

# 第二阶段rust for linux 作业说明

## 安装qemu 遇到的问题

```
Windows PowerShell
diwave@diwave: /home/work

Setting up qemu-system-x86 (1:6.2+dfsg-2ubuntu6.15) ...
Setting up librsvg2-2:amd64 (2.52.5+dfsg-3ubuntu0.2) ...
Setting up libdecor-0-plugin-1-cairo:amd64 (0.1.0-3build1) ...
Setting up librsvg2-common:amd64 (2.52.5+dfsg-3ubuntu0.2) ...
Setting up adwaita-icon-theme (41.0-1ubuntu1) ...
update-alternatives: using /usr/share/icons/Adwaita/cursor.theme to provide /usr/share/icons/default/index.theme (x-cursor-theme) in auto mode
Setting up humanity-icon-theme (0.6.16) ...
Setting up ubuntu-mono (20.10-0ubuntu2) ...
Processing triggers for man-db (2.10.2-1) ...
Processing triggers for libgl1-0:amd64 (2.72.4-0ubuntu2.2) ...
Setting up libgtk-3-0:amd64 (3.24.33-1ubuntu2) ...
Processing triggers for libc-bin (2.35-0ubuntu3.1) ...
Setting up libgtk-3-bin (3.24.33-1ubuntu2) ...
Setting up libvte-2.91-0:amd64 (0.68.0-1) ...
Setting up at-spi2-core (2.44.0-3) ...
Setting up glib-networking:amd64 (2.72.0-1) ...
Setting up libsoup2.4-1:amd64 (2.74.2-3) ...
Setting up qemu-system-gui (1:6.2+dfsg-2ubuntu6.15) ...
Setting up gstreamer1.0-plugins-good:amd64 (1.20.3-0ubuntu1.1) ...
Processing triggers for libgdk-pixbuf-2.0-0:amd64 (2.42.8+dfsg-1ubuntu0.2) ...
Processing triggers for libc-bin (2.35-0ubuntu3.1) ...
diwave@diwave: /home/work/rust_cicv/busybox-1.36.1$ qemu-system-x86_64 --version
QEMU emulator version 6.2.0 (Debian 1:6.2+dfsg-2ubuntu6.15)
Copyright (c) 2003-2021 Fabrice Bellard and the QEMU Project developers
diwave@diwave: /home/work/rust_cicv/busybox-1.36.1$
```

=> qemu的版本6.2.0升级需要升级到7.2.5

[Ubuntu20.04 上安装Qemu 6.1.1\\_ubuntu升级qemu\\_akaiziyou的博客-CSDN博客](#)

```
Windows PowerShell
diwave@diwave: /home/work

Installing /home/work/rust_cicv/qemu-7.2.5/pc-bios/keymaps/fr-ca to /usr/local/share/qemu/keymaps
Installing /home/work/rust_cicv/qemu-7.2.5/pc-bios/keymaps/fr-ch to /usr/local/share/qemu/keymaps
Installing /home/work/rust_cicv/qemu-7.2.5/pc-bios/keymaps/hr to /usr/local/share/qemu/keymaps
Installing /home/work/rust_cicv/qemu-7.2.5/pc-bios/keymaps/hu to /usr/local/share/qemu/keymaps
Installing /home/work/rust_cicv/qemu-7.2.5/pc-bios/keymaps/is to /usr/local/share/qemu/keymaps
Installing /home/work/rust_cicv/qemu-7.2.5/pc-bios/keymaps/it to /usr/local/share/qemu/keymaps
Installing /home/work/rust_cicv/qemu-7.2.5/pc-bios/keymaps/ja to /usr/local/share/qemu/keymaps
Installing /home/work/rust_cicv/qemu-7.2.5/pc-bios/keymaps/lt to /usr/local/share/qemu/keymaps
Installing /home/work/rust_cicv/qemu-7.2.5/pc-bios/keymaps/lv to /usr/local/share/qemu/keymaps
Installing /home/work/rust_cicv/qemu-7.2.5/pc-bios/keymaps/mk to /usr/local/share/qemu/keymaps
Installing /home/work/rust_cicv/qemu-7.2.5/pc-bios/keymaps/nl to /usr/local/share/qemu/keymaps
Installing /home/work/rust_cicv/qemu-7.2.5/pc-bios/keymaps/no to /usr/local/share/qemu/keymaps
Installing /home/work/rust_cicv/qemu-7.2.5/pc-bios/keymaps/pl to /usr/local/share/qemu/keymaps
Installing /home/work/rust_cicv/qemu-7.2.5/pc-bios/keymaps/pt to /usr/local/share/qemu/keymaps
Installing /home/work/rust_cicv/qemu-7.2.5/pc-bios/keymaps/pt-br to /usr/local/share/qemu/keymaps
Installing /home/work/rust_cicv/qemu-7.2.5/pc-bios/keymaps/ru to /usr/local/share/qemu/keymaps
Installing /home/work/rust_cicv/qemu-7.2.5/pc-bios/keymaps/th to /usr/local/share/qemu/keymaps
Installing /home/work/rust_cicv/qemu-7.2.5/pc-bios/keymaps/tr to /usr/local/share/qemu/keymaps
Installing /home/work/rust_cicv/qemu-7.2.5/pc-bios/keymaps/sl to /usr/local/share/qemu/keymaps
Installing /home/work/rust_cicv/qemu-7.2.5/pc-bios/keymaps/sv to /usr/local/share/qemu/keymaps
make[1]: Leaving directory '/home/work/rust_cicv/qemu-7.2.5/build'
diwave@diwave: /home/work/rust_cicv/qemu-7.2.5$ cd ..
diwave@diwave: /home/work/rust_cicv$ qemu-system-arm -version
QEMU emulator version 7.2.5
Copyright (c) 2003-2022 Fabrice Bellard and the QEMU Project developers
diwave@diwave: /home/work/rust_cicv$
```

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## 课程作业内容

# 作业1：编译Linux内核

## 作业说明：

进入Linux文件夹，使用如下命令进行编译：

```
make x86_64_defconfig
```

```
make LLVM=1 menuconfig
```

#set the following config to yes

General setup

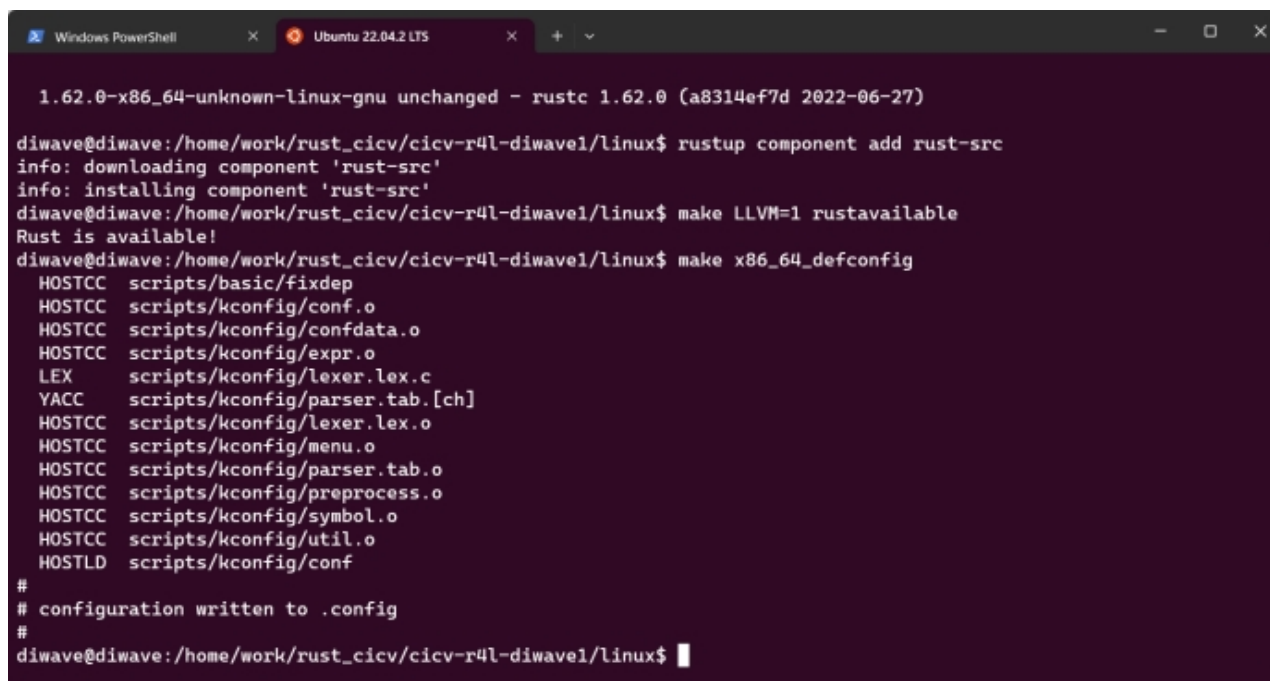
---> [\*] Rust support

```
make LLVM=1 -j$(nproc)
```

-----

```
make x86_64_defconfig
```

==>

A terminal window with a dark purple background and white text. The window has two tabs: 'Windows PowerShell' and 'Ubuntu 22.04.2 LTS'. The terminal output shows the following commands and their results:  
1. A header line: '1.62.0-x86\_64-unknown-linux-gnu unchanged - rustc 1.62.0 (a8314ef7d 2022-06-27)'  
2. Command: 'rustup component add rust-src'. Output: 'info: downloading component 'rust-src'', 'info: installing component 'rust-src''.  
3. Command: 'make LLVM=1 rustavailable'. Output: 'Rust is available!'.  
4. Command: 'make x86\_64\_defconfig'. Output: A list of files being compiled by HOSTCC and HOSTLD, including scripts/basic/fixdep, scripts/kconfig/conf.o, scripts/kconfig/confdata.o, scripts/kconfig/expr.o, scripts/kconfig/lexer.lex.c, scripts/kconfig/parser.tab.[ch], scripts/kconfig/lexer.lex.o, scripts/kconfig/menu.o, scripts/kconfig/parser.tab.o, scripts/kconfig/preprocess.o, scripts/kconfig/symbol.o, scripts/kconfig/util.o, and scripts/kconfig/conf.  
5. Output continues with '# configuration written to .config' and '#'.  
6. The prompt 'diwave@diwave:/home/work/rust\_cicv/cicv-r4l-diwave1/linux\$' is shown at the end.

```
make LLVM=1 menuconfig ==>
```

```
Windows PowerShell x Ubuntu 22.04.2 LTS x + v
#
# configuration written to .config
#
diwave@diwave:/home/work/rust_cicv/cicv-r4l-diwave1/linux$ make LLVM=1 menuconfig
HOSTCC scripts/basic/fixdep
HOSTCC scripts/kconfig/confdata.o
HOSTCC scripts/kconfig/expr.o
HOSTCC scripts/kconfig/lexer.lex.o
HOSTCC scripts/kconfig/menu.o
HOSTCC scripts/kconfig/parser.tab.o
HOSTCC scripts/kconfig/preprocess.o
HOSTCC scripts/kconfig/symbol.o
HOSTCC scripts/kconfig/util.o
UPD scripts/kconfig/mconf-cfg
HOSTCC scripts/kconfig/mconf.o
HOSTCC scripts/kconfig/lxdialog/checklist.o
HOSTCC scripts/kconfig/lxdialog/inputbox.o
HOSTCC scripts/kconfig/lxdialog/menubox.o
HOSTCC scripts/kconfig/lxdialog/textbox.o
HOSTCC scripts/kconfig/lxdialog/util.o
HOSTCC scripts/kconfig/lxdialog/yesno.o
HOSTLD scripts/kconfig/mconf
scripts/Kconfig.include:40: linker 'ld.lld' not found
make[1]: *** [scripts/kconfig/Makefile:48: menuconfig] Error 1
make: *** [Makefile:697: menuconfig] Error 2
diwave@diwave:/home/work/rust_cicv/cicv-r4l-diwave1/linux$
```

