

Лабораторная работа №10

Управление модулями ядра Linux

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Цель работы

Получить навыки работы с модулями ядра Linux: * просмотр устройств и связанных модулей; * загрузка и выгрузка модулей; * просмотр информации о модулях; * обновление версии ядра.

Выполнение лабораторной работы

Инвентаризация устройств

```
root@dsyakovleva:~ -- -bash

dsyakovleva@dsyakovleva:~$ su -
Password:
Last login: Wed Oct 29 00:02:46 MSK 2025 on pts/0
root@dsyakovleva:~# lspci -k
00:00.0 Host bridge: Intel Corporation 440FX - 82441FX PMC [Natoma] (rev 02)
00:01.0 ISA bridge: Intel Corporation 82371SB PIIX3 ISA [Natoma/Triton II]
00:01.1 IDE interface: Intel Corporation 82371AB/EB/MB PIIX4 IDE (rev 01)
        Kernel driver in use: ata_piix
        Kernel modules: ata_piix, ata_generic
00:02.0 VGA compatible controller: VMware SVGA II Adapter
        Subsystem: VMware SVGA II Adapter
        Kernel driver in use: vmwgfx
        Kernel modules: vmwgfx
00:03.0 Ethernet controller: Intel Corporation 82540EM Gigabit Ethernet Controller (rev 02)
        Subsystem: Intel Corporation PRO/1000 MT Desktop Adapter
        Kernel driver in use: e1000
        Kernel modules: e1000
00:04.0 System peripheral: InnoTek Systemberatung GmbH VirtualBox Guest Service
        Kernel driver in use: vboxguest
        Kernel modules: vboxguest
00:05.0 Multimedia audio controller: Intel Corporation 82801AA AC'97 Audio Controller (rev 01)
        Subsystem: Dell Device 0177
        Kernel driver in use: snd_intel8x0
        Kernel modules: snd_intel8x0
00:06.0 USB controller: Apple Inc. KeyLargo/Intrepid USB
        Kernel driver in use: ohci-pci
00:07.0 Bridge: Intel Corporation 82371AB/EB/MB PIIX4 ACPI (rev 08)
        Kernel driver in use: piix4_smbus
        Kernel modules: i2c_piix4
00:0b.0 USB controller: Intel Corporation 82801FB/FBM/FR/FW/FRW (ICH6 Family) USB2 EHCI Controller
        Kernel driver in use: ehci-pci
00:0d.0 SATA controller: Intel Corporation 82801HM/HEM (ICH8M/ICH8M-E) SATA Controller [AHCI mode]
        (rev 02)
        Kernel driver in use: ahci
        Kernel modules: ahci
root@dsyakovleva:~#
```

Проверка и загрузка модуля ext4

```
snd_timer          57344  3  snd_seq,snd_hrtimer,snd_pcm
soundcore          16384  1  snd
sr_mod            28672  1
ttm               110592  2  vmwgfx,drm_ttm_helper
uinput            24576  0
vboxguest         516096  4
video             81920  0
vmwgfx            495616  3
vmw_vmci          118784  1  vmw_vsock_vmci_transport
vmw_vsock_virtio_transport_common  61440  1  vsock_loopback
vmw_vsock_vmci_transport  49152  0
vsock             65536  5  vmw_vsock_virtio_transport_common,vsock_loopback,vmw_vsock_vmci_tr
ansport
vsock_loopback    12288  0
wmi               32768  1  video
xfs              3207168  2
root@dsyakovleva:~# lsmod | grep ext4
root@dsyakovleva:~# modprobe ext4
root@dsyakovleva:~# lsmod | grep ext4
ext4              1187840  0
mbcache           16384  1  ext4
jbd2              217088  1  ext4
```

