

Отчёт о лабораторной работе

Лабораторная работа 10. Основы работы с модулями ядра операционной системы

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Содержание

1. Цель работы

Получить навыки работы с утилитами управления модулями ядра операционной системы.

2. Задание

1. Продемонстрируйте навыки работы по управлению модулями ядра (см. раздел 10.4.1).
2. Продемонстрируйте навыки работы по загрузке модулей ядра с параметрами (см. раздел 10.4.2).

3. Выполнение лабораторной работы

3.1 Работа с устройствами и модулями ядра

Получаем полномочия администратора и просматриваем устройства системы с связанными модулями ядра (рис. [fig:001?]).

```
Activities Terminal Sep 8 21:00 en
root@ndbaranov:~

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/FB/FW/FRW (ICH6 Family) USB2 EHCI Controller
Kernel driver in use: ehci-pci
Kernel modules: ehci
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@ndbaranov ~]# lsmod | sort
ac97_bus 12288 1 snd_ac97_codec
ahci 49152 3
ata_generic 16384 0
ata_piix 45056 1
cdrom 90112 2 isofs,sr_mod
crc32c_intel 24576 1
crc32_pclmul 12288 0
crt10dif_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 811908 7 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
```

Просмотр устройств системы

Информация об устройствах системы: - 06:01.1 IDE interface: Intel Corporation 82371AB/EB/MB PIIX4 IDE - IDE контроллер с драйвером ata_piix - 06:02.0 VGA compatible controller: VMware SVGA II Adapter - видеоконтроллер VMware с драйвером vmwgfx - 06:03.0 Ethernet controller: Intel Corporation 82540EM - сетевой контроллер с драйвером e1000 - 06:04.0 System peripheral: VirtualBox Guest Service - службы гостевой ОС VirtualBox с драйвером vboxguest - 06:05.0 Multimedia audio controller: Intel Corporation 82801AA - аудиоконтроллер с драйвером snd_intel8x0 - 06:06.0 USB controller: Apple Inc. KeyLargo/Intrepid USB - USB контроллер с драйвером ohci-pci - 06:07.0 Bridge: Intel Corporation 82371AB/EB/MB PIIX4 ACPI - мост с драйвером piix4_smbus - 06:08.0 USB controller: Intel Corporation 82801FB - USB2 контроллер с драйвером ehci-pci - 06:09.0 SATA controller: Intel Corporation 82801HM - SATA контроллер с драйвером ahci

Просматриваем загруженные модули ядра (рис. [fig:001?]).

```
Activities Terminal Sep 8 21:00 en
root@ndbaranov:~

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
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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
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Kernel driver in use: ehci-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@ndbaranov ~]# lsmod | sort
ac97_bus          12288  1 snd_ac97_codec
ahci              49152  3
ata_generic      16384  0
ata_piix         45056  1
cdrom            90112  2 isofs,sr_mod
crc32c_intel     24576  1
crc32_pclmul     12288  0
crt10dif_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  7 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
```

Просмотр загруженных модулей ядра

Проверяем наличие модуля ext4 и загружаем его (рис. [fig:002?]).

```
Activities Terminal Sep 8 21:02 en
root@ndbaranov:~
xfs 2686976 2
[root@ndbaranov ~]# lsmod | grep ext4
[root@ndbaranov ~]# modprobe ext4
[root@ndbaranov ~]# lsmod | grep ext4
ext4 1191936 0
mbcache 16384 1 ext4
jbd2 221184 1 ext4
[root@ndbaranov ~]# modinfo ext4
filename: /lib/modules/5.14.0-570.37.1.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: 30C9EDC227E3D26EE09D87
depends: jbd2,mbcache
retpoline: Y
intree: Y
name: ext4
vermagic: 5.14.0-570.37.1.el9_6.x86_64 SMP preempt mod_unload modversions
sig_id: PKCS#7
signer: Rocky kernel signing key
sig_key: 77:C6:BE:A7:1A:16:5B:25:A1:C4:0B:B5:D9:73:22:B2:D5:17:FE:C0
sig_hashalgo: sha256
signature: 73:71:28:83:96:C2:20:F2:B8:05:8A:2D:9C:79:CF:C9:AE:2D:C1:92:
1A:B9:60:27:40:5A:E0:22:9A:CF:A3:F2:F3:AD:D7:30:16:45:8D:EA:
42:87:97:12:42:CA:99:82:69:69:F8:99:38:B5:B3:C5:5D:11:84:A4:
60:06:C3:29:60:9F:1B:D3:F6:94:8B:9A:44:DF:65:55:82:04:54:BC:
CE:04:CA:5C:14:D3:36:31:CB:DE:0D:96:F9:85:1D:4F:2C:56:25:8D:
75:4B:DB:51:8C:B7:FE:10:8D:2B:14:BF:A3:C0:29:78:4A:5D:5E:FB:
24:4B:6E:4A:1A:2B:8B:CF:D1:65:43:31:84:86:16:F9:D7:46:8E:1F:
A7:9B:99:A5:61:D9:DC:98:25:F6:8F:3F:3E:B9:79:14:82:58:91:75:
4A:F3:E3:C8:EF:3A:F6:CC:18:2D:EA:2E:2F:B7:05:10:87:63:D1:68:
E6:EC:1C:D3:15:3F:89:09:7F:9F:AF:1E:FB:79:14:8D:25:C8:B2:C2:
34:10:B3:B8:8C:50:FE:5E:67:C1:CF:C0:C8:48:E9:0C:C6:35:4B:A6:
0A:47:21:D2:90:65:BD:AA:1D:C0:3C:61:67:72:AF:00:4C:36:63:15:
7C:9B:8F:35:35:83:14:2C:7B:CE:95:4B:D5:58:3A:AB:A3:A0:B1:0C:31:
3F:12:8A:33:31:B7:C5:0A:D7:16:9E:95:A5:02:35:4C:97:25:EB:06:
9F:81:B4:D3:D8:0A:39:9F:F0:31:9D:76:AC:53:3A:D6:A6:AA:AB:2C:
BB:03:1A:2E:AF:0D:C4:F0:EA:9F:38:F4:43:BC:C5:22:80:0E:4B:C8:
66:E2:9F:8C:1D:02:5D:6D:9E:A5:39:47:FC:6F:00:17:D9:6A:AA:ED:
87:EF:9C:B9:76:6E:13:62:AF:92:DA:EA:B3:22:98:73:7B:FF:E1:51:
7B:20:F6:8E:B1:42:32:8B:A4:EF:A4:C4:00:DB:8E:64:3F:A3:E4:32:
86:9E:AD:B4
[root@ndbaranov ~]#
```