==>编译不通过是由于缺少安装llvm

```
Windows PowerShell x Ubuntu 22.04.2 LTS x + v
Reading state information... Done
automake is already the newest version (1:1.16.5-1.3).
bc is already the newest version (1.07.1-3build1).
bison is already the newest version (2:3.8.2+dfsg-1build1).
build-essential is already the newest version (12.9ubuntu3).
flex is already the newest version (2.6.4-8build2).
grep is already the newest version (3.7-1build1).
libelf-dev is already the newest version (0.186-1build1).
libfdt-dev is already the newest version (1.6.1-1).
libmpc-dev is already the newest version (1.2.1-2build1).
libtool is already the newest version (2.4.6-15build2).
patchutils is already the newest version (0.4.2-1build2).
sed is already the newest version (4.8-1ubuntu2).
zip is already the newest version (3.0-12build2).
gzip is already the newest version (3.1-1build1).
ninja-build is already the newest version (1.10.1-1).
texinfo is already the newest version (6.8-4build1).
cmake is already the newest version (3.22.1-1ubuntu1.22.04.1).
gawk is already the newest version (1:5.1.0-1ubuntu0.1).
gzip is already the newest version (1.10-4ubuntu4.1).
libexpat1-dev is already the newest version (2.4.7-1ubuntu0.2).
libglib2.0-dev is already the newest version (2.72.4-0ubuntu2.2).
libncurses-dev is already the newest version (6.3-2ubuntu0.1).
libpixman-1-dev is already the newest version (0.40.0-1ubuntu0.22.04.1).
libssl-dev is already the newest version (3.0.2-0ubuntu1.12).
unzip is already the newest version (6.0-26ubuntu3.1).
zlib1g-dev is already the newest version (1:1.2.11.dfsg-2ubuntu9.2).
0 upgraded, 0 newly installed, 0 to remove and 106 not upgraded.
diwave@diwave:/home/work/rust_cicv/cicv-r4l-diwave1/linux$ make LLVM=1 menuconfig
configuration written to .config

*** End of the configuration.
*** Execute 'make' to start the build or try 'make help'.

diwave@diwave:/home/work/rust_cicv/cicv-r4l-diwave1/linux$
```

-----

make LLVM=1 -j\$(nproc)==>

```
Windows PowerShell x Ubuntu 22.04.2 LTS x + v
AS arch/x86/boot/compressed/kernel_info.o
AS arch/x86/boot/compressed/head_64.o
VOFFSET arch/x86/boot/compressed/..voffset.h
CPUSTR arch/x86/boot/cpustr.h
CC arch/x86/boot/compressed/string.o
CC arch/x86/boot/compressed/cadline.o
CC arch/x86/boot/cpu.o
CC arch/x86/boot/compressed/error.o
OBJCOPY arch/x86/boot/compressed/vmlinux.bin
RELOCS arch/x86/boot/compressed/vmlinux.relocs
HOSTCC arch/x86/boot/compressed/mkpiggy
CC arch/x86/boot/compressed/cpuflags.o
CC arch/x86/boot/compressed/early_serial_console.o
CC arch/x86/boot/compressed/kaslr.o
CC arch/x86/boot/compressed/ident_map_64.o
CC arch/x86/boot/compressed/idt_64.o
AS arch/x86/boot/compressed/idt_handlers_64.o
AS arch/x86/boot/compressed/mem_encrypt.o
CC arch/x86/boot/compressed/pgtable_64.o
CC arch/x86/boot/compressed/acpi.o
AS arch/x86/boot/compressed/efi_thunk_64.o
CC arch/x86/boot/compressed/efi.o
CC arch/x86/boot/compressed/misc.o
GZIP arch/x86/boot/compressed/vmlinux.bin.gz
MKPIGGY arch/x86/boot/compressed/piggy.S
AS arch/x86/boot/compressed/piggy.o
LD arch/x86/boot/compressed/vmlinux
ZOFFSET arch/x86/boot/zoffset.h
OBJCOPY arch/x86/boot/vmlinux.bin
AS arch/x86/boot/header.o
LD arch/x86/boot/setup.elf
OBJCOPY arch/x86/boot/setup.bin
BUILD arch/x86/boot/bzImage
Kernel: arch/x86/boot/bzImage is ready (#1)
diwave@diwave:/home/work/rust_cicv/cicv-r4l-diwave1/linux$
```

```
Windows PowerShell x Ubuntu 22.04.2 LTS x + v
CC arch/x86/boot/cpu.o
CC arch/x86/boot/compressed/error.o
OBJCOPY arch/x86/boot/compressed/vmlinux.bin
RELOCS arch/x86/boot/compressed/vmlinux.relocs
HOSTCC arch/x86/boot/compressed/mkpiggy
CC arch/x86/boot/compressed/cpuflags.o
CC arch/x86/boot/compressed/early_serial_console.o
CC arch/x86/boot/compressed/kaslr.o
CC arch/x86/boot/compressed/ident_map_64.o
CC arch/x86/boot/compressed/idt_64.o
AS arch/x86/boot/compressed/idt_handlers_64.o
AS arch/x86/boot/compressed/mem_encrypt.o
CC arch/x86/boot/compressed/pgtable_64.o
CC arch/x86/boot/compressed/acpi.o
AS arch/x86/boot/compressed/efi_thunk_64.o
CC arch/x86/boot/compressed/efi.o
CC arch/x86/boot/compressed/misc.o
GZIP arch/x86/boot/compressed/vmlinux.bin.gz
MKPIGGY arch/x86/boot/compressed/piggy.S
AS arch/x86/boot/compressed/piggy.o
LD arch/x86/boot/compressed/vmlinux
ZOFFSET arch/x86/boot/zoffset.h
OBJCOPY arch/x86/boot/vmlinux.bin
AS arch/x86/boot/header.o
LD arch/x86/boot/setup.elf
OBJCOPY arch/x86/boot/setup.bin
BUILD arch/x86/boot/bzImage
Kernel: arch/x86/boot/bzImage is ready (#1)
diwave@diwave:/home/work/rust_cicv/cicv-r4l-diwave1/linux$ ls
COPYING      LICENSES      README.md    certs        init         mm           rust         tools        vmlinux.o
CREDITS      MAINTAINERS  System.map   crypto       io_uring     modules.built  samples     usr
Documentation Makefile     arch         drivers      ipc          modules.built  scripts     virt
Kbuild       Module.symvers block        fs           kernel       modules.order  security    vmlinux
Kconfig      README       built-in.a   include     lib          net           sound       vmlinux.a
```

## 作业2：对Linux内核进行一些配置

作业说明：

编译成功：



```
diwave@diwave:/home/work/rust_cicv/cicv-r4l-diwave/src_e1000$ make LLVM=1
make -C ../linux M=$PWD
make[1]: Entering directory '/home/work/rust_cicv/cicv-r4l-diwave/linux'
RUSTC [M] /home/work/rust_cicv/cicv-r4l-diwave/src_e1000/r4l_e1000_demo.o
MODPOST /home/work/rust_cicv/cicv-r4l-diwave/src_e1000/Module.symvers
CC [M] /home/work/rust_cicv/cicv-r4l-diwave/src_e1000/r4l_e1000_demo.mod.o
LD [M] /home/work/rust_cicv/cicv-r4l-diwave/src_e1000/r4l_e1000_demo.ko
make[1]: Leaving directory '/home/work/rust_cicv/cicv-r4l-diwave/linux'
diwave@diwave:/home/work/rust_cicv/cicv-r4l-diwave/src_e1000$
```

```
diwave@diwave:/home/work/rust_cicv/cicv-r4l-diwave/busybox-1.36.1$ cd ..
diwave@diwave:/home/work/rust_cicv/cicv-r4l-diwave$ ls
README.md busybox-1.36.1 linux src_e1000
diwave@diwave:/home/work/rust_cicv/cicv-r4l-diwave$ cd src_e1000/
diwave@diwave:/home/work/rust_cicv/cicv-r4l-diwave/src_e1000$ ls
Kbuild Module.symvers consts.rs hw_defs.rs r4l_e1000_demo.mod r4l_e1000_demo.o rootfs
LICENSE README.md dump.dat modules.order r4l_e1000_demo.mod.c r4l_e1000_demo.rs rootfs_img
Makefile build_image.sh e1000_ops.rs r4l_e1000_demo.ko r4l_e1000_demo.mod.o ring_buf.rs
diwave@diwave:/home/work/rust_cicv/cicv-r4l-diwave/src_e1000$ ./build_image.sh
make -C ../linux M=$PWD
make[1]: Entering directory '/home/work/rust_cicv/cicv-r4l-diwave/linux'
make[1]: Leaving directory '/home/work/rust_cicv/cicv-r4l-diwave/linux'

5312 blocks
qemu-system-x86_64: -netdev user,id=eth0: network backend 'user' is not compiled into this binary
diwave@diwave:/home/work/rust_cicv/cicv-r4l-diwave/src_e1000$ qemu-system-x86_64 --version
QEMU emulator version 7.2.5
Copyright (c) 2003-2022 Fabrice Bellard and the QEMU Project developers
diwave@diwave:/home/work/rust_cicv/cicv-r4l-diwave/src_e1000$
```

```
diwave@diwave:/home/work/rust_cicv/cicv-r4l-diwave/src_e1000$ qemu-system-x86_64 --version
QEMU emulator version 7.2.5
Copyright (c) 2003-2022 Fabrice Bellard and the QEMU Project developers
diwave@diwave:/home/work/rust_cicv/cicv-r4l-diwave/src_e1000$ ./build_image.sh
make -C ../linux M=$PWD
make[1]: Entering directory '/home/work/rust_cicv/cicv-r4l-diwave/linux'
make[1]: Leaving directory '/home/work/rust_cicv/cicv-r4l-diwave/linux'

5312 blocks
qemu-system-x86_64: -netdev user,id=eth0: network backend 'user' is not compiled into this binary
```

==>解决

qemu v7.2 network backend 'user' is not compiled into this binary 问题\_network backend 'user' is not compiled into this b\_qq502233945的博客-CSDN博客

```
[ 0.000000] Linux version 6.1.0-rc1 (diwave@diwave) (Ubuntu clang version 14.0.0-1ubuntu1.1, Ubuntu LLD 14.0.0) #1 SMP PREEMPT_DYNAMIC Thu N3
[ 0.000000] Command line: root=/dev/ram rdinit=sbin/init ip=10.0.2.15::10.0.2.1:255.255.255.0 console=ttyS0 no_timer_check
[ 0.000000] x86/fpu: x87 FPU will use FXSAVE
[ 0.000000] signal: max sigframe size: 1440
[ 0.000000] BIOS-provided physical RAM map:
[ 0.000000] BIOS-e820: [mem 0x0000000000000000-0x000000000009fbff] usable
[ 0.000000] BIOS-e820: [mem 0x000000000009fc00-0x000000000009ffff] reserved
[ 0.000000] BIOS-e820: [mem 0x00000000000f0000-0x00000000000fffff] reserved
[ 0.000000] BIOS-e820: [mem 0x0000000000100000-0x00000000007fdffff] usable
[ 0.000000] BIOS-e820: [mem 0x00000000007fe0000-0x00000000007ffffff] reserved
```