Рис. 2: Загрузка и проверка модуля ext4

Информация о модуле ext4

```
root@dsyakovleva:~# modinfo ext4
filename:          /lib/modules/6.12.0-55.12.1.el10_0.x86_64/kernel/fs/ext4/ext4.ko.xz
softdep:           pre: crc32c
license:           GPL
description:       Fourth Extended Filesystem
author:            Remy Card, Stephen Tweedie, Andrew Morton, Andreas Dilger, Theodore Ts'o and other
s
alias:             fs-ext4
alias:             ext3
alias:             fs-ext3
alias:             ext2
alias:             fs-ext2
rhelversion:       10.0
srcversion:        CBA9BD0FC931061AEC0A8F4
depends:            jbd2,mbcache
intree:            Y
name:              ext4
retpoline:         Y
vermagic:          6.12.0-55.12.1.el10_0.x86_64 SMP preempt mod_unload modversions
sig_id:            PKCS#7
signer:            Rocky kernel signing key
sig_key:           57:BC:A1:34:94:0D:57:12:99:67:28:D8:C0:8B:1C:4B:8C:8A:13:06
sig_hashalgo:      sha256
signature:         05:D7:3D:A0:55:EA:4A:16:70:78:23:1F:C7:9A:17:C6:A9:9C:B5:71:
6B:EB:97:2C:94:5A:49:CB:07:A0:85:2E:27:8D:C4:01:27:43:2A:C8:
B8:37:9C:AB:EF:B7:D9:AC:70:98:F6:2B:1B:A6:9D:7D:62:0E:8C:2E:
4E:D6:0E:3F:B9:33:E7:D9:8E:05:F0:70:09:81:08:5F:1E:26:99:E4:
C2:33:CD:4A:01:B2:F3:17:11:06:81:B2:F8:C6:23:85:76:76:43:9B:
00:78:01:A7:51:FA:AC:9F:25:39:88:1C:FF:27:C2:AF:0B:30:64:BA:
D6:FB:2C:81:43:AA:61:09:3E:6B:C8:5C:43:D2:B1:BB:8F:E4:99:95:
45:FE:EF:EC:B8:E0:3F:A1:50:E8:31:E2:8C:F2:5D:EF:15:87:2D:54:
98:24:93:D0:87:A8:17:6B:E7:5A:23:6B:DB:9D:1C:CC:42:F1:5B:2B:
D5:48:EE:F5:A4:EA:FC:0E:D4:AD:8B:FB:A9:0B:53:DD:33:AD:DA:F4:
73:F5:28:0B:2B:19:84:75:BB:B6:D5:2E:34:3E:89:53:FB:FD:78:C6:
FB:83:F0:1D:75:8B:8C:96:8D:87:62:27:B0:58:99:A0:A0:23:E2:A7:
2B:E7:E7:25:2C:AB:D2:68:A2:C9:44:30:39:FF:46:82:CC:80:DF:CB:
```

```
root@dsyakovleva:~# modprobe -r ext4
root@dsyakovleva:~# modprobe -r ext4
root@dsyakovleva:~# modprobe -r ext4
root@dsyakovleva:~# modprobe -r ext4
root@dsyakovleva:~# modprobe -r xfs
modprobe: FATAL: Module xfs is in use.
root@dsyakovleva:~#
```