Проверка и загрузка модуля ext4

Просматриваем информацию о модуле ext4 (рис. [fig:002?], [fig:003?]).

```
Activities Terminal Sep 8 21:02 en
root@ndbaranov:~

xfs 2686976 2
[root@ndbaranov ~]# lsmod | grep ext4
[root@ndbaranov ~]# modprobe ext4
[root@ndbaranov ~]# lsmod | grep ext4
ext4 1191936 0
mbcache 16384 1 ext4
jbd2 221184 1 ext4
[root@ndbaranov ~]# modinfo ext4
filename: /lib/modules/5.14.0-570.37.1.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: 30C9EDC227E3D26EE09D87
depends: jbd2,mbcache
retpoline: Y
intree: Y
name: ext4
vermagic: 5.14.0-570.37.1.el9_6.x86_64 SMP preempt mod_unload modversions
sig_id: PKCS#7
signer: Rocky kernel signing key
sig_key: 77:C6:BE:A7:1A:16:5B:25:A1:C4:0B:B5:D9:73:22:B2:D5:17:FE:C0
sig_hashalgo: sha256
signature: 73:71:28:83:96:C2:20:F2:B8:05:8A:2D:9C:79:CF:C9:AE:2D:C1:92:
1A:B9:60:27:40:5A:E0:22:9A:CF:A3:F2:F3:AD:D7:30:16:45:8D:EA:
42:87:97:12:42:CA:99:82:69:69:F8:99:38:B5:B3:C5:5D:11:84:A4:
60:06:C3:29:60:9F:1B:D3:F6:94:8B:9A:44:DF:65:55:82:04:54:BC:
CE:D4:CA:5C:14:D3:36:31:CB:DE:0D:96:F9:85:1D:4F:2C:56:25:BD:
75:48:DB:51:B6:B7:FE:10:8D:2B:14:BF:A3:C0:29:78:4A:5D:5E:F5:
24:48:6E:4A:1A:28:8B:CF:D1:65:43:31:84:B6:16:F9:D7:46:8E:1F:
A7:99:99:A5:61:D9:DC:98:25:F6:8F:3F:3E:B9:79:14:82:58:91:75:
4A:F3:E3:C8:EF:3A:F6:CC:18:2D:EA:2E:2F:B7:05:10:87:63:D1:68:
E6:EC:1C:D3:15:3F:89:09:7F:9F:AF:1E:F8:79:14:8D:25:C8:B2:C2:
34:10:B3:B8:8C:50:FE:5E:67:C1:CF:C0:C8:48:E9:0C:C6:35:4B:A6:
0A:47:21:D2:90:65:BD:AA:1D:C0:3C:61:67:72:AF:00:4C:36:63:15:
7C:9B:8F:35:83:14:2C:7B:CE:95:4B:D5:58:3A:AB:A3:A0:B1:BC:31:
3F:12:8A:33:31:B7:C5:0A:D7:16:9E:95:A5:02:35:4C:97:25:EB:06:
9F:81:B4:D3:DB:0A:39:9F:F0:31:9D:76:AC:53:3A:D6:A6:AA:AB:2C:
BB:03:1A:2E:AF:0D:C4:F0:EA:9F:38:F4:43:BC:C5:22:B0:0E:4B:C8:
66:E2:9F:8C:1D:02:5D:6D:9E:A5:39:47:FC:6F:00:17:D9:6A:AA:ED:
87:EF:9C:B9:76:6E:13:62:AF:92:DA:EA:B3:22:98:73:7B:FF:E1:51:
7B:29:F6:8E:B1:42:32:8B:A4:EF:A4:C4:00:DB:8E:64:3F:A3:E4:32:
86:9E:AD:B4
[root@ndbaranov ~]#