[ 0.000000] BIOS-e820: [mem 0x00000000fffc0000-0x00000000ffffffff] reserved  
[ 0.000000] BIOS-e820: [mem 0x000000fd00000000-0x000000ffffffff] reserved  
[ 0.000000] NX (Execute Disable) protection: active  
[ 0.000000] SMBIOS 2.8 present.  
[ 0.000000] DMI: QEMU Standard PC (i440FX + PIIX, 1996), BIOS rel-1.16.1-0-g3208b098f51a-prebuilt.qemu.org  
04/01/2014  
[ 0.000000] tsc: Fast TSC calibration using PIT  
[ 0.000000] tsc: Detected 1992.016 MHz processor  
[ 0.006625] last\_pfn = 0x7fe0 max\_arch\_pfn = 0x400000000  
[ 0.007405] x86/PAT: Configuration [0-7]: WB WC UC- UC WB WP UC- WT  
[ 0.018529] found SMP MP-table at [mem 0x000f5c00-0x000f5c0f]  
[ 0.023152] RAMDISK: [mem 0x07d48000-0x07fdffff]  
[ 0.023913] ACPI: Early table checksum verification disabled  
[ 0.024180] ACPI: RSDP 0x000000000000F5A20 000014 (v00 BOCHS )  
[ 0.024445] ACPI: RSDT 0x00000000007FE1AC6 000034 (v01 BOCHS BXPC 00000001 BXPC 00000001)  
[ 0.024962] ACPI: FACP 0x00000000007FE197A 000074 (v01 BOCHS BXPC 00000001 BXPC 00000001)  
[ 0.025669] ACPI: DSDT 0x00000000007FE0040 00193A (v01 BOCHS BXPC 00000001 BXPC 00000001)  
[ 0.025743] ACPI: FACS 0x00000000007FE0000 000040  
[ 0.025784] ACPI: APIC 0x00000000007FE19EE 000078 (v01 BOCHS BXPC 00000001 BXPC 00000001)  
[ 0.025802] ACPI: HPET 0x00000000007FE1A66 000038 (v01 BOCHS BXPC 00000001 BXPC 00000001)  
[ 0.025817] ACPI: WAET 0x00000000007FE1A9E 000028 (v01 BOCHS BXPC 00000001 BXPC 00000001)  
[ 0.025880] ACPI: Reserving FACP table memory at [mem 0x7fe197a-0x7fe19ed]  
[ 0.025905] ACPI: Reserving DSDT table memory at [mem 0x7fe0040-0x7fe1979]  
[ 0.025912] ACPI: Reserving FACS table memory at [mem 0x7fe0000-0x7fe003f]  
[ 0.025916] ACPI: Reserving APIC table memory at [mem 0x7fe19ee-0x7fe1a65]  
[ 0.025920] ACPI: Reserving HPET table memory at [mem 0x7fe1a66-0x7fe1a9d]  
[ 0.025924] ACPI: Reserving WAET table memory at [mem 0x7fe1a9e-0x7fe1ac5]  
[ 0.027525] No NUMA configuration found  
[ 0.027544] Faking a node at [mem 0x0000000000000000-0x00000000007fdffff]  
[ 0.028160] NODE\_DATA(0) allocated [mem 0x07d44000-0x07d47fff]  
[ 0.030074] Zone ranges:  
[ 0.030084] DMA [mem 0x0000000000001000-0x000000000000ffffff]  
[ 0.030201] DMA32 [mem 0x0000000001000000-0x00000000007fdffff]  
[ 0.030209] Normal empty  
[ 0.030225] Movable zone start for each node  
[ 0.030250] Early memory node ranges  
[ 0.030277] node 0: [mem 0x0000000000001000-0x0000000000009eff]

[ 0.030467] node 0: [mem 0x0000000000100000-0x0000000007fdffff]  
[ 0.030653] Initmem setup node 0 [mem 0x0000000000001000-0x0000000007fdffff]  
[ 0.031732] On node 0, zone DMA: 1 pages in unavailable ranges  
[ 0.032045] On node 0, zone DMA: 97 pages in unavailable ranges  
[ 0.033036] On node 0, zone DMA32: 32 pages in unavailable ranges  
[ 0.033363] ACPI: PM-Timer IO Port: 0x608  
[ 0.033789] ACPI: LAPIC\_NMI (acpi\_id[0xff] dfl dfl lint[0x1])  
[ 0.034132] IOAPIC[0]: apic\_id 0, version 32, address 0xfec00000, GSI 0-23  
[ 0.034230] ACPI: INT\_SRC\_OVR (bus 0 bus\_irq 0 global\_irq 2 dfl dfl)  
[ 0.034442] ACPI: INT\_SRC\_OVR (bus 0 bus\_irq 5 global\_irq 5 high level)  
[ 0.034479] ACPI: INT\_SRC\_OVR (bus 0 bus\_irq 9 global\_irq 9 high level)  
[ 0.034557] ACPI: INT\_SRC\_OVR (bus 0 bus\_irq 10 global\_irq 10 high level)  
[ 0.034565] ACPI: INT\_SRC\_OVR (bus 0 bus\_irq 11 global\_irq 11 high level)  
[ 0.034758] ACPI: Using ACPI (MADT) for SMP configuration information  
[ 0.034795] ACPI: HPET id: 0x8086a201 base: 0xfed00000  
[ 0.035062] smpboot: Allowing 1 CPUs, 0 hotplug CPUs  
[ 0.035823] PM: hibernation: Registered nosave memory: [mem 0x00000000-0x00000fff]  
[ 0.035872] PM: hibernation: Registered nosave memory: [mem 0x0009f000-0x0009ffff]  
[ 0.035907] PM: hibernation: Registered nosave memory: [mem 0x000a0000-0x000effff]  
[ 0.035912] PM: hibernation: Registered nosave memory: [mem 0x000f0000-0x000fffff]  
[ 0.036021] [mem 0x08000000-0xffffbfff] available for PCI devices  
[ 0.036042] Booting paravirtualized kernel on bare hardware  
[ 0.036277] clocksource: refined-jiffies: mask: 0xffffffff max\_cycles: 0xffffffff, max\_idle\_ns: 1910969940391419 ns  
[ 0.045863] setup\_percpu: NR\_CPUS:64 nr\_cpumask\_bits:1 nr\_cpu\_ids:1 nr\_node\_ids:1  
[ 0.047366] percpu: Embedded 52 pages/cpu s175720 r8192 d29080 u2097152  
[ 0.049462] Fallback order for Node 0: 0  
[ 0.049683] Built 1 zonelists, mobility grouping on. Total pages: 31968  
[ 0.049707] Policy zone: DMA32  
[ 0.049895] Kernel command line: root=/dev/ram rdinit=sbin/init ip=10.0.2.15::10.0.2.1:255.255.255.0  
console=ttyS0 no\_timer\_check  
[ 0.051368] Dentry cache hash table entries: 16384 (order: 5, 131072 bytes, linear)  
[ 0.051483] Inode-cache hash table entries: 8192 (order: 4, 65536 bytes, linear)  
[ 0.052915] mem auto-init: stack:off, heap alloc:off, heap free:off  
[ 0.057811] Memory: 89608K/130552K available (16396K kernel code, 2548K rdata, 5320K rodata, 1324K init, 1400K bss, 40684K reserved, 0K cma)  
[ 0.061126] SLUB: HWalign=64, Order=0-3, MinObjects=0, CPUs=1, Nodes=1  
[ 0.069517] Dynamic Preempt: voluntary

[ 0.072461] rcu: Preemptible hierarchical RCU implementation.

[ 0.072475] rcu: RCU event tracing is enabled.

[ 0.072498] rcu: RCU restricting CPUs from NR\_CPUS=64 to nr\_cpu\_ids=1.

[ 0.072605] Trampoline variant of Tasks RCU enabled.

[ 0.072679] rcu: RCU calculated value of scheduler-enlistment delay is 100 jiffies.

[ 0.072702] rcu: Adjusting geometry for rcu\_fanout\_leaf=16, nr\_cpu\_ids=1

[ 0.080164] NR\_IRQS: 4352, nr\_irqs: 256, preallocated irqs: 16

[ 0.084969] rcu: srcu\_init: Setting srcu\_struct sizes based on contention.

[ 0.090488] Console: colour VGA+ 80x25

[ 0.155835] printk: console [ttyS0] enabled

[ 0.157125] ACPI: Core revision 20220331

[ 0.162203] clocksource: hpet: mask: 0xffffffff max\_cycles: 0xffffffff, max\_idle\_ns: 19112604467 ns

[ 0.167210] APIC: Switch to symmetric I/O mode setup

[ 0.171761] ..TIMER: vector=0x30 apic1=0 pin1=2 apic2=-1 pin2=-1

[ 0.173184] clocksource: tsc-early: mask: 0xffffffffffffffff max\_cycles: 0x396d7030be2, max\_idle\_ns: 881590679739 ns

[ 0.174116] Calibrating delay loop (skipped), value calculated using timer frequency.. 3984.03 BogoMIPS (lpj=1992016)

[ 0.174674] pid\_max: default: 32768 minimum: 301

[ 0.176711] LSM: Security Framework initializing

[ 0.178559] SELinux: Initializing.

[ 0.180546] Mount-cache hash table entries: 512 (order: 0, 4096 bytes, linear)

[ 0.180870] Mountpoint-cache hash table entries: 512 (order: 0, 4096 bytes, linear)

[ 0.201695] process: using AMD E400 aware idle routine

[ 0.202064] Last level iTLB entries: 4KB 512, 2MB 255, 4MB 127

[ 0.202318] Last level dTLB entries: 4KB 512, 2MB 255, 4MB 127, 1GB 0

[ 0.203225] Spectre V1 : Mitigation: usercopy/swapgs barriers and \_\_user pointer sanitization

[ 0.204084] Spectre V2 : Mitigation: Retpolines

[ 0.204661] Spectre V2 : Spectre v2 / SpectreRSB mitigation: Filling RSB on context switch

[ 0.205568] Spectre V2 : Spectre v2 / SpectreRSB : Filling RSB on VMEXIT

[ 0.495021] Freeing SMP alternatives memory: 52K

[ 0.609333] smpboot: CPU0: AMD QEMU Virtual CPU version 2.5+ (family: 0xf, model: 0x6b, stepping: 0x1)

[ 0.615306] cblist\_init\_generic: Setting adjustable number of callback queues.

[ 0.615902] cblist\_init\_generic: Setting shift to 0 and lim to 1.

[ 0.616479] Performance Events: PMU not available due to virtualization, using software events only.

[ 0.618999] rcu: Hierarchical SRCU implementation.

[ 0.619425] rcu: Max phase no-delay instances is 400.



[ 0.625167] smp: Bringing up secondary CPUs ...

[ 0.625720] smp: Brought up 1 node, 1 CPU

[ 0.625927] smpboot: Max logical packages: 1

[ 0.626305] smpboot: Total of 1 processors activated (3984.03 BogoMIPS)

[ 0.639506] devtmpfs: initialized

[ 0.648617] clocksource: jiffies: mask: 0xffffffff max\_cycles: 0xffffffff, max\_idle\_ns: 1911260446275000 ns

[ 0.649975] futex hash table entries: 256 (order: 2, 16384 bytes, linear)

[ 0.653020] PM: RTC time: 23:58:34, date: 2023-11-08

[ 0.657803] NET: Registered PF\_NETLINK/PF\_ROUTE protocol family

[ 0.660898] audit: initializing netlink subsys (disabled)

[ 0.665339] audit: type=2000 audit(1699487913.497:1): state=initialized audit\_enabled=0 res=1

[ 0.667331] thermal\_sys: Registered thermal governor 'step\_wise'

[ 0.667372] thermal\_sys: Registered thermal governor 'user\_space'

[ 0.669896] cpuidle: using governor menu

[ 0.673580] PCI: Using configuration type 1 for base access

[ 0.701319] kprobes: kprobe jump-optimization is enabled. All kprobes are optimized if possible.

[ 1.096247] HugeTLB: registered 2.00 MiB page size, pre-allocated 0 pages

[ 1.096608] HugeTLB: 28 KiB vmemmap can be freed for a 2.00 MiB page

[ 1.103212] ACPI: Added \_OSI(Module Device)

[ 1.103410] ACPI: Added \_OSI(Processor Device)

[ 1.103930] ACPI: Added \_OSI(3.0 \_SCP Extensions)

[ 1.104348] ACPI: Added \_OSI(Processor Aggregator Device)

[ 1.117344] ACPI: 1 ACPI AML tables successfully acquired and loaded

[ 1.132230] ACPI: Interpreter enabled

[ 1.133923] ACPI: PM: (supports S0 S3 S4 S5)

[ 1.134314] ACPI: Using IOAPIC for interrupt routing

[ 1.135080] PCI: Using host bridge windows from ACPI; if necessary, use "pci=nocrs" and report a bug

[ 1.135692] PCI: Using E820 reservations for host bridge windows

[ 1.137595] ACPI: Enabled 2 GPEs in block 00 to 0F

[ 1.168822] ACPI: PCI Root Bridge [PCI0] (domain 0000 [bus 00-ff])

[ 1.170032] acpi PNP0A03:00: \_OSC: OS supports [ASPM ClockPM Segments MSI HPX-Type3]

[ 1.170922] acpi PNP0A03:00: \_OSC: not requesting OS control; OS requires [ExtendedConfig ASPM ClockPM MSI]

[ 1.172511] acpi PNP0A03:00: fail to add MMCONFIG information, can't access extended PCI configuration space under this bridge.