Рис. 4: Выгрузка ext4 и ошибка при удалении xfs

Модули с параметрами (Bluetooth)

```
root@dsyakovleva:~# lsmod | grep bluetooth
root@dsyakovleva:~# modprobe bluetooth
root@dsyakovleva:~# lsmod | grep bluetooth
bluetooth          1114112  0
rfkill              40960  4 bluetooth
root@dsyakovleva:~# modinfo bluetooth
filename:           /lib/modules/6.12.0-55.12.1.el10_0.x86_64/kernel/net/bluetooth/bluetooth.ko.xz
alias:              net-pf-31
license:            GPL
version:            2.22
description:        Bluetooth Core ver 2.22
author:             Marcel Holtmann <marcel@holtmann.org>
rhelversion:        10.0
srcversion:         5F9AA895ADC3BA3840211D1
depends:             rfkill
intree:             Y
name:               bluetooth
retpoline:          Y
vermagic:           6.12.0-55.12.1.el10_0.x86_64 SMP preempt mod_unload modversions
sig_id:             PKCS#7
signer:             Rocky kernel signing key
sig_key:            57:BC:A1:34:94:0D:57:12:99:67:28:D8:C0:8B:1C:4B:8C:8A:13:06
sig_hashalgo:       sha256
signature:          2E:24:0B:EE:9E:E6:A3:58:91:2A:D3:87:25:A3:1B:46:06:89:06:BC:
                    4A:99:10:8D:7A:0F:1E:FF:92:59:FD:59:74:DB:7E:42:40:14:03:C9:
                    43:D0:A3:4F:F3:10:71:07:4D:FF:34:52:96:1A:8B:90:9C:DF:D8:FB:
                    07:E9:07:16:2E:8D:4B:23:0C:92:93:0B:88:E9:82:6B:06:1B:BD:25:
                    69:7D:37:70:CC:C2:A5:08:85:C9:34:D9:69:1C:28:BB:81:B0:8A:C7:
                    9F:AD:5D:46:AB:C1:B2:B1:C4:E3:8B:1A:12:5D:E2:52:D0:42:DD:FD:
                    2B:D0:5A:51:5C:6E:AD:0D:FD:90:EB:62:89:91:D2:C8:4A:25:EA:9D:
                    CA:B9:BE:27:C7:BB:85:D6:A5:A1:7B:8B:DE:E2:CC:26:F3:D6:D1:D2:
                    8C:FF:82:18:76:56:0C:DE:85:BB:B2:BD:8C:56:99:B6:21:B5:3A:ED:
                    15:E8:CC:3D:5F:C9:84:65:1C:94:DD:98:ED:03:D3:6D:DE:F3:B7:31:
                    19:34:07:1F:19:4A:82:C6:F5:82:F3:3C:87:38:F3:A7:69:66:0E:3B:
                    54:25:78:36:FC:A5:17:C0:5A:62:C5:4C:41:F6:FF:87:5F:0C:58:45:
                    AF:12:D3:12:5D:11:49:20:BD:B1:E1:A4:DB:BA:D3:18:B6:EE:D0:57:
                    EC:75:3A:A6:0D:E2:36:37:78:C6:BB:DD:9B:1C:67:EB:D2:A8:9F:16:
                    2B:8A:CF:8F:23:38:B4:7A:A9:92:49:86:D7:9F:08:7D:8A:92:7D:DD:
```

```
parm:          disable_esco:Disable eSCO connection creation (bool)
parm:          disable_ertm:Disable enhanced retransmission mode (bool)
parm:          enable_ecred:Enable enhanced credit flow control mode (bool)
root@dsyakovleva:~# █
```

Рис. 6: Информация о модуле bluetooth

```
Complete!
root@dsyakovleva:~# dnf update kernel
Last metadata expiration check: 0:01:23 ago on Tue 04 Nov 2025 03:40:37 PM MSK.
Dependencies resolved.
Nothing to do.
Complete!
root@dsyakovleva:~# dnf update
Last metadata expiration check: 0:01:38 ago on Tue 04 Nov 2025 03:40:37 PM MSK.
Dependencies resolved.
Nothing to do.
Complete!
root@dsyakovleva:~# dnf update --refresh
Rocky Linux 10 - BaseOS          9.8 kB/s | 4.3 kB      00:00
Rocky Linux 10 - AppStream       14 kB/s | 4.3 kB      00:00
Rocky Linux 10 - Extras         8.9 kB/s | 3.1 kB      00:00
Dependencies resolved.
Nothing to do.
Complete!
root@dsyakovleva:~# █
```

Рис. 7: Обновление пакетов и ядра

Проверка новой версии ядра

```
dsyakovleva@dsyakovleva:~$ uname -r
6.12.0-55.41.1.el10_0.x86_64
dsyakovleva@dsyakovleva:~$ hostnamectl
  Static hostname: dsyakovleva.localdomain
    Icon name: computer-vm
    Chassis: vm 🖥️
  Machine ID: c1751782e9cf4affa180480ac67c0b9e
    Boot ID: 82aa6347a236400bbaf870aeaae88f57
  Virtualization: oracle
  Operating System: Rocky Linux 10.0 (Red Quartz)
    CPE OS Name: cpe:/o:rocky:rocky:10::baseos
    OS Support End: Thu 2035-05-31
OS Support Remaining: 9y 6month 3w 3d
    Kernel: Linux 6.12.0-55.41.1.el10_0.x86_64
    Architecture: x86-64
    Hardware Vendor: innotek GmbH
    Hardware Model: VirtualBox
  Firmware Version: VirtualBox
    Firmware Date: Fri 2006-12-01
    Firmware Age: 18y 11month 4d
dsyakovleva@dsyakovleva:~$
```

Рис. 8: Проверка версии ядра после перезагрузки

Контрольные вопросы

- текущая версия ядра — `uname -r`;
- загруженные модули — `lsmod`;
- загрузка / выгрузка — `modprobe, modprobe -r`;
- параметры модуля — `modinfo`.

Вывод

Были получены практические навыки работы с модулями ядра Linux:

- определение устройств и связанных модулей;
- загрузка и выгрузка модулей;
- просмотр параметров модулей;
- обновление ядра.