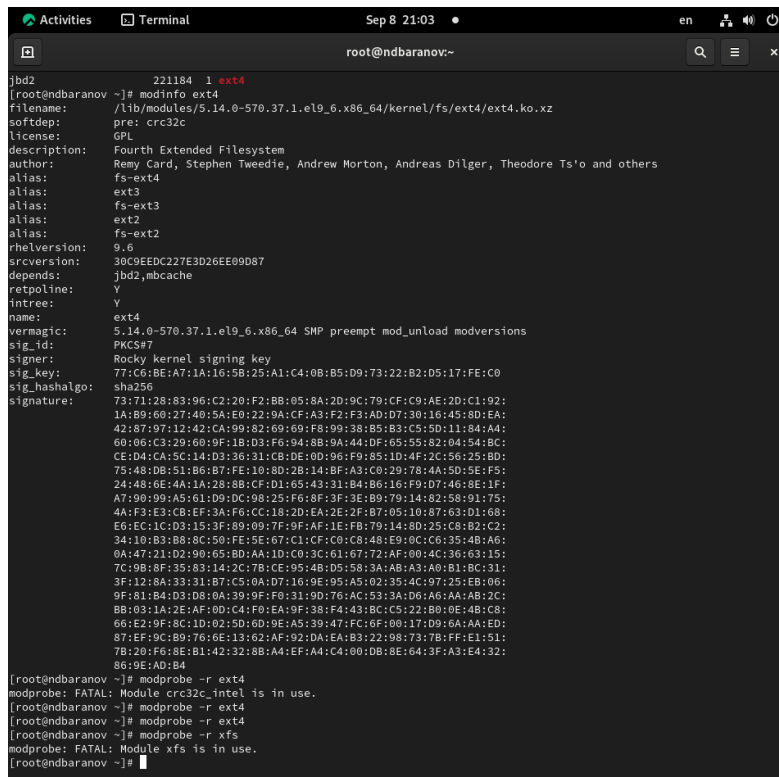
Activities Terminal Sep 8 21:03 en
root@ndbaranov:~

jbd2 221184 1 ext4
[root@ndbaranov ~]# modinfo ext4
filename: /lib/modules/5.14.0-570.37.1.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: 30C9EDC227E3D26EE09D87
depends: jbd2,mbcache
retpoline: Y
intree: Y
name: ext4
vermagic: 5.14.0-570.37.1.el9_6.x86_64 SMP preempt mod_unload modversions
sig_id: PKCS#7
signer: Rocky kernel signing key
sig_key: 77:C6:BE:A7:1A:16:5B:25:A1:C4:0B:B5:D9:73:22:B2:D5:17:FE:C0
sig_hashalgo: sha256
signature: 73:71:28:83:96:C2:20:F2:B8:05:8A:2D:9C:79:CF:C9:AE:2D:C1:92:
1A:B9:60:27:40:5A:E0:22:9A:CF:A3:F2:F3:AD:D7:30:16:45:8D:EA:
42:87:97:12:42:CA:99:82:69:69:F8:99:38:B5:B3:C5:5D:11:84:A4:
60:06:C3:29:60:9F:1B:D3:F6:94:8B:9A:44:DF:65:55:82:04:54:BC:
CE:D4:CA:5C:14:D3:36:31:CB:DE:0D:96:F9:85:1D:4F:2C:56:25:BD:
75:48:DB:51:B6:B7:FE:10:8D:2B:14:BF:A3:C0:29:78:4A:5D:5E:F5:
24:48:6E:4A:1A:28:8B:CF:D1:65:43:31:84:B6:16:F9:D7:46:8E:1F:
A7:99:99:A5:61:D9:DC:98:25:F6:8F:3F:3E:B9:79:14:82:58:91:75:
4A:F3:E3:C8:EF:3A:F6:CC:18:2D:EA:2E:2F:B7:05:10:87:63:D1:68:
E6:EC:1C:D3:15:3F:89:09:7F:9F:AF:1E:F8:79:14:8D:25:C8:B2:C2:
34:10:B3:B8:8C:50:FE:5E:67:C1:CF:C0:C8:48:E9:0C:C6:35:4B:A6:
0A:47:21:D2:90:65:BD:AA:1D:C0:3C:61:67:72:AF:00:4C:36:63:15:
7C:9B:8F:35:83:14:2C:7B:CE:95:4B:D5:58:3A:AB:A3:A0:B1:BC:31:
3F:12:8A:33:31:B7:C5:0A:D7:16:9E:95:A5:02:35:4C:97:25:EB:06:
9F:81:B4:D3:DB:0A:39:9F:F0:31:9D:76:AC:53:3A:D6:A6:AA:AB:2C:
BB:03:1A:2E:AF:0D:C4:F0:EA:9F:38:F4:43:BC:C5:22:B0:0E:4B:C8:
66:E2:9F:8C:1D:02:5D:6D:9E:A5:39:47:FC:6F:00:17:D9:6A:AA:ED:
87:EF:9C:B9:76:6E:13:62:AF:92:DA:EA:B3:22:98:73:7B:FF:E1:51:
7B:29:F6:8E:B1:42:32:8B:A4:EF:A4:C4:00:DB:8E:64:3F:A3:E4:32:
86:9E:AD:B4
[root@ndbaranov ~]# modprobe -r ext4
modprobe: FATAL: Module crc32c_intel is in use.
[root@ndbaranov ~]# modprobe -r ext4
[root@ndbaranov ~]# modprobe -r ext4
[root@ndbaranov ~]# modprobe -r xfs
modprobe: FATAL: Module xfs is in use.
[root@ndbaranov ~]#
```