[ 1.176570] PCI host bridge to bus 0000:00

[ 1.177055] pci\_bus 0000:00: root bus resource [io 0x0000-0x0cf7 window]

[ 1.177899] pci\_bus 0000:00: root bus resource [io 0x0d00-0xffff window]  
[ 1.178912] pci\_bus 0000:00: root bus resource [mem 0x000a0000-0x000bffff window]  
[ 1.179338] pci\_bus 0000:00: root bus resource [mem 0x08000000-0xfebfffff window]  
[ 1.179906] pci\_bus 0000:00: root bus resource [mem 0x100000000-0x17ffffff window]  
[ 1.181159] pci\_bus 0000:00: root bus resource [bus 00-ff]  
[ 1.182997] pci 0000:00:00.0: [8086:1237] type 00 class 0x060000  
[ 1.191298] pci 0000:00:01.0: [8086:7000] type 00 class 0x060100  
[ 1.195584] pci 0000:00:01.1: [8086:7010] type 00 class 0x010180  
[ 1.198110] pci 0000:00:01.1: reg 0x20: [io 0xc040-0xc04f]  
[ 1.198899] pci 0000:00:01.1: legacy IDE quirk: reg 0x10: [io 0x01f0-0x01f7]  
[ 1.199891] pci 0000:00:01.1: legacy IDE quirk: reg 0x14: [io 0x03f6]  
[ 1.200919] pci 0000:00:01.1: legacy IDE quirk: reg 0x18: [io 0x0170-0x0177]  
[ 1.201456] pci 0000:00:01.1: legacy IDE quirk: reg 0x1c: [io 0x0376]  
[ 1.202383] pci 0000:00:01.3: [8086:7113] type 00 class 0x068000  
[ 1.203113] pci 0000:00:01.3: quirk: [io 0x0600-0x063f] claimed by PIIX4 ACPI  
[ 1.203810] pci 0000:00:01.3: quirk: [io 0x0700-0x070f] claimed by PIIX4 SMB  
[ 1.204742] pci 0000:00:02.0: [1234:1111] type 00 class 0x030000  
[ 1.205465] pci 0000:00:02.0: reg 0x10: [mem 0xfd000000-0xfdffffff pref]  
[ 1.207870] pci 0000:00:02.0: reg 0x18: [mem 0xfebf0000-0xfebf0fff]  
[ 1.210146] pci 0000:00:02.0: reg 0x30: [mem 0xfebe0000-0xfebeffff pref]  
[ 1.211120] pci 0000:00:02.0: Video device with shadowed ROM at [mem 0x000c0000-0x000dffff]  
[ 1.216418] pci 0000:00:03.0: [8086:100e] type 00 class 0x020000  
[ 1.216870] pci 0000:00:03.0: reg 0x10: [mem 0xfebc0000-0xfebdffff]  
[ 1.218351] pci 0000:00:03.0: reg 0x14: [io 0xc000-0xc03f]  
[ 1.219870] pci 0000:00:03.0: reg 0x30: [mem 0xfeb80000-0xfebbffff pref]  
[ 1.228985] ACPI: PCI: Interrupt link LNKA configured for IRQ 10  
[ 1.230440] ACPI: PCI: Interrupt link LNKB configured for IRQ 10  
[ 1.231912] ACPI: PCI: Interrupt link LNKC configured for IRQ 11  
[ 1.232897] ACPI: PCI: Interrupt link LNKD configured for IRQ 11  
[ 1.233606] ACPI: PCI: Interrupt link LNKS configured for IRQ 9  
[ 1.237319] iommu: Default domain type: Translated  
[ 1.237585] iommu: DMA domain TLB invalidation policy: lazy mode  
[ 1.239678] SCSI subsystem initialized  
[ 1.241533] ACPI: bus type USB registered  
[ 1.242357] usbcore: registered new interface driver usbfs  
[ 1.243233] usbcore: registered new interface driver hub  
[ 1.244069] usbcore: registered new device driver usb

[ 1.244827] pps\_core: LinuxPPS API ver. 1 registered

[ 1.244913] pps\_core: Software ver. 5.3.6 - Copyright 2005-2007 Rodolfo Giometti <giometti@linux.it>

[ 1.245918] PTP clock support registered

[ 1.248550] Advanced Linux Sound Architecture Driver Initialized.

[ 1.257922] NetLabel: Initializing

[ 1.258063] NetLabel: domain hash size = 128

[ 1.258340] NetLabel: protocols = UNLABELED CIPSOv4 CALIPSO

[ 1.259773] NetLabel: unlabeled traffic allowed by default

[ 1.264320] PCI: Using ACPI for IRQ routing

[ 1.267451] pci 0000:00:02.0: vgaarb: setting as boot VGA device

[ 1.267870] pci 0000:00:02.0: vgaarb: bridge control possible

[ 1.267870] pci 0000:00:02.0: vgaarb: VGA device added: decodes=io+mem,owns=io+mem,locks=none

[ 1.267914] vgaarb: loaded

[ 1.269360] hpet: 3 channels of 0 reserved for per-cpu timers

[ 1.269918] hpet0: at MMIO 0xfed00000, IRQs 2, 8, 0

[ 1.270151] hpet0: 3 comparators, 64-bit 100.000000 MHz counter

[ 1.274630] clocksource: Switched to clocksource tsc-early

[ 1.281242] VFS: Disk quotas dquot\_6.6.0

[ 1.281802] VFS: Dquot-cache hash table entries: 512 (order 0, 4096 bytes)

[ 1.285258] pnp: PnP ACPI init

[ 1.290193] pnp: PnP ACPI: found 6 devices

[ 1.319196] clocksource: acpi\_pm: mask: 0xfffff max\_cycles: 0xfffff, max\_idle\_ns: 2085701024 ns

[ 1.321187] NET: Registered PF\_INET protocol family

[ 1.323571] IP idents hash table entries: 2048 (order: 2, 16384 bytes, linear)

[ 1.331134] tcp\_listen\_portaddr\_hash hash table entries: 256 (order: 0, 4096 bytes, linear)

[ 1.332147] Table-perturb hash table entries: 65536 (order: 6, 262144 bytes, linear)

[ 1.333414] TCP established hash table entries: 1024 (order: 1, 8192 bytes, linear)

[ 1.334219] TCP bind hash table entries: 1024 (order: 3, 32768 bytes, linear)

[ 1.335358] TCP: Hash tables configured (established 1024 bind 1024)

[ 1.336756] UDP hash table entries: 256 (order: 1, 8192 bytes, linear)

[ 1.337661] UDP-Lite hash table entries: 256 (order: 1, 8192 bytes, linear)

[ 1.339502] NET: Registered PF\_UNIX/PF\_LOCAL protocol family

[ 1.341874] RPC: Registered named UNIX socket transport module.

[ 1.342591] RPC: Registered udp transport module.

[ 1.344395] RPC: Registered tcp transport module.

[ 1.346536] RPC: Registered tcp NFSv4.1 backchannel transport module.

[ 1.350016] pci\_bus 0000:00: resource 4 [io 0x0000-0x0cf7 window]

[ 1.350447] pci\_bus 0000:00: resource 5 [io 0x0d00-0xffff window]  
[ 1.350796] pci\_bus 0000:00: resource 6 [mem 0x000a0000-0x000bffff window]  
[ 1.351415] pci\_bus 0000:00: resource 7 [mem 0x08000000-0xfebfffff window]  
[ 1.351765] pci\_bus 0000:00: resource 8 [mem 0x100000000-0x17ffffff window]  
[ 1.353574] pci 0000:00:01.0: PIIX3: Enabling Passive Release  
[ 1.354024] pci 0000:00:00.0: Limiting direct PCI/PCI transfers  
[ 1.354419] PCI: CLS 0 bytes, default 64  
[ 1.363441] Unpacking initramfs...  
[ 1.418325] Freeing initrd memory: 2656K  
[ 1.521590] Initialise system trusted keyrings  
[ 1.524622] workingset: timestamp\_bits=56 max\_order=15 bucket\_order=0  
[ 1.539781] NFS: Registering the id\_resolver key type  
[ 1.540631] Key type id\_resolver registered  
[ 1.540828] Key type id\_legacy registered  
[ 1.542306] 9p: Installing v9fs 9p2000 file system support  
[ 1.572207] Key type asymmetric registered  
[ 1.572514] Asymmetric key parser 'x509' registered  
[ 1.573401] Block layer SCSI generic (bsg) driver version 0.4 loaded (major 251)  
[ 1.574609] io scheduler mq-deadline registered  
[ 1.575164] io scheduler kyber registered  
[ 1.579457] input: Power Button as /devices/LNXSYSTM:00/LNXPWRBN:00/input/input0  
[ 1.618469] ACPI: button: Power Button [PWRF]  
[ 1.622827] Serial: 8250/16550 driver, 4 ports, IRQ sharing enabled  
[ 1.625364] 00:04: ttyS0 at I/O 0x3f8 (irq = 4, base\_baud = 115200) is a 16550A  
[ 1.631885] Non-volatile memory driver v1.3  
[ 1.632293] Linux agpgart interface v0.103  
[ 1.634564] ACPI: bus type drm\_connector registered  
[ 1.684609] loop: module loaded  
[ 1.693141] scsi host0: ata\_piix  
[ 1.695651] scsi host1: ata\_piix  
[ 1.696730] ata1: PATA max MWDMA2 cmd 0x1f0 ctl 0x3f6 bmdma 0xc040 irq 14  
[ 1.697376] ata2: PATA max MWDMA2 cmd 0x170 ctl 0x376 bmdma 0xc048 irq 15  
[ 1.707181] e100: Intel(R) PRO/100 Network Driver  
[ 1.707443] e100: Copyright(c) 1999-2006 Intel Corporation  
[ 1.708387] e1000: Intel(R) PRO/1000 Network Driver  
[ 1.708645] e1000: Copyright (c) 1999-2006 Intel Corporation.  
[ 1.861466] ata2: found unknown device (class 0)

[ 1.867537] ata2.00: ATAPI: QEMU DVD-ROM, 2.5+, max UDMA/100

[ 1.885029] scsi 1:0:0:0: CD-ROM QEMU QEMU DVD-ROM 2.5+ PQ: 0 ANSI: 5

[ 1.922842] sr 1:0:0:0: [sr0] scsi3-mmc drive: 4x/4x cd/rw xa/form2 tray

[ 1.924203] cdrom: Uniform CD-ROM driver Revision: 3.20

[ 1.928580] ACPI: \\_SB\_.LNKC: Enabled at IRQ 11

[ 1.946165] sr 1:0:0:0: Attached scsi generic sg0 type 5

[ 2.238188] e1000 0000:00:03:0 eth0: (PCI:33MHz:32-bit) 52:54:00:12:34:56

[ 2.239113] e1000 0000:00:03:0 eth0: Intel(R) PRO/1000 Network Connection

[ 2.240350] e1000e: Intel(R) PRO/1000 Network Driver

[ 2.240713] e1000e: Copyright(c) 1999 - 2015 Intel Corporation.

