scsi)
UDEV  [527.371287] add        /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0/host2/target2:0:0/
2:0:0:0/block/sda (block)
UDEV  [527.431432] add        /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0/host2/target2:0:0/
2:0:0:0/block/sda/sda1 (block)
UDEV  [527.432260] bind       /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0/host2/target2:0:0/
2:0:0:0 (scsi)
```

4. Флешка sda


```
┌──(aqua㉿kali)-[~]
└─$ lsblk
NAME          MAJ:MIN RM   SIZE RO TYPE MOUNTPOINTS
sda             8:0    1  29.1G  0 disk
└─sda1          8:1    1  29.1G  0 part
nvme0n1       259:0    0 476.9G  0 disk
├─nvme0n1p1   259:1    0   260M  0 part /boot/efi
├─nvme0n1p2   259:2    0    16M  0 part
├─nvme0n1p3   259:3    0 417.1G  0 part /media/aqua/OS
├─nvme0n1p4   259:4    0   750M  0 part
├─nvme0n1p5   259:5    0   200M  0 part
├─nvme0n1p6   259:6    0  55.9G  0 part /
└─nvme0n1p7   259:7    0   2.7G  0 part [SWAP]

┌──(aqua㉿kali)-[~]
└─$
```

```
Disk /dev/nvme0n1: 476.94 GiB, 512110190592 bytes, 1000215216 sectors
Disk model: INTEL SSDPEKNU512GZ
Units: sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disklabel type: gpt
Disk identifier: 7C969974-AB1C-407D-BEFB-E9C6F2BF8F76

Device            Start       End    Sectors   Size Type
/dev/nvme0n1p1     2048    534527     532480   260M EFI System
/dev/nvme0n1p2   534528    567295      32768    16M Microsoft reserved
/dev/nvme0n1p3   567296 875385486  874818191 417.1G Microsoft basic data
/dev/nvme0n1p4 998268928 999804927    1536000   750M Windows recovery environment
/dev/nvme0n1p5 999804928 1000214527    409600   200M Windows recovery environment
/dev/nvme0n1p6 875386880 992573439  117186560  55.9G Linux filesystem
/dev/nvme0n1p7 992573440 998268927    5695488   2.7G Linux swap

Partition table entries are not in disk order.


Disk /dev/sda: 29.11 GiB, 31260704768 bytes, 61056064 sectors
Disk model: Cruzer Edge
Units: sectors of 1 * 512 = 512 bytes
Sector size (logical/physical): 512 bytes / 512 bytes
I/O size (minimum/optimal): 512 bytes / 512 bytes
Disklabel type: dos
Disk identifier: 0×990d6b7c


Device    Boot Start      End  Sectors  Size Id Type
/dev/sda1  *    2048 61054975 61052928 29.1G  c W95 FAT32 (LBA)
```

5. Информация о sda

