

# Лабораторная работа №10

Основы работы с модулями ядра операционной системы

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2025-11-08

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## Информация

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## Цели и задачи

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- Получить навыки работы с утилитами управления модулями ядра операционной системы.
- Продемонстрируйте навыки работы по управлению модулями ядра (см. раздел 10.4.1).
- Продемонстрируйте навыки работы по загрузке модулей ядра с параметрами (см. раздел 10.4.2).

## Материалы и методы

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- Linux (дистрибутив Rocky 9.6)
- Linux Fedora Sway (Markdown)
- Oracle VirtualBox

## Выполнение лабораторной работы

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# Отображение информации об устройствах системы и модулях

`lspci -k`

```
[aeakunaeva@aeakunaeva ~]$ su -
Password:
[root@aeakunaeva ~]# 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
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
```

# Отображение списка загруженных модулей ядра

`lsmod`

```
[root@aeakunaeva ~]# lsmod | sort
ac97_bus           12288  1 snd_ac97_codec
ahci              49152   3
ata_generic       16384   0
ata_piix          45056   0
cdrom             90112   1 sr_mod
crc32c_intel     24576   1
crc32_pclmul      12288   0
crc32c_pclmul     12288   1
dm_log            24576   2 dm_region_hash,dm_mirror
dm_mirror         28672   0
dm_mod            245760  9 dm_log,dm_mirror
dm_region_hash    28672   1 dm_mirror
drm               811008  6 vmwgfx,drm_kms_helper,drm_ttm_helper,ttm
drm_kms_helper    266240  2 vmwgfx,drm_ttm_helper
drm_ttm_helper    16384   2 vmwgfx
e1000             196608  0
fuse              212992  5
ghash_clmulni_intel 16384   0
i2c_piix4        28672   0
intel_rapl_common 57344   1 intel_rapl_ms
intel_rapl_ms      20480   0
ip_set            69632   0
libahci           61440   1 ahci
libata            520192  4 ata_piix,libahci,ahci,ata_generic
libcrc32c          12288  4 nf_conntrack,nf_nat,nf_tables,xfs
Module           Size Used by
nf_conntrack      229376  2 nf_nat,nft_ct
nf_defrag_ipv4    12288   1 nf_conntrack
nf_defrag_ipv6    24576   1 nf_conntrack
nf_nat            65536   1 nft_chain_nat
nfnetlink         20480   3 nf_tables,ip_set
```

# Проверка загрузки модуля ядра (ext4)

modprobe [модуль ядра]

lsmod | grep [модуль ядра]

modinfo [модуль ядра]

```
[root@aakunaeva ~]# lsmod | grep ext4
[root@aakunaeva ~]# modprobe ext4
[root@aakunaeva ~]# lsmod | grep ext4
ext4                  1191936  0
mbcache                 16384  1 ext4
jbd2                  221184  1 ext4
[root@aakunaeva ~]# modinfo ext4
filename:      /lib/modules/5.14.0-570.17.1.el9_6.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 others
alias:         fs-ext4
alias:         ext3
alias:         fs-ext3
alias:         ext2
alias:         fs-ext2
rhelversion:   9.6
srcversion:    414CA771338855FD8AA67C4
depends:       jbd2,mbcache
retpoline:     Y
intree:        Y
name:          ext4
vermagic:     5.14.0-570.17.1.el9_6.x86_64 SMP preempt mod_unload modversions
sig_id:        PKCS#7
signer:        Rocky kernel signing key
sig_key:       F5:03:24:D1:25:4A:DE:82:57:F2:1C:EE:7C:D6:C7:14:28:E3:FF
sig_hashalgo:  sha256
signature:    61:BC:53:9F:C0:C1:2A:2D:B2:34:DF:10:67:4E:50:C6:10:A5:13:AB:
                2E:2B:4D:A7:EE:AD:A3:55:E7:39:D4:25:67:53:8B:1E:0B:8F:0F:05:
                90:48:2A:CA:64:CD:DE:62:5D:18:2B:9A:B2:D2:D1:6A:9B:18:DE:60:
```

## Выгрузка модулей ядра (ext4 и xfs)

modprobe -r [модуль ядра]

```
[root@aeakunaeva ~]# modprobe -r ext4
modprobe: FATAL: Module crc32c_intel is in use.
[root@aeakunaeva ~]# modprobe -r ext4
[root@aeakunaeva ~]# lsmod | grep ext4
[root@aeakunaeva ~]# modprobe -r xfs
modprobe: FATAL: Module xfs is in use.
[root@aeakunaeva ~]# modprobe -r xfs
modprobe: FATAL: Module xfs is in use.
```