[ 2.241366] sky2: driver version 1.30

[ 2.243705] usbcore: registered new interface driver usblp

[ 2.244326] usbcore: registered new interface driver usb-storage

[ 2.246693] i8042: PNP: PS/2 Controller [PNP0303:KBD,PNP0f13:MOU] at 0x60,0x64 irq 1,12

[ 2.250566] serio: i8042 KBD port at 0x60,0x64 irq 1

[ 2.251233] serio: i8042 AUX port at 0x60,0x64 irq 12

[ 2.255342] input: AT Translated Set 2 keyboard as /devices/platform/i8042/serio0/input/input1

[ 2.264556] rtc\_cmos 00:05: registered as rtc0

[ 2.265700] rtc\_cmos 00:05: alarms up to one day, 242 bytes nvram, hpet irqs

[ 2.267254] rtc\_cmos 00:05: RTC can wake from S4

[ 2.268391] fail to initialize ptp\_kvm

[ 2.269288] device-mapper: ioctl: 4.47.0-ioclt (2022-07-28) initialised: dm-devel@redhat.com

[ 2.270637] hid: raw HID events driver (C) Jiri Kosina

[ 2.272566] usbcore: registered new interface driver usbhid

[ 2.272905] usbhid: USB HID core driver

[ 2.282102] Initializing XFRM netlink socket

[ 2.283384] NET: Registered PF\_INET6 protocol family

[ 2.298331] Segment Routing with IPv6

[ 2.299063] In-situ OAM (IOAM) with IPv6

[ 2.300546] sit: IPv6, IPv4 and MPLS over IPv4 tunneling driver

[ 2.303534] NET: Registered PF\_PACKET protocol family

[ 2.305200] 9pnet: Installing 9P2000 support

[ 2.305706] Key type dns\_resolver registered

[ 2.307908] IPI shorthand broadcast: enabled

[ 2.309639] sched\_clock: Marking stable (2229428775, 79469842)->(2321754516, -12855899)

[ 2.313364] registered taskstats version 1

[ 2.313639] Loading compiled-in X.509 certificates



```
[ 2.321347] cryptomgr_test (44) used greatest stack depth: 15584 bytes left
[ 2.331354] PM: Magic number: 15:515:1009
[ 2.332554] printk: console [netcon0] enabled
[ 2.332828] netconsole: network logging started
[ 2.893661] input: ImExPS/2 Generic Explorer Mouse as /devices/platform/i8042/serio1/input/input3
[ 2.939850] e1000: eth0 NIC Link is Up 1000 Mbps Full Duplex, Flow Control: RX
[ 2.955089] IP-Config: Complete:
[ 2.955271]   device=eth0, hwaddr=52:54:00:12:34:56, ipaddr=10.0.2.15, mask=255.255.255.0, gw=10.0.2.1
[ 2.955829]   host=10.0.2.15, domain=, nis-domain=(none)
[ 2.956227]   bootserver=255.255.255.255, rootserver=255.255.255.255, rootpath=
[ 2.960816] cfg80211: Loading compiled-in X.509 certificates for regulatory database
[ 3.023767] modprobe (66) used greatest stack depth: 14272 bytes left
[ 3.037750] cfg80211: Loaded X.509 cert 'sforshee: 00b28ddf47aef9cea7'
[ 3.040154] platform regulatory.0: Direct firmware load for regulatory.db failed with error -2
[ 3.041004] cfg80211: failed to load regulatory.db
[ 3.042771] ALSA device list:
[ 3.043052]  No soundcards found.
[ 3.110575] Freeing unused kernel image (initmem) memory: 1324K
[ 3.113287] Write protecting the kernel read-only data: 24576k
[ 3.116561] Freeing unused kernel image (text/rodata gap) memory: 2032K
[ 3.117658] Freeing unused kernel image (rodata/data gap) memory: 824K
[ 3.271505] x86/mm: Checked W+X mappings: passed, no W+X pages found.
[ 3.272366] IPv6: ADDRCONF(NETDEV_CHANGE): eth0: link becomes ready
[ 3.274355] Run sbin/init as init process
[ 3.323581] mount (71) used greatest stack depth: 13920 bytes left
[ 3.397179] tsc: Refined TSC clocksource calibration: 1992.000 MHz
[ 3.397617] clocksource: tsc: mask: 0xffffffffffffff max_cycles: 0x396d519840e, max_idle_ns: 881590569543 ns
[ 3.398693] clocksource: Switched to clocksource tsc
```

Please press Enter to activate this console.

~ #

==> 正确

```
[ 0.000000] Linux version 6.1.0-rc1 (diwave@diwave) (Ubuntu clang version 14.0.0-1ubuntu1.1, Ubuntu LLD
14.0.0) #1 SMP PREEMPT_DYNAMIC Thu Nov  9 22:39:12 CST 2023
[ 0.000000] Command line: root=/dev/ram rdinit=sbin/init ip=10.0.2.15::10.0.2.1:255.255.255.0 console=ttyS0
no_timer_check
```

[ 0.000000] x86/fpu: x87 FPU will use FXSAVE

[ 0.000000] signal: max sigframe size: 1440

[ 0.000000] BIOS-provided physical RAM map:

[ 0.000000] BIOS-e820: [mem 0x0000000000000000-0x000000000009fbff] usable

[ 0.000000] BIOS-e820: [mem 0x000000000009fc00-0x000000000009ffff] reserved

[ 0.000000] BIOS-e820: [mem 0x00000000000f0000-0x00000000000fffff] reserved

[ 0.000000] BIOS-e820: [mem 0x0000000000100000-0x00000000007fdfff] usable

[ 0.000000] BIOS-e820: [mem 0x00000000007fe000-0x00000000007fffff] reserved

[ 0.000000] BIOS-e820: [mem 0x00000000fffc0000-0x00000000ffffffff] reserved

[ 0.000000] BIOS-e820: [mem 0x000000fd00000000-0x000000ffffffff] reserved

[ 0.000000] NX (Execute Disable) protection: active

[ 0.000000] SMBIOS 2.8 present.

[ 0.000000] DMI: QEMU Standard PC (i440FX + PIIX, 1996), BIOS rel-1.16.1-0-g3208b098f51a-prebuilt.qemu.org  
04/01/2014

[ 0.000000] tsc: Fast TSC calibration using PIT

[ 0.000000] tsc: Detected 1992.007 MHz processor

[ 0.006695] last\_pfn = 0x7fe0 max\_arch\_pfn = 0x400000000

[ 0.007485] x86/PAT: Configuration [0-7]: WB WC UC- UC WB WP UC- WT

[ 0.018283] found SMP MP-table at [mem 0x000f5c00-0x000f5c0f]

[ 0.022999] RAMDISK: [mem 0x07d48000-0x07fdffff]

[ 0.023779] ACPI: Early table checksum verification disabled

[ 0.024065] ACPI: RSDP 0x000000000000F5A20 000014 (v00 BOCHS )

[ 0.024355] ACPI: RSDT 0x00000000007FE1AC6 000034 (v01 BOCHS BXPC 00000001 BXPC 00000001)

[ 0.025023] ACPI: FACP 0x00000000007FE197A 000074 (v01 BOCHS BXPC 00000001 BXPC 00000001)

[ 0.025533] ACPI: DSDT 0x00000000007FE0040 00193A (v01 BOCHS BXPC 00000001 BXPC 00000001)

[ 0.025603] ACPI: FACS 0x00000000007FE0000 000040

[ 0.025642] ACPI: APIC 0x00000000007FE19EE 000078 (v01 BOCHS BXPC 00000001 BXPC 00000001)

[ 0.025660] ACPI: HPET 0x00000000007FE1A66 000038 (v01 BOCHS BXPC 00000001 BXPC 00000001)

[ 0.025675] ACPI: WAET 0x00000000007FE1A9E 000028 (v01 BOCHS BXPC 00000001 BXPC 00000001)

[ 0.025754] ACPI: Reserving FACP table memory at [mem 0x7fe197a-0x7fe19ed]

[ 0.025782] ACPI: Reserving DSDT table memory at [mem 0x7fe0040-0x7fe1979]

[ 0.025789] ACPI: Reserving FACS table memory at [mem 0x7fe0000-0x7fe003f]

[ 0.025793] ACPI: Reserving APIC table memory at [mem 0x7fe19ee-0x7fe1a65]

[ 0.025798] ACPI: Reserving HPET table memory at [mem 0x7fe1a66-0x7fe1a9d]

[ 0.025802] ACPI: Reserving WAET table memory at [mem 0x7fe1a9e-0x7fe1ac5]

[ 0.027492] No NUMA configuration found

[ 0.027511] Faking a node at [mem 0x0000000000000000-0x00000000007fdfff]

[ 0.028166] NODE\_DATA(0) allocated [mem 0x07d44000-0x07d47fff]

[ 0.030142] Zone ranges:

[ 0.030154] DMA [mem 0x0000000000001000-0x0000000000ffff]

[ 0.030273] DMA32 [mem 0x0000000001000000-0x0000000007fdffff]

[ 0.030281] Normal empty

[ 0.030298] Movable zone start for each node

[ 0.030323] Early memory node ranges

[ 0.030350] node 0: [mem 0x0000000000001000-0x000000000009efff]

[ 0.030542] node 0: [mem 0x0000000000100000-0x0000000007fdffff]

[ 0.030728] Initmem setup node 0 [mem 0x0000000000001000-0x0000000007fdffff]

[ 0.031816] On node 0, zone DMA: 1 pages in unavailable ranges

[ 0.032112] On node 0, zone DMA: 97 pages in unavailable ranges

[ 0.033105] On node 0, zone DMA32: 32 pages in unavailable ranges

[ 0.033436] ACPI: PM-Timer IO Port: 0x608

[ 0.033865] ACPI: LAPIC\_NMI (acpi\_id[0xff] dfl dfl lint[0x1])

[ 0.034208] IOAPIC[0]: apic\_id 0, version 32, address 0xfec00000, GSI 0-23

[ 0.034306] ACPI: INT\_SRC\_OVR (bus 0 bus\_irq 0 global\_irq 2 dfl dfl)

[ 0.034518] ACPI: INT\_SRC\_OVR (bus 0 bus\_irq 5 global\_irq 5 high level)

[ 0.034555] ACPI: INT\_SRC\_OVR (bus 0 bus\_irq 9 global\_irq 9 high level)

[ 0.034634] ACPI: INT\_SRC\_OVR (bus 0 bus\_irq 10 global\_irq 10 high level)

[ 0.034642] ACPI: INT\_SRC\_OVR (bus 0 bus\_irq 11 global\_irq 11 high level)

[ 0.034859] ACPI: Using ACPI (MADT) for SMP configuration information

[ 0.034897] ACPI: HPET id: 0x8086a201 base: 0xfed00000

[ 0.035166] smpboot: Allowing 1 CPUs, 0 hotplug CPUs

[ 0.036059] PM: hibernation: Registered nosave memory: [mem 0x00000000-0x00000fff]

[ 0.036123] PM: hibernation: Registered nosave memory: [mem 0x0009f000-0x0009ffff]

[ 0.036174] PM: hibernation: Registered nosave memory: [mem 0x000a0000-0x000effff]

[ 0.036180] PM: hibernation: Registered nosave memory: [mem 0x000f0000-0x000fffff]

[ 0.036310] [mem 0x08000000-0xffffbfff] available for PCI devices

[ 0.036334] Booting paravirtualized kernel on bare hardware

[ 0.036596] clocksource: refined-jiffies: mask: 0xffffffff max\_cycles: 0xffffffff, max\_idle\_ns: 1910969940391419 ns

[ 0.046232] setup\_percpu: NR\_CPUS:64 nr\_cpumask\_bits:1 nr\_cpu\_ids:1 nr\_node\_ids:1

[ 0.048106] percpu: Embedded 52 pages/cpu s175720 r8192 d29080 u2097152

[ 0.050768] Fallback order for Node 0: 0

[ 0.051010] Built 1 zonelists, mobility grouping on. Total pages: 31968

[ 0.051036] Policy zone: DMA32

[ 0.051239] Kernel command line: root=/dev/ram rdinit=sbin/init ip=10.0.2.15::10.0.2.1:255.255.255.0 console=ttyS0 no\_timer\_check

[ 0.052868] Dentry cache hash table entries: 16384 (order: 5, 131072 bytes, linear)

[ 0.052975] Inode-cache hash table entries: 8192 (order: 4, 65536 bytes, linear)

[ 0.054534] mem auto-init: stack:off, heap alloc:off, heap free:off

[ 0.059632] Memory: 89608K/130552K available (16396K kernel code, 2545K rdata, 5304K rodata, 1324K init, 1416K bss, 40684K reserved, 0K cma-reserved)

[ 0.062927] SLUB: HWalign=64, Order=0-3, MinObjects=0, CPUs=1, Nodes=1

[ 0.071729] Dynamic Preempt: voluntary

[ 0.074819] rcu: Preemptible hierarchical RCU implementation.

[ 0.074834] rcu: RCU event tracing is enabled.

[ 0.074857] rcu: RCU restricting CPUs from NR\_CPUS=64 to nr\_cpu\_ids=1.

[ 0.074971] Trampoline variant of Tasks RCU enabled.

[ 0.075045] rcu: RCU calculated value of scheduler-enlistment delay is 100 jiffies.

[ 0.075070] rcu: Adjusting geometry for rcu\_fanout\_leaf=16, nr\_cpu\_ids=1

[ 0.082763] NR\_IRQS: 4352, nr\_irqs: 256, preallocated irqs: 16

[ 0.087616] rcu: srcu\_init: Setting srcu\_struct sizes based on contention.

