

Лабораторная работа №10

Основы работы с модулями ядра операционной системы

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Цели и задачи

- 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

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

Выполнение лабораторной работы

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_intel     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@aeakunaeva ~]# lsmod | grep ext4
[root@aeakunaeva ~]# modprobe ext4
[root@aeakunaeva ~]# lsmod | grep ext4
ext4                1191936  0
mbcache             16384    1 ext4
jbd2                 221184    1 ext4
[root@aeakunaeva ~]# 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:B7:D7:D1:6A:9B:18:DE:60:
```

`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@aeakunaeva ~]# lsmod | grep bluetooth
[root@aeakunaeva ~]# modprobe bluetooth
[root@aeakunaeva ~]# lsmod | grep bluetooth
bluetooth                1114112  0
rfkill                    40960  4 bluetooth
[root@aeakunaeva ~]# modinfo blurtooth
modinfo: ERROR: Module blurtooth not found.
[root@aeakunaeva ~]# 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:      60:45:4D: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_esco
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_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@aeakunaeva ~]# modprobe -r bluetooth
[root@aeakunaeva ~]# lsmod | grep bluetooth
```

```
uname -r
```

```
dnf list kernel
```

```
[root@aeakunaeva ~]# uname -r
5.14.0-570.17.1.el9_6.x86_64
[root@aeakunaeva ~]# 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@aeakunaeva ~]#
```

dnf upgrade --refresh

```
[root@aeakunaeva ~]# 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    334-2-1.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 
        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

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