```
┌──(root㉿kali)-[/home/aqua]
└─# udevadm info --query=all --name=sda1
P: /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0/host2/target2:0:0/2:0:0:0/block/sda/sda1
M: sda1
R: 1
U: block
T: partition
D: b 8:1
N: sda1
L: 0
S: disk/by-uuid/669C-67F8
S: disk/by-id/usb-SanDisk_Cruzer_Edge_4C530599960513110171-0:0-part1
S: disk/by-partuuid/990d6b7c-01
S: disk/by-label/ESD-USB
S: disk/by-path/pci-0000:03:00.3-usb-0:4:1.0-scsi-0:0:0:0-part1
Q: 3
E: DEVPATH=/devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0/host2/target2:0:0/2:0:0:0/block/sda
E: DEVNAME=/dev/sda1
E: DEVTYPE=partition
E: DISKSEQ=3
E: PARTN=1
E: MAJOR=8
E: MINOR=1
E: SUBSYSTEM=block
E: USEC_INITIALIZED=527431032
E: ID_BUS=usb
E: ID_MODEL=Cruzer_Edge
E: ID_MODEL_ENC=Cruzer\x20Edge\x20\x20\x20\x20\x20
E: ID_MODEL_ID=556b
E: ID_SERIAL=SanDisk_Cruzer_Edge_4C530599960513110171-0:0
E: ID_SERIAL_SHORT=4C530599960513110171
lines 1-29 ... skipping ...
P: /devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0/host2/target2:0:0/2:0:0:0/block/sda/sda1
M: sda1
R: 1
U: block
T: partition
D: b 8:1
N: sda1
L: 0
S: disk/by-uuid/669C-67F8
S: disk/by-id/usb-SanDisk_Cruzer_Edge_4C530599960513110171-0:0-part1
S: disk/by-partuuid/990d6b7c-01
S: disk/by-label/ESD-USB
S: disk/by-path/pci-0000:03:00.3-usb-0:4:1.0-scsi-0:0:0:0-part1
Q: 3
E: DEVPATH=/devices/pci0000:00/0000:00:08.1/0000:03:00.3/usb1/1-4/1-4:1.0/host2/target2:0:0/2:0:0:0/block/sda/sda1
E: DEVNAME=/dev/sda1
E: DEVTYPE=partition
E: DISKSEQ=3
E: PARTN=1
E: MAJOR=8
E: MINOR=1
E: SUBSYSTEM=block
E: USEC_INITIALIZED=527431032
E: ID_BUS=usb
E: ID_MODEL=Cruzer_Edge
E: ID_MODEL_ENC=Cruzer\x20Edge\x20\x20\x20\x20\x20
E: ID_MODEL_ID=556b
E: ID_SERIAL=SanDisk_Cruzer_Edge_4C530599960513110171-0:0
E: ID_SERIAL_SHORT=4C530599960513110171
```

6. Создание правила


```
GNU nano 7.2                                    100-script.rules *
KERNEL="sda"
ACTION="add"
RUN+="/usr/bin/mkdir -p /home/user
```



```
┌──(aqua㊀kali)-[/etc/udev/rules.d]
└─$ ls /home/
aqua   user
```

7. Список загруженных модулей ядра

```
┌──(aqua㉿kali)-[/etc/udev/rules.d]
└─$ lsmod
Module                    Size  Used by
sd_mod                   65536  0
sg                       40960  0
uas                      32768  0
usb_storage              81920  1 uas
ctr                      16384  2
ccm                      20480  6
rfcomm                   94208  16
cmac                     16384  3
algif_hash               16384  1
algif_skcipher           16384  1
af_alg                   36864  6 algif_hash,algif_skcipher
xt_CHECKSUM              16384  1
xt_MASQUERADE            20480  3
xt_conntrack             16384  1
ipt_REJECT               16384  2
nf_reject_ipv4           16384  1 ipt_REJECT
xt_tcpudp                20480  0
nft_compat               20480  7
nft_chain_nat            16384  2
nf_nat                   57344  2 nft_chain_nat,xt_MASQUERADE
nf_conntrack            188416  3 xt_conntrack,nf_nat,xt_MASQUERADE
nf_defrag_ipv6           24576  1 nf_conntrack
nf_defrag_ipv4           16384  1 nf_conntrack
nf_tables               286720  156 nft_compat,nft_chain_nat
libcrc32c                16384  3 nf_conntrack,nf_nat,nf_tables
nfnetlink                20480  2 nft_compat,nf_tables
bridge                  311296  0
stp                      16384  1 bridge
llc                      16384  2 bridge,stp
qrtr                     49152  4
bnep                     28672  2
sunrpc                  692224  1
binfmt_misc              24576  1
nls_ascii                16384  1
nls_cp437                20480  1
vfat                     24576  1
fat                      90112  1 vfat
btusb                    65536  0
btrtl                    28672  1 btusb
btbcm                    24576  1 btusb
btintel                  45056  1 btusb
intel_rapl_msr           20480  0
btmtk                    16384  1 btusb
intel_rapl_common        32768  1 intel_rapl_msr
edac_mce_amd             40960  0
bluetooth               950272  44 btrtl,btmtk,btintel,btbcm,bnep,btusb,rfcomm
uvcvideo                131072  0
videobuf2_vmalloc        20480  1 uvcvideo
videobuf2_memops         20480  1 videobuf2_vmalloc
kvm_amd                 155648  0
snd_hda_codec_realtek   172032  1
videobuf2_v4l2           36864  1 uvcvideo
snd_hda_codec_generic    98304  1 snd_hda_codec_realtek
jitterentropy_rng        16384  1
snd_hda_codec_hdmi       81920  1
videobuf2_common         73728  4 videobuf2_vmalloc,videobuf2_v4l2,uvcvideo,videobuf2_memops
kvm                    1138688  1 kvm_amd
```

8. Информация про модуль button