Информация о модуле ext4: - filename - путь к файлу модуля -
description - описание: Fourth Extended Filesystem - author - авторы файловой
системы - license - лицензия: GPL - depends - зависимости: jbd2, mbcache -

vermagic - версия ядра, для которой скомпилирован модуль - alias - псевдонимы модуля (поддержка ext3, ext2)

Пытаемся выгрузить модуль ext4 (рис. [fig:003?]).



```
jbd2 221184 1 ext4
[root@ndbaranov ~]# modinfo ext4
filename:       /lib/modules/5.14.0-570.37.1.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:     30C9EEDC227E3D26EE09087
depends:         jbd2,mbcache
retpoline:      Y
intree:         Y
name:           ext4
vermagic:       5.14.0-570.37.1.el9_6.x86_64 SMP preempt mod_unload modversions
sig_id:         PKCSH7
signer:         Rocky kernel signing key
sig_key:        77:C6:8E:A7:1A:16:5B:25:A1:C4:0B:B5:D9:73:22:B2:D5:17:FE:C0
sig_hashalgo:   sha256
signature:      73:71:28:83:96:C2:20:F2:BB:05:8A:2D:9C:79:CF:C9:AE:2D:C1:92:
1A:B9:60:27:40:5A:E0:22:9A:CF:A3:F2:F3:AD:D7:30:16:45:8D:EA:
42:87:97:12:42:CA:99:82:69:69:F8:99:38:B5:B3:C5:5D:11:84:A4:
60:06:C3:29:60:9F:1B:D3:F6:04:8B:9A:44:DF:05:55:82:04:54:8C:
CE:D4:CA:5C:14:D3:36:31:C8:0E:00:96:F9:05:1D:4F:2C:56:25:8D:
75:48:DB:51:86:B7:FE:10:80:2B:14:BF:A3:C0:29:78:4A:5D:5E:FS:
24:48:6E:4A:1A:28:8B:CF:D1:65:43:31:84:B6:16:F0:D7:46:8E:1F:
A7:99:99:A5:61:D9:DC:98:25:F6:8F:3F:3E:B9:79:14:82:58:91:75:
4A:F3:E3:C8:EF:3A:F6:CC:18:2D:EA:2E:2F:B7:05:10:87:63:D1:68:
E6:EC:1C:D3:15:3F:89:09:7F:9F:AF:1E:FB:79:14:8D:25:C8:B2:C2:
34:10:B3:B8:8C:50:FE:5E:67:C1:CF:C0:C8:48:E9:0C:C6:35:4B:A6:
0A:47:21:D2:90:65:BD:AA:1D:C0:3C:61:67:72:AF:00:4C:36:63:15:
7C:9B:8F:35:03:14:26:7B:CE:95:4B:D5:58:3A:AB:A0:B1:0C:31:
3F:12:8A:33:31:87:C5:0A:D7:16:9E:95:A5:02:35:4C:97:25:EB:06:
9F:81:B4:D3:D8:0A:39:9F:F0:31:9D:76:AC:53:3A:D6:A6:AA:AB:2C:
BB:03:1A:2E:1A:FD:0D:C4:F0:EA:9F:38:F4:43:BC:C5:22:B0:0E:4B:C8:
66:E2:9F:8C:1D:02:5D:6D:9E:A5:39:47:FC:6C:00:17:D9:6A:AA:ED:
87:EF:9C:B9:76:6E:13:62:AF:92:DA:EA:B3:22:98:73:78:FF:E1:51:
7B:20:F6:8E:B1:42:32:8B:A4:EF:A4:C4:00:DB:8E:64:3F:A3:E4:32:
86:9E:AD:B4
[root@ndbaranov ~]# modprobe -r ext4
modprobe: FATAL: Module crc32c_intel is in use.
[root@ndbaranov ~]# modprobe -r ext4
[root@ndbaranov ~]# modprobe -r ext4
[root@ndbaranov ~]# modprobe -r xfs
modprobe: FATAL: Module xfs is in use.
[root@ndbaranov ~]#
```

Попытка выгрузки модуля ext4

Реакция системы: При попытке выгрузки модуля ext4 система сообщает, что модуль `crc32c_intel` используется, что препятствует выгрузке ext4. После нескольких попыток модуль удастся выгрузить.