# Загрузка модуля ядра bluetooth

```
modprobe bluetooth
```

```
lsmod | grep bluetooth
```

```
[root@aekunaeva ~]# lsmod | grep bluetooth
[root@aekunaeva ~]# modprobe bluetooth
[root@aekunaeva ~]# lsmod | grep bluetooth
bluetooth           1114112  0
rfkill                40960  4 bluetooth
[root@aekunaeva ~]# modinfo blurtooth
modinfo: ERROR: Module blurtooth not found.
[root@aekunaeva ~]# modinfo bluetooth
filename:      /lib/modules/5.14.0-570.17.1.el9_6.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:   9.6
srcversion:    7FC17935133A8AA3F10AD0C
depends:      rfkill
retpoline:    Y
intree:       Y
name:         bluetooth
vermagic:     5.14.0-570.17.1.el9_6.x86_64 SMP preempt mod_unload modversions
sig_id:       PKCS#7
signer:       Rocky kernel signing key
sig_key:      F5:03:24:D1:25:4A:DE:82:57:F2:1C:EE:7C:D6:C7:14:28:E3:FF
sig_hashalgo: sha256
signature:    60:45:40:31:29:07:01:AA:4A:4B:CF:C6:7C:F0:40:01:07:FA:B9:60:
            53:60:AC:A4:F8:DE:0F:4A:44:BC:57:6B:F6:6C:E5:4F:AF:37:F7:96:
            F7:A3:99:62:88:DB:5C:34:35:06:4C:97:14:79:17:96:FA:71:CE:F0:
            99:3D:32:04:E9:C3:61:60:35:DA:47:8C:CB:D0:40:5C:4E:A2:F4:68:
            C9:5E:A7:48:64:BA:24:71:C5:44:CF:60:4F:1D:35:F6:73:77:27:F9:
            07:5A:A2:60:E7:FE:AB:D3:54:F1:93:2F:24:37:CA:DA:CF:3C:9B:6A:
```

## Параметры bluetooth и выгрузка модуля

1. disable\_esc0
2. disable\_ertm
3. enable\_ecred

```
9A:32:6B:B9:7B:D4:F1:3A:8A:BA:A8:6E:E4:7F:EE:9A:60:C6:AE:A5:  
8D:8D:23:7F:E3:2F:EF:4B:4C:43:3E:52:F8:9C:B1:55:15:77:66:DF:  
42:04:B9:4E:1D:9D:6C:3B:4B:80:C3:43:3F:5A:58:AE:DB:BB:E5:82:  
D7:76:76:34:6C:F2:0F:69:38:03:DF:A4:89:A7:30:61:8D:D5:07:72:  
2C:3E:9E:A3:35:EE:9B:8D:64:AD:07:07:DA:73:75:20:FE:44:28:BC:  
7C:A3:26:F7:82:B8:DA:B1:0A:8B:87:F2:69:2D:F8:F5:7F:0C:2B:C2:  
B3:40:73:8F:1D:48:EE:62:F7:08:43:33:A1:18:52:7E:F3:91:E1:49:  
A7:61:FF:DA:FA:6C:F5:DD:B3:AB:B2:9D:AA:DB:58:41:CF:F8:38:0B:  
EE:C1:85:7E:14:6C:AF:33:F8:40:B4:1B:BD:0B:8A:53:5D:6C:EE:84:  
47:1E:DA:9F  
parm:      disable_esc0:Disable eSCO connection creation (bool)  
parm:      disable_ertm:Disable enhanced retransmission mode (bool)  
parm:      enable_ecred:Enable enhanced credit flow control mode (bool)  
[root@aeakunaeva ~]# modprobe -r bluetooth  
[root@aeakunaeva ~]# lsmod | grep bluetooth
```

## Информация о текущей версии ядра и доступных пакетах

```
uname -r
```

```
dnf list kernel
```

```
[root@aekunaeva ~]# uname -r
5.14.0-570.17.1.el9_6.x86_64
[root@aekunaeva ~]# dnf list kernel
Last metadata expiration check: 0:48:41 ago on Sat 04 Oct 2025 09:50:08 PM MSK.
Installed Packages
kernel.x86_64          5.14.0-570.17.1.el9_6                  @anaconda
Available Packages
kernel.x86_64          5.14.0-570.42.2.el9_6                baseos
[root@aekunaeva ~]# █
```