[ 0.093329] Console: colour VGA+ 80x25

[ 0.156874] printk: console [ttyS0] enabled

[ 0.158026] ACPI: Core revision 20220331

[ 0.163376] clocksource: hpet: mask: 0xffffffff max\_cycles: 0xffffffff, max\_idle\_ns: 19112604467 ns

[ 0.168654] APIC: Switch to symmetric I/O mode setup

[ 0.174047] ..TIMER: vector=0x30 apic1=0 pin1=2 apic2=-1 pin2=-1

[ 0.175243] clocksource: tsc-early: mask: 0xffffffffffffffff max\_cycles: 0x396d5f483f0, max\_idle\_ns: 881590717882 ns

[ 0.176416] Calibrating delay loop (skipped), value calculated using timer frequency.. 3984.01 BogoMIPS (lpj=1992007)

[ 0.177358] pid\_max: default: 32768 minimum: 301

[ 0.178597] LSM: Security Framework initializing

[ 0.179976] SELinux: Initializing.

[ 0.182248] Mount-cache hash table entries: 512 (order: 0, 4096 bytes, linear)

[ 0.182845] Mountpoint-cache hash table entries: 512 (order: 0, 4096 bytes, linear)

[ 0.204672] process: using AMD E400 aware idle routine

[ 0.205428] Last level iTLB entries: 4KB 512, 2MB 255, 4MB 127

[ 0.205851] Last level dTLB entries: 4KB 512, 2MB 255, 4MB 127, 1GB 0

[ 0.207485] Spectre V1 : Mitigation: usercopy/swapgs barriers and \_\_user pointer sanitization

[ 0.208319] Spectre V2 : Mitigation: Retpolines

[ 0.208673] Spectre V2 : Spectre v2 / SpectreRSB mitigation: Filling RSB on context switch

[ 0.209232] Spectre V2 : Spectre v2 / SpectreRSB : Filling RSB on VMEXIT

[ 0.485719] Freeing SMP alternatives memory: 52K

[ 0.600937] smpboot: CPU0: AMD QEMU Virtual CPU version 2.5+ (family: 0xf, model: 0x6b, stepping: 0x1)

[ 0.607577] cblist\_init\_generic: Setting adjustable number of callback queues.

[ 0.608229] cblist\_init\_generic: Setting shift to 0 and lim to 1.

[ 0.609104] Performance Events: PMU not available due to virtualization, using software events only.

[ 0.612249] rcu: Hierarchical SRCU implementation.

[ 0.612619] rcu: Max phase no-delay instances is 400.

[ 0.618795] smp: Bringing up secondary CPUs ...

[ 0.619139] smp: Brought up 1 node, 1 CPU

[ 0.619414] smpboot: Max logical packages: 1

[ 0.619803] smpboot: Total of 1 processors activated (3984.01 BogomIPS)

[ 0.632293] devtmpfs: initialized

[ 0.640441] clocksource: jiffies: mask: 0xffffffff max\_cycles: 0xffffffff, max\_idle\_ns: 1911260446275000 ns

[ 0.641109] futex hash table entries: 256 (order: 2, 16384 bytes, linear)

[ 0.644205] PM: RTC time: 14:41:18, date: 2023-11-09

[ 0.649640] NET: Registered PF\_NETLINK/PF\_ROUTE protocol family

[ 0.652788] audit: initializing netlink subsys (disabled)

[ 0.657579] audit: type=2000 audit(1699540877.487:1): state=initialized audit\_enabled=0 res=1

[ 0.659554] thermal\_sys: Registered thermal governor 'step\_wise'

[ 0.659595] thermal\_sys: Registered thermal governor 'user\_space'

[ 0.662294] cpuidle: using governor menu

[ 0.668403] PCI: Using configuration type 1 for base access

[ 0.694946] kprobes: kprobe jump-optimization is enabled. All kprobes are optimized if possible.

[ 1.053800] HugeTLB: registered 2.00 MiB page size, pre-allocated 0 pages

[ 1.054200] HugeTLB: 28 KiB vmemmap can be freed for a 2.00 MiB page

[ 1.061377] ACPI: Added \_OSI(Module Device)

[ 1.061824] ACPI: Added \_OSI(Processor Device)

[ 1.062087] ACPI: Added \_OSI(3.0 \_SCP Extensions)

[ 1.062263] ACPI: Added \_OSI(Processor Aggregator Device)

[ 1.075377] ACPI: 1 ACPI AML tables successfully acquired and loaded

[ 1.089922] ACPI: Interpreter enabled

[ 1.091331] ACPI: PM: (supports S0 S3 S4 S5)

[ 1.091550] ACPI: Using IOAPIC for interrupt routing

[ 1.092300] PCI: Using host bridge windows from ACPI; if necessary, use "pci=nocrs" and report a bug

[ 1.093037] PCI: Using E820 reservations for host bridge windows



[ 1.095186] ACPI: Enabled 2 GPEs in block 00 to 0F

[ 1.127505] ACPI: PCI Root Bridge [PCI0] (domain 0000 [bus 00-ff])

[ 1.128754] acpi PNP0A03:00: \_OSC: OS supports [ASPM ClockPM Segments MSI HPX-Type3]

[ 1.129307] acpi PNP0A03:00: \_OSC: not requesting OS control; OS requires [ExtendedConfig ASPM ClockPM MSI]

[ 1.131428] acpi PNP0A03:00: fail to add MMCONFIG information, can't access extended PCI configuration space under this bridge.

[ 1.134903] PCI host bridge to bus 0000:00

[ 1.135342] pci\_bus 0000:00: root bus resource [io 0x0000-0x0cf7 window]

[ 1.135727] pci\_bus 0000:00: root bus resource [io 0x0d00-0xffff window]

[ 1.136186] pci\_bus 0000:00: root bus resource [mem 0x000a0000-0x000bffff window]

[ 1.137239] pci\_bus 0000:00: root bus resource [mem 0x08000000-0xfebfffff window]

[ 1.137690] pci\_bus 0000:00: root bus resource [mem 0x100000000-0x17ffffff window]

[ 1.138935] pci\_bus 0000:00: root bus resource [bus 00-ff]

[ 1.141326] pci 0000:00:00.0: [8086:1237] type 00 class 0x060000

[ 1.150437] pci 0000:00:01.0: [8086:7000] type 00 class 0x060100

[ 1.154149] pci 0000:00:01.1: [8086:7010] type 00 class 0x010180

[ 1.156584] pci 0000:00:01.1: reg 0x20: [io 0xc040-0xc04f]

[ 1.157206] pci 0000:00:01.1: legacy IDE quirk: reg 0x10: [io 0x01f0-0x01f7]

[ 1.158228] pci 0000:00:01.1: legacy IDE quirk: reg 0x14: [io 0x03f6]

[ 1.158822] pci 0000:00:01.1: legacy IDE quirk: reg 0x18: [io 0x0170-0x0177]

[ 1.159276] pci 0000:00:01.1: legacy IDE quirk: reg 0x1c: [io 0x0376]

[ 1.160858] pci 0000:00:01.3: [8086:7113] type 00 class 0x068000

[ 1.161627] pci 0000:00:01.3: quirk: [io 0x0600-0x063f] claimed by PIIX4 ACPI

[ 1.162238] pci 0000:00:01.3: quirk: [io 0x0700-0x070f] claimed by PIIX4 SMB

[ 1.163275] pci 0000:00:02.0: [1234:1111] type 00 class 0x030000

[ 1.164186] pci 0000:00:02.0: reg 0x10: [mem 0xfd000000-0xfdffffff pref]

[ 1.165186] pci 0000:00:02.0: reg 0x18: [mem 0xfebf0000-0xfebf0fff]

[ 1.167186] pci 0000:00:02.0: reg 0x30: [mem 0xfebe0000-0xfebeffff pref]

[ 1.167744] pci 0000:00:02.0: Video device with shadowed ROM at [mem 0x000c0000-0x000dffff]

[ 1.174963] pci 0000:00:03.0: [8086:100e] type 00 class 0x020000

[ 1.175769] pci 0000:00:03.0: reg 0x10: [mem 0xfebc0000-0xfebdffff]

[ 1.176665] pci 0000:00:03.0: reg 0x14: [io 0xc000-0xc03f]

[ 1.178186] pci 0000:00:03.0: reg 0x30: [mem 0xfeb80000-0xfebbffff pref]

[ 1.187537] ACPI: PCI: Interrupt link LNKA configured for IRQ 10

[ 1.188607] ACPI: PCI: Interrupt link LNKB configured for IRQ 10

[ 1.189557] ACPI: PCI: Interrupt link LNKC configured for IRQ 11

[ 1.191543] ACPI: PCI: Interrupt link LNKD configured for IRQ 11

[ 1.192462] ACPI: PCI: Interrupt link LNKS configured for IRQ 9

[ 1.196561] iommu: Default domain type: Translated

[ 1.196770] iommu: DMA domain TLB invalidation policy: lazy mode

[ 1.198341] SCSI subsystem initialized

[ 1.200198] ACPI: bus type USB registered

[ 1.200854] usbcore: registered new interface driver usbfs

[ 1.201696] usbcore: registered new interface driver hub

[ 1.202013] usbcore: registered new device driver usb

[ 1.202579] pps\_core: LinuxPPS API ver. 1 registered

[ 1.202754] pps\_core: Software ver. 5.3.6 - Copyright 2005-2007 Rodolfo Giometti <giometti@linux.it>

[ 1.203284] PTP clock support registered

[ 1.205677] Advanced Linux Sound Architecture Driver Initialized.

[ 1.214882] NetLabel: Initializing

[ 1.215021] NetLabel: domain hash size = 128

[ 1.215210] NetLabel: protocols = UNLABELED CIPSOv4 CALIPSO

[ 1.216684] NetLabel: unlabeled traffic allowed by default

[ 1.220483] PCI: Using ACPI for IRQ routing

[ 1.222184] pci 0000:00:02.0: vgaarb: setting as boot VGA device

[ 1.222186] pci 0000:00:02.0: vgaarb: bridge control possible

[ 1.222186] pci 0000:00:02.0: vgaarb: VGA device added: decodes=io+mem,owns=io+mem,locks=none

[ 1.222235] vgaarb: loaded

[ 1.223837] hpet: 3 channels of 0 reserved for per-cpu timers

[ 1.224412] hpet0: at MMIO 0xfed00000, IRQs 2, 8, 0

[ 1.224794] hpet0: 3 comparators, 64-bit 100.000000 MHz counter

[ 1.229690] clocksource: Switched to clocksource tsc-early

[ 1.235523] VFS: Disk quotas dquot\_6.6.0

[ 1.236083] VFS: Dquot-cache hash table entries: 512 (order 0, 4096 bytes)

[ 1.240188] pnp: PnP ACPI init

[ 1.244989] pnp: PnP ACPI: found 6 devices

[ 1.266889] clocksource: acpi\_pm: mask: 0xfffff max\_cycles: 0xfffff, max\_idle\_ns: 2085701024 ns

[ 1.268457] NET: Registered PF\_INET protocol family

[ 1.269778] IP idents hash table entries: 2048 (order: 2, 16384 bytes, linear)

[ 1.277451] tcp\_listen\_portaddr\_hash hash table entries: 256 (order: 0, 4096 bytes, linear)

[ 1.278708] Table-perturb hash table entries: 65536 (order: 6, 262144 bytes, linear)

[ 1.279545] TCP established hash table entries: 1024 (order: 1, 8192 bytes, linear)

[ 1.280294] TCP bind hash table entries: 1024 (order: 3, 32768 bytes, linear)

[ 1.281369] TCP: Hash tables configured (established 1024 bind 1024)

[ 1.282795] UDP hash table entries: 256 (order: 1, 8192 bytes, linear)

[ 1.283813] UDP-Lite hash table entries: 256 (order: 1, 8192 bytes, linear)

[ 1.286756] NET: Registered PF\_UNIX/PF\_LOCAL protocol family

[ 1.290487] RPC: Registered named UNIX socket transport module.

[ 1.291421] RPC: Registered udp transport module.

[ 1.291620] RPC: Registered tcp transport module.