Пытаемся выгрузить модуль xfs (рис. [fig:003?]).

```
Activities Terminal Sep 8 21:03 en
root@ndbaranov:~
jbd2 221184 1 ext4
[root@ndbaranov ~]# modinfo ext4
filename: /lib/modules/5.14.0-570.37.1.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
ehelversion: 9.6
srcversion: 30C9EE0C227E3D26EE09087
depends: jbd2,mbcache
retpoline: Y
intree: Y
name: ext4
vermagic: 5.14.0-570.37.1.el9_6.x86_64 SMP preempt mod_unload modversions
sig_id: PKCS7
signer: Rocky kernel signing key
sig_key: 77:C6:BE:A7:1A:16:5B:25:A1:C4:0B:B5:D9:73:22:B2:D5:17:FE:C0
sig_hashalgo: sha256
signature: 73:71:28:83:96:C2:20:F2:BB:05:8A:2D:9C:79:CF:C9:AE:2D:C1:92:
1A:B9:60:27:40:5A:E0:22:9A:CF:A3:F2:F3:AD:D7:30:16:45:8D:EA:
42:87:97:12:42:CA:99:82:69:69:F8:99:38:B5:B3:C5:5D:11:84:A4:
00:06:C3:29:60:0F:18:D3:F6:94:8B:9A:4A:DF:05:55:82:04:54:BC:
CE:04:CA:5C:14:D3:36:31:CB:0E:00:96:F9:85:1D:4F:2C:56:25:8D:
75:48:DB:51:86:B7:FE:10:80:2B:14:BF:A3:C0:29:78:4A:5D:5E:F5:
24:48:6E:4A:1A:28:8B:CF:D1:65:43:31:84:B6:16:F9:D7:46:8E:1F:
A7:99:99:A5:61:D9:DC:98:25:F6:8F:3F:3E:B9:79:14:82:58:91:75:
4A:F3:E3:C8:EF:3A:F6:CC:18:2D:EA:2E:2F:87:05:10:87:63:D1:68:
E6:EC:1C:D3:15:3F:89:09:7F:9F:AF:1E:FB:79:14:8D:25:C8:B2:C2:
34:10:B3:B8:8C:50:FE:9E:67:C1:CF:C0:C8:48:E9:0C:C6:35:4B:A6:
0A:47:21:D2:99:65:9D:AA:1D:C0:3C:61:67:72:AF:00:4C:36:63:15:
7C:96:8F:35:83:14:2C:7B:CE:95:4B:D5:58:3A:AB:A3:A0:B1:0C:31:
3F:12:8A:33:31:87:C5:0A:D7:16:9E:95:A5:02:35:4C:97:25:EB:06:
9F:81:84:D3:D8:0A:39:9F:F0:31:9D:76:AC:53:3A:D6:A6:AA:2C:
BB:03:1A:2E:AF:0D:C4:F0:EA:9F:38:F4:43:BC:C5:22:B0:0E:4B:C8:
66:E2:9F:8C:1D:02:5D:6D:9E:A5:39:47:FC:6F:00:17:D9:6A:AA:ED:
87:EF:9C:B9:76:6E:13:62:AF:92:DA:EA:B3:22:98:73:7B:FF:E1:51:
7B:2D:F6:8E:B1:42:32:8B:A4:EF:A4:C4:00:DB:8E:64:3F:A3:E4:32:
86:9E:AD:84
[root@ndbaranov ~]# modprobe -r ext4
modprobe: FATAL: Module crc32c_intel is in use.
[root@ndbaranov ~]# modprobe -r ext4
[root@ndbaranov ~]# modprobe -r ext4
[root@ndbaranov ~]# modprobe -r xfs
modprobe: FATAL: Module xfs is in use.
[root@ndbaranov ~]#
```

Попытка выгрузки модуля xfs

Реакция системы: Система сообщает об ошибке - модуль xfs используется и не может быть выгружен.