# Обновление системы

```
dnf upgrade --refresh
```

```
[root@aakunaeva ~]# dnf upgrade --refresh
Rocky Linux 9 - BaseOS                                     7.4 kB/s | 4.1 kB   00:00
Rocky Linux 9 - BaseOS                                     4.1 MB/s | 2.5 MB   00:00
Rocky Linux 9 - AppStream                                    15 kB/s | 4.5 kB   00:00
Rocky Linux 9 - AppStream                                    12 MB/s | 9.5 MB   00:00
Rocky Linux 9 - Extras                                      7.5 kB/s | 2.9 kB   00:00
Dependencies resolved.
=====
Package           Arch    Version            Repository  Size
=====
Installing:
kernel          x86_64  5.14.0-570.58.1.el9_6      baseos     1.8 M
Upgrading:
NetworkManager   x86_64  1:1.52.0-9.el9_6        baseos     2.3 M
NetworkManager-adsl          x86_64  1:1.52.0-9.el9_6        baseos     31 k
NetworkManager-bluetooth      x86_64  1:1.52.0-9.el9_6        baseos     57 k
NetworkManager-config-server  noarch   1:1.52.0-9.el9_6        baseos     17 k
NetworkManager-libnm          x86_64  1:1.52.0-9.el9_6        baseos     1.9 M
NetworkManager-team          x86_64  1:1.52.0-9.el9_6        baseos     36 k
NetworkManager-tui          x86_64  1:1.52.0-9.el9_6        baseos     246 k
NetworkManager-wifi          x86_64  1:1.52.0-9.el9_6        baseos     80 k
NetworkManager-wwan          x86_64  1:1.52.0-9.el9_6        baseos     64 k
at                  x86_64  3.1.23-12.el9_6        baseos     59 k
avahi              x86_64  0.8-22.el9_6.1       baseos     287 k
avahi-glib         x86_64  0.8-22.el9_6.1       appstream   14 k
avahi-libs          x86_64  0.8-22.el9_6.1       baseos     66 k
avahi-tools         x86_64  0.8-22.el9_6.1       appstream   38 k
bind-libs           x86_64  32:9.16.23-31.el9_6     appstream   1.2 M
bind-license        noarch   32:9.16.23-31.el9_6     appstream   12 k
bind-utils          x86_64  32:9.16.23-31.el9_6     appstream   199 k
buildah            x86_64  2:1.39.4-2.el9_6       appstream   11 M
cockpit            x86_64  224.2-1.el9_6       baseos     40 k
```

# Обновление ядра и ОС

```
dnf update kernel
```

```
dnf update
```

```
dnf upgrade --refresh
```

```
Installed:
  grub2-tools-efi-1:2.06-105.el9_6.x86_64          grub2-tools-extra-1:2.06-105.el9_6.x86_64
  kernel-5.14.0-570.58.1.el9_6.x86_64            kernel-core-5.14.0-570.58.1.el9_6.x86_64
  kernel-devel-5.14.0-570.58.1.el9_6.x86_64       kernel-modules-5.14.0-570.58.1.el9_6.x86_64
  kernel-modules-core-5.14.0-570.58.1.el9_6.x86_64

Complete!
[root@aeakunaeva ~]# dnf update kernel
Last metadata expiration check: 0:12:45 ago on Sat 04 Oct 2025 10:44:03 PM MSK.
Dependencies resolved.
Nothing to do.
Complete!
[root@aeakunaeva ~]# dnf update kernel
Rocky Linux 9 - BaseOS                               12 kB/s | 4.1 kB   00:00
Rocky Linux 9 - AppStream                            9.9 kB/s | 4.5 kB   00:00
Rocky Linux 9 - Extras                             9.1 kB/s | 2.9 kB   00:00
Dependencies resolved.
Nothing to do.
Complete!
[root@aeakunaeva ~]# dnf update
Last metadata expiration check: 0:00:24 ago on Sat 08 Nov 2025 04:29:36 AM MSK.
Dependencies resolved.
Nothing to do.
Complete!
[root@aeakunaeva ~]# dnf upgrade --refresh
Rocky Linux 9 - BaseOS                               13 kB/s | 4.1 kB   00:00
Rocky Linux 9 - AppStream                            13 kB/s | 4.5 kB   00:00
Rocky Linux 9 - Extras                             9.0 kB/s | 2.9 kB   00:00
Dependencies resolved.
Nothing to do.
```

## Проверка установки новой версии ядра ОС

```
uname -r
```

```
hostnamectl
```

```
u[aeakunaeva@aeakunaeva ~]$ uname -r
5.14.0-570.58.1.el9_6.x86_64
[aeakunaeva@aeakunaeva ~]$ hostnamectl
  Static hostname: aeakunaeva.localdomain
    Icon name: computer-vm
      Chassis: vm [81F]
    Machine ID: 2edc6ad45edc4b8ca12fb8e088515ec9
        Boot ID: bfc2b228c97d4dacada01bdbd30872b1
  Virtualization: oracle
Operating System: Rocky Linux 9.6 (Blue Onyx)
  CPE OS Name: cpe:/o:rocky:rocky:9::baseos
        Kernel: Linux 5.14.0-570.58.1.el9_6.x86_64
  Architecture: x86-64
Hardware Vendor: innotek GmbH
  Hardware Model: VirtualBox
Firmware Version: VirtualBox
[aeakunaeva@aeakunaeva ~]$ █
```

## Выводы

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## Выводы

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Я получила навыки работы с утилитами управления модулями ядра операционной системы.