[ 1.291886] RPC: Registered tcp NFSv4.1 backchannel transport module.

[ 1.295087] pci\_bus 0000:00: resource 4 [io 0x0000-0x0cf7 window]

[ 1.295304] pci\_bus 0000:00: resource 5 [io 0x0d00-0xffff window]

[ 1.296028] pci\_bus 0000:00: resource 6 [mem 0x000a0000-0x000bffff window]

[ 1.296542] pci\_bus 0000:00: resource 7 [mem 0x08000000-0xfebfffff window]

[ 1.297044] pci\_bus 0000:00: resource 8 [mem 0x100000000-0x17ffffff window]

[ 1.298471] pci 0000:00:01.0: PIIX3: Enabling Passive Release

[ 1.299034] pci 0000:00:00.0: Limiting direct PCI/PCI transfers

[ 1.299843] PCI: CLS 0 bytes, default 64

[ 1.308412] Unpacking initramfs...

[ 1.362578] Freeing initrd memory: 2656K

[ 1.449089] Initialise system trusted keyrings

[ 1.452494] workingset: timestamp\_bits=56 max\_order=15 bucket\_order=0

[ 1.466692] NFS: Registering the id\_resolver key type

[ 1.467395] Key type id\_resolver registered

[ 1.467567] Key type id\_legacy registered

[ 1.468951] 9p: Installing v9fs 9p2000 file system support

[ 1.498871] Key type asymmetric registered

[ 1.499090] Asymmetric key parser 'x509' registered

[ 1.499861] Block layer SCSI generic (bsg) driver version 0.4 loaded (major 251)

[ 1.501128] io scheduler mq-deadline registered

[ 1.501754] io scheduler kyber registered

[ 1.505662] input: Power Button as /devices/LNXSYSTM:00/LNXPWRBN:00/input/input0

[ 1.509404] ACPI: button: Power Button [PWRF]

[ 1.513212] Serial: 8250/16550 driver, 4 ports, IRQ sharing enabled

[ 1.515682] 00:04: ttyS0 at I/O 0x3f8 (irq = 4, base\_baud = 115200) is a 16550A

[ 1.521877] Non-volatile memory driver v1.3

[ 1.522098] Linux agpgart interface v0.103

[ 1.524533] ACPI: bus type drm\_connector registered

[ 1.545569] loop: module loaded

[ 1.554509] scsi host0: ata\_piix  
[ 1.557040] scsi host1: ata\_piix  
[ 1.557703] ata1: PATA max MWDMA2 cmd 0x1f0 ctl 0x3f6 bmdma 0xc040 irq 14  
[ 1.558206] ata2: PATA max MWDMA2 cmd 0x170 ctl 0x376 bmdma 0xc048 irq 15  
[ 1.566033] e100: Intel(R) PRO/100 Network Driver  
[ 1.566237] e100: Copyright(c) 1999-2006 Intel Corporation  
[ 1.567217] e1000e: Intel(R) PRO/1000 Network Driver  
[ 1.567740] e1000e: Copyright(c) 1999 - 2015 Intel Corporation.  
[ 1.568190] sky2: driver version 1.30  
[ 1.571335] usbcore: registered new interface driver usblp  
[ 1.572199] usbcore: registered new interface driver usb-storage  
[ 1.574771] i8042: PNP: PS/2 Controller [PNP0303:KBD,PNP0f13:MOU] at 0x60,0x64 irq 1,12  
[ 1.578643] serio: i8042 KBD port at 0x60,0x64 irq 1  
[ 1.579355] serio: i8042 AUX port at 0x60,0x64 irq 12  
[ 1.584153] input: AT Translated Set 2 keyboard as /devices/platform/i8042/serio0/input/input1  
[ 1.593639] rtc\_cmos 00:05: registered as rtc0  
[ 1.594654] rtc\_cmos 00:05: alarms up to one day, 242 bytes nvram, hpet irqs  
[ 1.595297] rtc\_cmos 00:05: RTC can wake from S4  
[ 1.596604] fail to initialize ptp\_kvm  
[ 1.598082] device-mapper: ioctl: 4.47.0-ioctl (2022-07-28) initialised: dm-devel@redhat.com  
[ 1.599781] hid: raw HID events driver (C) Jiri Kosina  
[ 1.601805] usbcore: registered new interface driver usbhid  
[ 1.602114] usbhid: USB HID core driver  
[ 1.610171] Initializing XFRM netlink socket  
[ 1.612248] NET: Registered PF\_INET6 protocol family  
[ 1.619548] Segment Routing with IPv6  
[ 1.620031] In-situ OAM (IOAM) with IPv6  
[ 1.621804] sit: IPv6, IPv4 and MPLS over IPv4 tunneling driver  
[ 1.625065] NET: Registered PF\_PACKET protocol family  
[ 1.626817] 9pnet: Installing 9P2000 support  
[ 1.627584] Key type dns\_resolver registered  
[ 1.629414] IPI shorthand broadcast: enabled  
[ 1.629890] sched\_clock: Marking stable (1550144804, 79144394)->(1635905790, -6616592)  
[ 1.632071] registered taskstats version 1  
[ 1.632265] Loading compiled-in X.509 certificates  
[ 1.639153] cryptomgr\_test (44) used greatest stack depth: 15584 bytes left  
[ 1.647657] PM: Magic number: 15:324:687

```
[ 1.648865] printk: console [netcon0] enabled
[ 1.649148] netconsole: network logging started
[ 1.721841] ata2: found unknown device (class 0)
[ 1.734292] ata2.00: ATAPI: QEMU DVD-ROM, 2.5+, max UDMA/100
[ 1.754131] scsi 1:0:0:0: CD-ROM          QEMU    QEMU DVD-ROM    2.5+ PQ: 0 ANSI: 5
[ 1.793493] sr 1:0:0:0: [sr0] scsi3-mmc drive: 4x/4x cd/rw xa/form2 tray
[ 1.794014] cdrom: Uniform CD-ROM driver Revision: 3.20
[ 1.813375] sr 1:0:0:0: Attached scsi generic sg0 type 5
[ 2.228014] input: ImExPS/2 Generic Explorer Mouse as /devices/platform/i8042/serio1/input/input3
[ 2.313202] tsc: Refined TSC clocksource calibration: 1991.973 MHz
[ 2.318146] clocksource: tsc: mask: 0xffffffffffff max_cycles: 0x396d1edf177, max_idle_ns: 881590683971 ns
[ 2.325130] clocksource: Switched to clocksource tsc
[ 14.536823] cfg80211: Loading compiled-in X.509 certificates for regulatory database
[ 14.602686] modprobe (67) used greatest stack depth: 14272 bytes left
[ 14.615936] cfg80211: Loaded X.509 cert 'sforshee: 00b28ddf47aef9cea7'
[ 14.617986] platform regulatory.0: Direct firmware load for regulatory.db failed with error -2
[ 14.618912] cfg80211: failed to load regulatory.db
[ 14.620570] ALSA device list:
[ 14.621037]  No soundcards found.
[ 14.690895] Freeing unused kernel image (initmem) memory: 1324K
[ 14.691934] Write protecting the kernel read-only data: 24576k
[ 14.695117] Freeing unused kernel image (text/rodata gap) memory: 2032K
[ 14.696216] Freeing unused kernel image (rodata/data gap) memory: 840K
[ 14.873187] x86/mm: Checked W+X mappings: passed, no W+X pages found.
[ 14.873934] Run/sbin/init as init process
[ 14.913473] mount (72) used greatest stack depth: 14160 bytes left
[ 15.066259] mdev (74) used greatest stack depth: 13960 bytes left
```

Please press Enter to activate this console.

```
~ # insmod r4l_e1000_demo.ko
```

```
[ 79.932243] r4l_e1000_demo: loading out-of-tree module taints kernel.
[ 79.939770] r4l_e1000_demo: Rust for linux e1000 driver demo (init)
[ 79.940590] r4l_e1000_demo: Rust for linux e1000 driver demo (probe): None
[ 80.137340] ACPI: \_SB_.LNKC: Enabled at IRQ 11
[ 80.159826] r4l_e1000_demo: Rust for linux e1000 driver demo (net device get_stats64)
[ 80.162165] insmod (80) used greatest stack depth: 10952 bytes left
```

```
~ # ip link set eth0 up
```



[ 88.699958] r4l\_e1000\_demo: Rust for linux e1000 driver demo (net device open)

[ 88.703553] r4l\_e1000\_demo: Rust for linux e1000 driver demo (net device get\_stats64)

[ 88.705037] IPv6: ADDRCONF(NETDEV\_CHANGE): eth0: link becomes ready

~ # [ 88.710969] r4l\_e1000\_demo: Rust for linux e1000 driver demo (net device get\_stats64)

[ 88.718618] r4l\_e1000\_demo: Rust for linux e1000 driver demo (net device start\_xmit) tdt=0, tdh=0, rdt=7, rdh=0

[ 88.719703] r4l\_e1000\_demo: Rust for linux e1000 driver demo (handle\_irq)

[ 88.720009] r4l\_e1000\_demo: pending\_irqs: 3

[ 88.720911] r4l\_e1000\_demo: Rust for linux e1000 driver demo (napi poll)

[ 89.181876] r4l\_e1000\_demo: Rust for linux e1000 driver demo (net device start\_xmit) tdt=1, tdh=1, rdt=7, rdh=0

[ 89.187420] r4l\_e1000\_demo: Rust for linux e1000 driver demo (handle\_irq)(probe)

[ 89.189606] r4l\_e1000\_demo: pending\_irqs: 3

[ 89.191175] r4l\_e1000\_demo: Rust for linux e1000 driver demo (napi poll)

[ 89.482031] r4l\_e1000\_demo: Rust for linux e1000 driver demo (net device start\_xmit) tdt=2, tdh=2, rdt=7, rdh=0

[ 89.486057] r4l\_e1000\_demo: Rust for linux e1000 driver demo (handle\_irq)

[ 89.491424] r4l\_e1000\_demo: pending\_irqs: 3

[ 89.493056] r4l\_e1000\_demo: Rust for linux e1000 driver demo (napi poll)

[ 90.191619] r4l\_e1000\_demo: Rust for linux e1000 driver demo (net device start\_xmit) tdt=3, tdh=3, rdt=7, rdh=0

[ 90.196468] r4l\_e1000\_demo: Rust for linux e1000 driver demo (handle\_irq)

[ 90.200113] r4l\_e1000\_demo: pending\_irqs: 3

[ 90.201580] r4l\_e1000\_demo: Rust for linux e1000 driver demo (napi poll)

[ 90.205084] r4l\_e1000\_demo: Rust for linux e1000 driver demo (net device start\_xmit) tdt=4, tdh=4, rdt=7, rdh=0

[ 90.209341] r4l\_e1000\_demo: Rust for linux e1000 driver demo (handle\_irq)

[ 90.211250] r4l\_e1000\_demo: pending\_irqs: 3

[ 90.213828] r4l\_e1000\_demo: Rust for linux e1000 driver demo (napi poll)

[ 90.698168] r4l\_e1000\_demo: Rust for linux e1000 driver demo (net device start\_xmit) tdt=5, tdh=5, rdt=7, rdh=0

[ 90.716571] r4l\_e1000\_demo: Rust for linux e1000 driver demo (handle\_irq)

[ 90.721659] r4l\_e1000\_demo: pending\_irqs: 3

[ 90.722810] r4l\_e1000\_demo: Rust for linux e1000 driver demo (napi poll)

[ 94.857686] r4l\_e1000\_demo: Rust for linux e1000 driver demo (net device start\_xmit) tdt=6, tdh=6, rdt=7, rdh=0

[ 94.862726] r4l\_e1000\_demo: Rust for linux e1000 driver demo (handle\_irq)

[ 94.865451] r4l\_e1000\_demo: pending\_irqs: 3

[ 94.867852] r4l\_e1000\_demo: Rust for linux e1000 driver demo (napi poll)

[ 103.049111] r4l\_e1000\_demo: Rust for linux e1000 driver demo (net device start\_xmit) tdt=7, tdh=7, rdt=7, rdh=0

[ 103.054549] r4l\_e1000\_demo: Rust for linux e1000 driver demo (handle\_irq)

[ 103.056979] r4l\_e1000\_demo: pending\_irqs: 3

[ 103.060190] r4l\_e1000\_demo: Rust for linux e1000 driver demo (napi poll)