3.2 Работа с модулем bluetooth

Проверяем и загружаем модуль bluetooth (рис. [fig:004?]).

```
Activities Terminal Sep 8 21:05 en
root@ndbaranov:~

[baranov@ndbaranov ~]$ su -
Password:
[root@ndbaranov ~]# lsmod | grep bluetooth
[root@ndbaranov ~]# modprobe bluetooth
[root@ndbaranov ~]# lsmod | grep bluetooth
bluetooth 1114112 0
rfkill 40960 4 bluetooth
[root@ndbaranov ~]# modinfo bluetooth
filename: /lib/modules/5.14.0-570.37.1.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: C6ED64B96F8C9A31FC91B17
depends: rfkill
retpoline: Y
intree: Y
name: bluetooth
vermagic: 5.14.0-570.37.1.el9_6.x86_64 SMP preempt mod_unload modversions
sig_id: PKCS#7
signer: Rocky kernel signing key
sig_key: 77:C6:BE:A7:1A:16:5B:25:A1:C4:0B:B5:D9:73:22:B2:D5:17:FE:C0
sig_hashalgo: sha256
signature: 06:29:62:44:10:27:4F:D4:54:19:8F:2C:62:C6:6D:8C:1F:BD:89:75:
28:45:A7:2F:56:6A:D1:58:14:93:A2:AC:B5:35:10:C4:35:16:1F:F4:
74:FE:61:C3:8A:E1:B5:73:84:59:F7:6D:79:80:4C:9E:8A:DE:CB:0D:
8E:4F:EC:06:96:26:AA:1A:E5:D4:B4:6D:F8:F7:06:A5:AD:4A:C3:48:
B2:1A:D6:02:BC:76:D9:33:38:D7:E5:13:76:30:C5:C1:2E:4A:E4:3F:
28:EE:71:6E:AF:89:2F:60:EC:B3:AC:D3:96:07:E4:D3:D0:34:D0:CF:
69:EC:58:FA:10:A9:A3:63:F2:DD:10:0B:A6:7B:44:53:BE:75:60:74:
55:DA:B4:AC:09:7E:3F:2F:FD:7B:6E:CE:CB:74:50:08:DE:FC:8F:84:
4B:FD:10:05:61:30:04:25:35:DA:55:5A:23:4E:42:F2:12:77:4B:FA:
36:5E:DD:D1:0D:8F:B4:68:49:43:5C:88:D6:AC:A0:4F:7E:18:B6:1A:
6A:43:2F:8D:33:C6:03:29:CD:A7:6D:8C:D3:D2:86:B6:61:F7:00:5F:
31:88:62:77:BA:07:B4:29:E1:57:83:F2:1A:09:18:2C:19:8D:E5:8D:
1C:E7:31:05:A0:9C:2E:89:D2:60:15:4E:ED:3D:F3:30:75:3B:CF:67:
9D:5A:76:09:B3:69:17:5C:80:29:2B:B5:CA:F5:DB:F5:18:7A:A7:D7:
E2:42:EB:0C:61:B6:83:0F:00:E8:22:08:80:6D:1B:47:3C:1D:54:67:
CC:DC:A9:D2:2B:FD:3E:76:9B:52:FF:21:18:AB:26:41:83:EC:30:10:
6B:E4:3C:F8:F8:48:3B:BB:E9:2D:75:E7:A8:CD:34:15:C0:FE:79:B2:
74:5B:B6:5F:C8:DD:9B:45:C2:4F:A1:03:84:60:59:78:19:9F:A4:7C:
95:CB:D0:20:1E:A8:F3:20:C0:51:C1:B3:B6:CD:3F:B9:6C:A0:6E:E4:
8E:C4:B6:82
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@ndbaranov ~]# modprobe -r bluetooth
[root@ndbaranov ~]#
```

Работа с модулем bluetooth

Просматриваем информацию о модуле bluetooth (рис. [fig:004?]).


```
Activities Terminal Sep 8 21:05 en
root@ndbaranov:~

[baranov@ndbaranov ~]$ su -
Password:
[root@ndbaranov ~]# lsmod | grep bluetooth
[root@ndbaranov ~]# modprobe bluetooth
[root@ndbaranov ~]# lsmod | grep bluetooth
bluetooth 11114112 0
rfkill 40960 4 bluetooth
[root@ndbaranov ~]# modinfo bluetooth
filename: /lib/modules/5.14.0-570.37.1.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>
rhmversion: 9.6
srcversion: C6ED64B96F8C9A31FC91B17
depends: rfkill
retpoline: Y
intree: Y
name: bluetooth
vermagic: 5.14.0-570.37.1.el9_6.x86_64 SMP preempt mod_unload modversions
sig_id: PKCS#7
signer: Rocky kernel signing key
sig_key: 77:C6:BE:A7:1A:16:5B:25:A1:C4:0B:B5:D9:73:22:B2:D5:17:FE:C0
sig_hashalgo: sha256
signature: 06:29:62:44:10:27:4F:D4:54:19:8F:2C:62:C6:6D:8C:1F:BD:89:75:
28:45:A7:2F:56:0A:D1:58:14:93:A2:AC:B5:35:10:C4:35:16:1F:F4:
74:FE:61:C3:8A:E1:B5:73:84:59:F7:6D:79:80:4C:9E:8A:DE:CB:0D:
0E:4F:EC:06:96:26:AA:1A:E5:D4:B4:6D:F8:F7:06:A5:AD:4A:C3:4B:
B2:1A:D6:02:BC:76:D9:33:38:D7:E5:13:76:30:C5:C1:2E:4A:E4:3F:
28:EE:71:6E:AF:89:2F:60:EC:B3:AC:D3:96:07:E4:D3:D0:34:D0:CF:
69:EC:58:FA:10:A9:A3:63:F2:DD:10:0B:A6:7B:44:53:BE:75:60:74:
55:DA:B4:AC:09:7E:3F:2F:FD:7B:6E:CE:CB:74:50:08:DE:FC:8F:84:
4B:FD:10:05:61:30:04:25:35:DA:55:5A:23:4E:42:F2:12:77:4B:FA:
36:5E:DD:D1:0D:8F:B4:68:49:43:5C:88:D6:AC:A0:4F:7E:1B:B6:1A:
6A:43:2F:8D:33:C6:03:29:CD:A7:6D:8C:D3:D2:86:B6:61:F7:00:5F:
31:88:62:77:BA:07:B4:29:E1:57:83:F2:1A:09:18:2C:19:8D:E5:8D:
1C:E7:31:05:A0:9C:2E:89:D2:60:15:4E:ED:3D:F3:30:75:3B:CF:67:
9D:5A:76:09:B3:69:17:5C:80:29:2B:B5:CA:F5:DB:F5:1B:7A:A7:D7:
E2:42:EB:0C:61:B6:83:0F:00:E8:22:08:80:6D:1B:47:3C:1D:54:67:
CC:DC:A9:D2:2B:FD:3E:76:9B:52:FF:21:18:AB:26:41:83:EC:30:10:
0B:E4:3C:F8:F8:4B:3B:BB:E9:2D:75:E7:A8:CD:34:15:C0:FE:79:B2:
74:5B:B6:5F:C8:DD:9B:45:C2:4F:A1:03:84:60:59:78:19:9F:A4:7C:
95:CB:D0:20:1E:A8:F3:20:C0:51:C1:B3:B6:CD:3F:B9:6C:A0:6E:E4:
8E:C4:B6:82
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@ndbaranov ~]# modprobe -r bluetooth
[root@ndbaranov ~]#
```