```
┌──(aqua☻kali)-[/etc/udev/rules.d]
└─$ modinfo button
filename:       /lib/modules/6.1.0-kali5-amd64/kernel/drivers/acpi/button.ko
license:        GPL
description:    ACPI Button Driver
author:         Paul Diefenbaugh
alias:          acpi*:LNXPWRBN:*
alias:          acpi*:PNP0C0C:*
alias:          acpi*:LNXSLPBN:*
alias:          acpi*:PNP0C0E:*
alias:          acpi*:PNP0C0D:*
depends:
retpoline:      Y
intree:         Y
name:           button
vermagic:       6.1.0-kali5-amd64 SMP preempt mod_unload modversions
parm:           lid_report_interval:Interval (ms) between lid key events (ulong)
parm:           lid_init_state:Behavior for reporting LID initial state
┌──(aqua☻kali)-[/etc/udev/rules.d]
```

9. Удаление модуля

```
hid                   155648  4 i2c_hid,usbhid,hid_multitouch,hid_generic
button                 24576  0

┌──(aqua☻kali)-[/lib/modules]
└─$ rmmod button
rmmod: ERROR: ../libkmod/libkmod-module.c:856 kmod_module_remove_module()
 not permitted
rmmod: ERROR: could not remove module button: Operation not permitted

┌──(aqua☻kali)-[/lib/modules]
└─$ sudo rmmod button

┌──(aqua☻kali)-[/lib/modules]
└─$
```

```
i2c_hid                32768  1 i2c_hid_acpi
wmi                    36864  3 video,asus_wmi,wmi_bmof
hid                   155648  4 i2c_hid,usbhid,hid_multitouch,

┌──(aqua☻kali)-[/lib/modules]
└─$
```

10. Добавления модуля

```
┌──(aqua💀kali)-[/lib/modules]
└─$ cd /lib/modules/6.1.0-kali5-amd64/kernel/drivers/acpi

┌──(aqua💀kali)-[/lib/…/6.1.0-kali5-amd64/kernel/drivers/acpi]
└─$ ls
ac.ko          acpi_pad.ko  battery.ko  fan.ko  platform_profile.ko  sbs.ko
acpi_ipmi.ko   acpi_tad.ko  button.ko   nfit    sbshc.ko             video.ko

┌──(aqua💀kali)-[/lib/…/6.1.0-kali5-amd64/kernel/drivers/acpi]
└─$ sudo insmod button.ko

┌──(aqua💀kali)-[/lib/…/6.1.0-kali5-amd64/kernel/drivers/acpi]
└─$ █
```

```
└─$ lsmod
Module          Size   Used by
button          24576  0
sd_mod          65536  0
sg              40960  0
```

Вывод: В ходе данной лабораторной работе я работал с udevadm, научился пользоваться udevadm monitor/info/ , а затем написал скрипт, который создаёт папку в директории /home, когда мы вставляем флешку. Также ознакомился с модулями ядра, вывел информацию про один из них, удалил его и скачал заново.