

Лабораторная работа №10

Основы работы с модулями ядра операционной системы

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Цель работы

Основная цель

Получить навыки работы с утилитами управления модулями ядра Linux: их загрузкой, выгрузкой, просмотром параметров и обновлением ядра системы.

Ход выполнения работы

Управление модулями ядра

```
mlabsi@mlabsi:~$ su
Password:
root@mlabsi:/home/mlabsi# 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: pix4_smbus
    Kernel modules: i2c_pix4
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@mlabsi:/home/mlabsi#
```

Просмотр загруженных модулей

```
root@mlabsi:/home/mlabsi# lsmod | sort
ac97_bus           12288  1 snd_ac97_codec
ahci              57344  3
ata_generic        16384  0
ata_piix          45056  1
cdrom             90112  2 isofs,sr_mod
crc32c_intel      16384  0
crc32_pclmul      12288  0
crct10dif_pclmul 12288  1
dm_log            24576  2 dm_region_hash,dm_mirror
dm_mirror         28672  0
dm_mod            245760 9 dm_multipath,dm_log,dm_mirror
dm_multipath      53248  0
dm_region_hash    28672  1 dm_mirror
drm_ttm_helper    16384  2 vmwgfx
e1000            200704  0
fuse              253952  5
ghash_clmulni_intel 16384  0
i2c_piix4        36864  0
i2c_smbus        20480  1 i2c_piix4
intel_pmc_core   126976  0
intel_rapl_common 53248  1 intel_rapl_msrm
intel_rapl_msrm  20480  0
intel_uncore_frequency_common 16384  0
intel_vsec        20480  1 intel_pmc_core
ip_set            69632  0
isofs             69632  1
joydev            28672  0
libahci           69632  1 ahci
libata           512000  4 ata_piix,libahci,ahci,ata_generic
loop              45056  0
Module           Size  Used by
```

Информация о модуле ext4

```
root@mlabsi:/home/mlabsi# lsmod | grep ext4
root@mlabsi:/home/mlabsi# modprobe ext4
root@mlabsi:/home/mlabsi# lsmod | grep ext4
ext4           1187840  0
mbcache          16384  1 ext4
jbd2            217088  1 ext4
root@mlabsi:/home/mlabsi# 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 others
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:A1:34:94:00:57:12:99:67:28: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:
```

Рис. 3: Просмотр информации о модуле ext4

Выгрузка модулей ext4 и xfs

```
vi.or.uu.e7.r9.wu.mg.o9.o2.39.13./v.w1.3e./o.10.mc.eu.go.  
FA:7A:C2:3E:9E:63:B4:57:50:92:28:E8:95:2D:D3:44:C5:8B:F5:C8:  
0A:BE:F5:96:B5:D8:DE:8F:91:DA:85:E5:BF:A2:7D:9B:2A:4C:AD:4E:  
07:54:52:A9:F2:62:B6:D7:58:9F:2E:8D:6A:C2:F4:8E:98:32:EB:14:  
E6:BE:EE:3B:C5:98:36:95:53:D8:61:BD:41:8A:FF:4B:AC:49:70:B2:  
19:94:AF:2A  
root@mlabsi:/home/mlabsi#  
root@mlabsi:/home/mlabsi# modprobe -r ext4  
root@mlabsi:/home/mlabsi# modprobe -r ext4  
root@mlabsi:/home/mlabsi# modprobe -r xfs  
modprobe: FATAL: Module xfs is in use.  
root@mlabsi:/home/mlabsi#
```

Рис. 4: Попытка выгрузки модулей ext4 и xfs

Проверка и загрузка bluetooth

```
root@mlabsi:/home/mlabsi# lsmod | grep bluetooth
root@mlabsi:/home/mlabsi# modprobe bluetooth
root@mlabsi:/home/mlabsi# lsmod | grep bluetooth
bluetooth           1114112  0
rfkill                  40960  4 bluetooth
root@mlabsi:/home/mlabsi# 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:
               44:99:10:80:7A:0F:FF:92:59:FD:59:74:0B:7F:42:40:14:03:C9:
```