Информация о модуле bluetooth

Параметры модуля bluetooth: - `disable_esco` - отключение создания eSCO соединений (bool) - `disable_ertm` - отключение расширенного режима повторной передачи (bool) - `enable_ecred` - включение расширенного управления потоком кредитов (bool)

Выгружаем модуль bluetooth (рис. [fig:004?]).

```
Activities Terminal Sep 8 21:05 en
root@ndbaranov:~

[baranov@ndbaranov ~]$ su -
Password:
[root@ndbaranov ~]# lsmod | grep bluetooth
[root@ndbaranov ~]# modprobe bluetooth
[root@ndbaranov ~]# lsmod | grep bluetooth
bluetooth 1114112 0
rfkill 40960 4 bluetooth
[root@ndbaranov ~]# modinfo bluetooth
filename: /lib/modules/5.14.0-570.37.1.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: C6ED64B96F8C9A31FC91B17
depends: rfkill
retpoline: Y
intree: Y
name: bluetooth
vermagic: 5.14.0-570.37.1.el9_6.x86_64 SMP preempt mod_unload modversions
sig_id: PKCS#7
signer: Rocky kernel signing key
sig_key: 77:C6:BE:A7:1A:16:5B:25:A1:C4:0B:85:D9:73:22:B2:D5:17:FE:C0
sig_hashalgo: sha256
signature: 06:29:62:44:10:27:4F:D4:54:19:8F:2C:62:C6:6D:8C:1F:BD:89:75:
28:45:A7:2F:56:0A:D1:58:14:93:A2:AC:85:35:10:C4:35:16:1F:F4:
74:FE:61:C3:8A:E1:86:73:84:59:F7:6D:79:80:4C:9E:8A:DE:CB:0D:
8E:4F:EC:06:96:26:AA:1A:E5:D4:B4:6D:F8:F7:06:A5:AD:4A:C3:48:
B2:1A:D6:02:BC:76:D9:33:38:D7:E5:13:76:30:C5:C1:2E:4A:E4:3F:
28:EE:71:6E:AF:89:2F:60:EC:83:AC:D3:96:07:E4:D3:D0:34:D0:CF:
69:EC:58:FA:10:A9:A3:63:F2:DD:10:0B:A6:7B:44:53:BE:75:60:74:
55:DA:B4:AC:09:7E:3F:2F:FD:7B:6E:CE:CB:74:50:08:DE:FC:8F:84:
4B:FD:10:05:61:30:04:25:35:DA:55:5A:23:4E:42:F2:12:77:4B:FA:
36:5E:DD:D1:0D:8F:B4:68:49:43:5C:88:D6:AC:A0:4F:7E:18:B6:1A:
6A:43:2F:8D:33:C6:03:29:CD:A7:6D:8C:D3:D2:86:B6:61:F7:00:5F:
31:88:62:77:BA:07:B4:29:E1:57:83:F2:1A:09:18:2C:19:8D:E5:8D:
1C:E7:31:05:A0:9C:2E:89:D2:60:15:4E:ED:3D:30:75:3B:CF:67:
9D:5A:76:09:B3:69:17:5C:80:29:2B:85:CA:F5:DB:F5:1B:7A:A7:D7:
E2:42:EB:0C:61:B6:83:0F:00:E8:22:08:80:6D:1B:47:3C:1D:54:67:
CC:DC:A9:D2:2B:FD:3E:76:9B:52:FF:21:18:AB:26:41:83:EC:30:10:
6B:E4:3C:F8:FB:48:3B:BB:E9:2D:75:E7:A8:CD:34:15:C0:FE:79:B2:
74:5B:B6:5F:C8:DD:9B:45:C2:4F:A1:03:84:60:59:78:19:9F:A4:7C:
95:CB:D0:20:1E:A8:F3:20:C0:51:C1:B3:B6:CD:3F:B9:6C:A0:6E:E4:
8E:C4:B6:82
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@ndbaranov ~]# modprobe -r bluetooth
[root@ndbaranov ~]#
```