Рис. 5: Информация о модуле bluetooth

Выгрузка модуля bluetooth

```
2B:8A:CF:8F:23:38:B4:7A:A9:92:49:86:D7:9F:08:7D:8A:92:7D:DD:  
41:D6:4B:31:F6:45:31:D4:7E:6E:E1:D6:94:BA:D0:6A:12:CC:76:A2:  
12:55:EF:6B:91:CB:45:F0:F5:75:0B:DD:7D:6B:D7:E1:B0:13:51:40:  
29:D2:1D:3B:DD:E2:BF:AC:4B:77:67:BA:C8:95:16:41:00:9A:8F:96:  
21:DC:9A:C2:B2:20:31:5C:EC:90:EA:B0:24:C3:5D:B9:72:31:B8:98:  
DB:A9:4D:FE  
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@mlabsi:/home/mlabsi# modprobe -r bluetooth  
root@mlabsi:/home/mlabsi# █
```

Рис. 6: Выгрузка модуля bluetooth

Просмотр версии ядра и списка пакетов

```
root@mlabsi:/home/mlabsi#  
root@mlabsi:/home/mlabsi# uname -r  
6.12.0-55.12.1.el10_0.x86_64  
root@mlabsi:/home/mlabsi# dnf list kernel  
Rocky Linux 10 - BaseOS  
Rocky Linux 10 - BaseOS  
Rocky Linux 10 - AppStream  
Rocky Linux 10 - AppStream  
Rocky Linux 10 - Extras  
Rocky Linux 10 - Extras  
Installed Packages  
kernel.x86_64          6.12.0-55.12.1.el10_0          @anaconda  
Available Packages  
kernel.x86_64          6.12.0-55.39.1.el10_0          baseos  
root@mlabsi:/home/mlabsi#
```

Рис. 7: Просмотр версии и списка пакетов ядра

Обновление пакетов и ядра

```
root@mlabsi:~# dnf check-update
xorg-x11-server-Xwayland-24.1.5-4.el10_0.x86_64
xxd-2:9.1.083-5.el10_0.1.x86_64
yum-4.20.0-14.el10_0.rocky.0.1.noarch
zlib-ng-compat-2.2.3-1.el10.rocky.0.1.x86_64
zlib-ng-compat-devel-2.2.3-1.el10.rocky.0.1.x86_64
Installed:
kernel-6.12.0-55.39.1.el10_0.x86_64
kernel-devel-6.12.0-55.39.1.el10_0.x86_64
kernel-modules-core-6.12.0-55.39.1.el10_0.x86_64
libatomic-14.2.1-7.el10.x86_64
kernel-core-6.12.0-55.39.1.el10_0.x86_64
kernel-modules-6.12.0-55.39.1.el10_0.x86_64
kernel-modules-extra-6.12.0-55.39.1.el10_0.x86_64
libdex-0.8.1-1.el10.x86_64

Complete!
root@mlabsi:/home/mlabsi# dnf update kernel
Last metadata expiration check: 0:00:57 ago on Sat 18 Oct 2025 01:24:24 PM MSK.
Dependencies resolved.
Nothing to do.
Complete!
root@mlabsi:/home/mlabsi# dnf update
Last metadata expiration check: 0:01:04 ago on Sat 18 Oct 2025 01:24:24 PM MSK.
Dependencies resolved.
Nothing to do.
Complete!
root@mlabsi:/home/mlabsi# dnf upgrade --refresh
Rocky Linux 10 - BaseOS
Rocky Linux 10 - AppStream
Rocky Linux 10 - Extras
Dependencies resolved.
Nothing to do.
Complete!
root@mlabsi:/home/mlabsi#
```

Рис. 8: Обновление ядра и системы

Проверка новой версии ядра

```
mlabsi@mlabsi:~$ uname -r
6.12.0-55.39.1.el10_0.x86_64
mlabsi@mlabsi:~$ hostnamectl
    Static hostname: mlabsi.localdomain
          Icon name: computer-vm
            Chassis: vm 🖥
        Machine ID: c371d82aeddd4c358d0da59eb13ae51b
          Boot ID: 9fddb632c4d24b5f81acec460437d10e
  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 7month 1w 4d
          Kernel: Linux 6.12.0-55.39.1.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 10month 2w 3d
mlabsi@mlabsi:~$ █
```

Заключение

Заключение

В ходе лабораторной работы освоены основные команды работы с модулями ядра Linux, их загрузка, выгрузка, просмотр параметров и обновление ядра системы.