Выгрузка модуля bluetooth

3.3 Обновление ядра операционной системы

Проверяем текущую версию ядра и информацию о системе (рис. [fig:005?], [fig:006?]).

```
Activities Terminal Sep 8 21:08 en root@ndbaranov:~
[baranov@ndbaranov ~]$ su -
Password:
[root@ndbaranov ~]# uname -r
5.14.0-570.37.1.el9_6.x86_64
[root@ndbaranov ~]# dnf list kernel
Last metadata expiration check: 0:06:32 ago on Mon 08 Sep 2025 08:59:51 PM MSK.
Installed Packages
kernel.x86_64                    5.14.0-570.17.1.el9_6      @anaconda
kernel.x86_64                    5.14.0-570.37.1.el9_6      @baseos
[root@ndbaranov ~]# dnf upgrade --refresh
packages for the GitHub CLI
Rocky Linux 9 - BaseOS          290 B/s | 3.0 kB | 00:14
Rocky Linux 9 - AppStream       428 B/s | 4.5 kB | 00:10
Rocky Linux 9 - Extras          278 B/s | 2.9 kB | 00:10
Dependencies resolved.
Nothing to do.
Complete!
[root@ndbaranov ~]# dnf update kernel
Last metadata expiration check: 0:00:12 ago on Mon 08 Sep 2025 09:07:40 PM MSK.
Dependencies resolved.
Nothing to do.
Complete!
[root@ndbaranov ~]# dnf update
Last metadata expiration check: 0:00:20 ago on Mon 08 Sep 2025 09:07:40 PM MSK.
Dependencies resolved.
Nothing to do.
Complete!
[root@ndbaranov ~]#

[baranov@ndbaranov ~]$ su -\
>
> ^C

[baranov@ndbaranov ~]$ su -
Password:
[root@ndbaranov ~]# uname -r
5.14.0-570.37.1.el9_6.x86_64
[root@ndbaranov ~]# hostnamectl
Static hostname: ndbaranov
Icon name: computer-vm
Chassis: vm
Machine ID: ce5436fdb891482c88cb03327500575e
Boot ID: 14b9ed57c6ca40d9871be68cb05204ab
Virtualization: oracle
Operating System: Rocky Linux 9.6 (Blue Onyx)
CPE OS Name: cpe:/o:rocky:rocky:9::baseos
Kernel: Linux 5.14.0-570.37.1.el9_6.x86_64
Architecture: x86_64
Hardware Vendor: innotek GmbH
Hardware Model: VirtualBox
Firmware Version: VirtualBox
[root@ndbaranov ~]#
```

Просматриваем список пакетов ядра и проверяем обновления (рис. [fig:005?]).

```
Activities Terminal Sep 8 21:08 en
root@ndbaranov:~

[baranov@ndbaranov ~]$ su -
Password:
[root@ndbaranov ~]# uname -r
5.14.0-570.37.1.el9_6.x86_64
[root@ndbaranov ~]# dnf list kernel
Last metadata expiration check: 0:06:32 ago on Mon 08 Sep 2025 08:59:51 PM MSK.
Installed Packages
kernel.x86_64                    5.14.0-570.17.1.el9_6      @anaconda
kernel.x86_64                    5.14.0-570.37.1.el9_6      @baseos
[root@ndbaranov ~]# dnf upgrade --refresh
packages for the GitHub CLI
Rocky Linux 9 - BaseOS           290 B/s | 3.0 kB | 00:05
Rocky Linux 9 - AppStream        428 B/s | 4.1 kB | 00:14
Rocky Linux 9 - Extras           278 B/s | 2.9 kB | 00:10
Dependencies resolved.
Nothing to do.
Complete!
[root@ndbaranov ~]# dnf update kernel
Last metadata expiration check: 0:00:12 ago on Mon 08 Sep 2025 09:07:40 PM MSK.
Dependencies resolved.
Nothing to do.
Complete!
[root@ndbaranov ~]# dnf update
Last metadata expiration check: 0:00:20 ago on Mon 08 Sep 2025 09:07:40 PM MSK.
Dependencies resolved.
Nothing to do.
Complete!
[root@ndbaranov ~]#
```

Проверка пакетов ядра и обновлений

Результат проверки обновлений: Система сообщает, что все пакеты уже обновлены и ничего не требуется делать.

4. Выводы

Мы получили навыки работы с утилитами управления модулями ядра операционной системы.

Список литературы