[ 119.432942] r4l\_e1000\_demo: Rust for linux e1000 driver demo (net device start\_xmit) tdt=0, tdh=0, rdt=7, rdh=0

```
[ 119.437052] r4l_e1000_demo: Rust for linux e1000 driver demo (handle_irq)
[ 119.440460] r4l_e1000_demo: pending_irqs: 3
[ 119.442704] r4l_e1000_demo: Rust for linux e1000 driver demo (napi poll)

~ #
~ # ip link set eth0 up[ 152.712697] r4l_e1000_demo: Rust for linux e1000 driver demo (net device start_xmit)
tdt=1, tdh=1, rdt=7, rdh=0
[ 152.716943] r4l_e1000_demo: Rust for linux e1000 driver demo (handle_irq)
[ 152.719516] r4l_e1000_demo: pending_irqs: 3
[ 152.720660] r4l_e1000_demo: Rust for linux e1000 driver demo (napi poll)
~ # ip addr add broadcast 10.0.2.255 dev eth0
[ 161.380984] r4l_e1000_demo: Rust for linux e1000 driver demo (net device get_stats64)
[ 161.383196] r4l_e1000_demo: Rust for linux e1000 driver demo (net device get_stats64)
ip: RTNETLINK answers: Invalid argument
~ # ip addr add 10.0.2.15/255.255.255.0 dev eth0
[ 170.028101] r4l_e1000_demo: Rust for linux e1000 driver demo (net device get_stats64)
[ 170.028927] r4l_e1000_demo: Rust for linux e1000 driver demo (net device get_stats64)
~ # ip route add default via 10.0.2.1
~ # ping 10.0.2.2
PING 10.0.2.2 (10.0.2.2): 56 data bytes
[ 180.284878] r4l_e1000_demo: Rust for linux e1000 driver demo (net device start_xmit) tdt=2, tdh=2, rdt=7, rdh=0
[ 180.285697] r4l_e1000_demo: Rust for linux e1000 driver demo (handle_irq)
[ 180.286118] r4l_e1000_demo: pending_irqs: 131
[ 180.286650] r4l_e1000_demo: Rust for linux e1000 driver demo (napi poll)
[ 180.289638] r4l_e1000_demo: Rust for linux e1000 driver demo (net device start_xmit) tdt=3, tdh=3, rdt=0, rdh=1
[ 180.290408] r4l_e1000_demo: Rust for linux e1000 driver demo (handle_irq)
[ 180.290713] r4l_e1000_demo: pending_irqs: 131
[ 180.291913] r4l_e1000_demo: Rust for linux e1000 driver demo (napi poll)
64 bytes from 10.0.2.2: seq=0 ttl=255 time=14.982 ms
[ 181.302167] r4l_e1000_demo: Rust for linux e1000 driver demo (net device start_xmit) tdt=4, tdh=4, rdt=1, rdh=2
[ 181.306881] r4l_e1000_demo: Rust for linux e1000 driver demo (handle_irq)
[ 181.309167] r4l_e1000_demo: pending_irqs: 131
[ 181.310555] r4l_e1000_demo: Rust for linux e1000 driver demo (napi poll)
64 bytes from 10.0.2.2: seq=1 ttl=255 time=14.518 ms
[ 182.316664] r4l_e1000_demo: Rust for linux e1000 driver demo (net device start_xmit) tdt=5, tdh=5, rdt=2, rdh=3
[ 182.318924] r4l_e1000_demo: Rust for linux e1000 driver demo (handle_irq)
[ 182.320581] r4l_e1000_demo: pending_irqs: 131
```

[ 182.321475] r4l\_e1000\_demo: Rust for linux e1000 driver demo (napi poll)  
64 bytes from 10.0.2.2: seq=2 ttl=255 time=8.724 ms

[ 183.326954] r4l\_e1000\_demo: Rust for linux e1000 driver demo (net device start\_xmit) tdt=6, tdh=6, rdt=3, rdh=4  
[ 183.333732] r4l\_e1000\_demo: Rust for linux e1000 driver demo (handle\_irq)  
[ 183.336586] r4l\_e1000\_demo: pending\_irqs: 131  
[ 183.338016] r4l\_e1000\_demo: Rust for linux e1000 driver demo (napi poll)  
64 bytes from 10.0.2.2: seq=3 ttl=255 time=14.873 ms

[ 184.342519] r4l\_e1000\_demo: Rust for linux e1000 driver demo (net device start\_xmit) tdt=7, tdh=7, rdt=4, rdh=5  
[ 184.344370] r4l\_e1000\_demo: Rust for linux e1000 driver demo (handle\_irq)  
[ 184.346059] r4l\_e1000\_demo: pending\_irqs: 131  
[ 184.346515] r4l\_e1000\_demo: Rust for linux e1000 driver demo (napi poll)  
64 bytes from 10.0.2.2: seq=4 ttl=255 time=5.226 ms

[ 185.348781] r4l\_e1000\_demo: Rust for linux e1000 driver demo (net device start\_xmit) tdt=0, tdh=0, rdt=5, rdh=6  
[ 185.349859] r4l\_e1000\_demo: Rust for linux e1000 driver demo (handle\_irq)  
[ 185.351215] r4l\_e1000\_demo: pending\_irqs: 131  
[ 185.351561] r4l\_e1000\_demo: Rust for linux e1000 driver demo (napi poll)  
64 bytes from 10.0.2.2: seq=5 ttl=255 time=3.520 ms

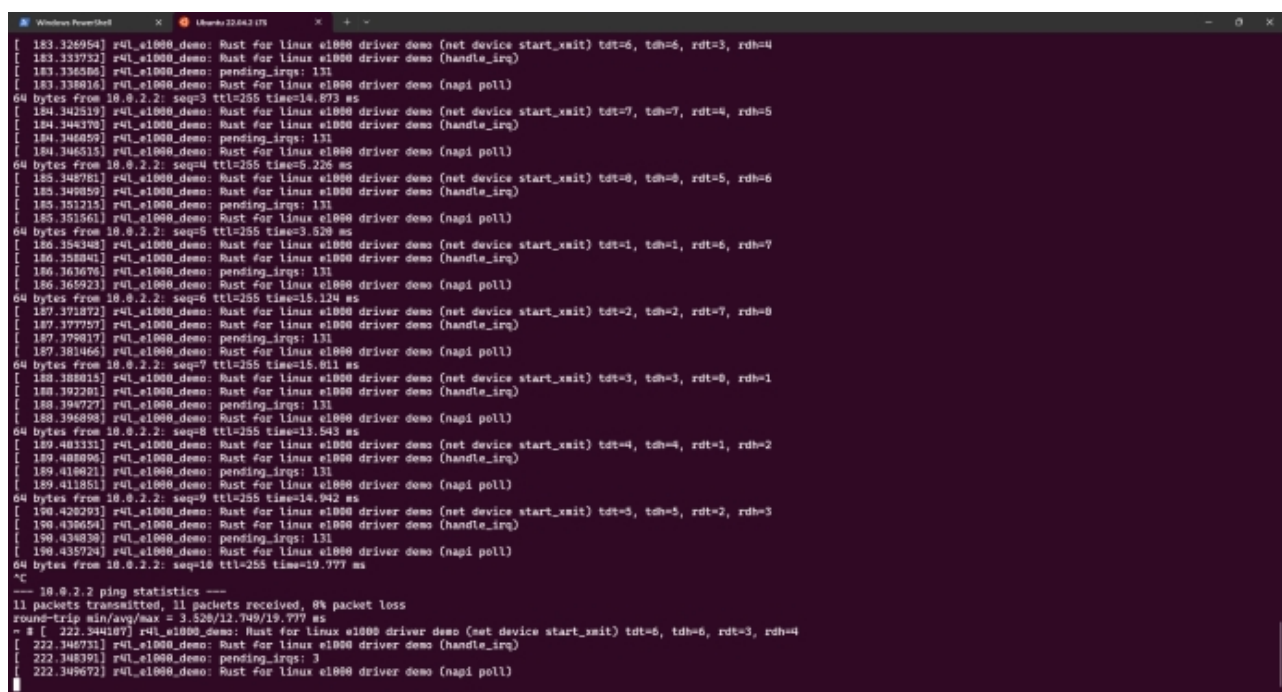
[ 186.354348] r4l\_e1000\_demo: Rust for linux e1000 driver demo (net device start\_xmit) tdt=1, tdh=1, rdt=6, rdh=7  
[ 186.358841] r4l\_e1000\_demo: Rust for linux e1000 driver demo (handle\_irq)  
[ 186.363676] r4l\_e1000\_demo: pending\_irqs: 131  
[ 186.365923] r4l\_e1000\_demo: Rust for linux e1000 driver demo (napi poll)  
64 bytes from 10.0.2.2: seq=6 ttl=255 time=15.124 ms

[ 187.371872] r4l\_e1000\_demo: Rust for linux e1000 driver demo (net device start\_xmit) tdt=2, tdh=2, rdt=7, rdh=0  
[ 187.377757] r4l\_e1000\_demo: Rust for linux e1000 driver demo (handle\_irq)  
[ 187.379817] r4l\_e1000\_demo: pending\_irqs: 131  
[ 187.381466] r4l\_e1000\_demo: Rust for linux e1000 driver demo (napi poll)  
64 bytes from 10.0.2.2: seq=7 ttl=255 time=15.011 ms

[ 188.388015] r4l\_e1000\_demo: Rust for linux e1000 driver demo (net device start\_xmit) tdt=3, tdh=3, rdt=0, rdh=1  
[ 188.392201] r4l\_e1000\_demo: Rust for linux e1000 driver demo (handle\_irq)  
[ 188.394727] r4l\_e1000\_demo: pending\_irqs: 131  
[ 188.396898] r4l\_e1000\_demo: Rust for linux e1000 driver demo (napi poll)  
64 bytes from 10.0.2.2: seq=8 ttl=255 time=13.543 ms

[ 189.403331] r4l\_e1000\_demo: Rust for linux e1000 driver demo (net device start\_xmit) tdt=4, tdh=4, rdt=1, rdh=2  
[ 189.408096] r4l\_e1000\_demo: Rust for linux e1000 driver demo (handle\_irq)  
[ 189.410021] r4l\_e1000\_demo: pending\_irqs: 131  
[ 189.411851] r4l\_e1000\_demo: Rust for linux e1000 driver demo (napi poll)  
64 bytes from 10.0.2.2: seq=9 ttl=255 time=14.942 ms

```
[ 190.420293] r4l_e1000_demo: Rust for linux e1000 driver demo (net device start_xmit) tdt=5, tdh=5, rdt=2, rdh=3
[ 190.430654] r4l_e1000_demo: Rust for linux e1000 driver demo (handle_irq)
[ 190.434830] r4l_e1000_demo: pending_irqs: 131
[ 190.435724] r4l_e1000_demo: Rust for linux e1000 driver demo (napi poll)
64 bytes from 10.0.2.2: seq=10 ttl=255 time=19.777 ms
^C
--- 10.0.2.2 ping statistics ---
11 packets transmitted, 11 packets received, 0% packet loss
round-trip min/avg/max = 3.520/12.749/19.777 ms
```



```
Windows PowerShell
X  Libvirt 32.04.2 LTS
[ 183.326954] r4l_e1000_demo: Rust for linux e1000 driver demo (net device start_xmit) tdt=6, tdh=6, rdt=3, rdh=4
[ 183.333732] r4l_e1000_demo: Rust for linux e1000 driver demo (handle_irq)
[ 183.336586] r4l_e1000_demo: pending_irqs: 131
[ 183.338016] r4l_e1000_demo: Rust for linux e1000 driver demo (napi poll)
64 bytes from 10.0.2.2: seq=3 ttl=255 time=14.873 ms
[ 184.342519] r4l_e1000_demo: Rust for linux e1000 driver demo (net device start_xmit) tdt=7, tdh=7, rdt=4, rdh=5
[ 184.344379] r4l_e1000_demo: Rust for linux e1000 driver demo (handle_irq)
[ 184.346559] r4l_e1000_demo: pending_irqs: 131
[ 184.346515] r4l_e1000_demo: Rust for linux e1000 driver demo (napi poll)
64 bytes from 10.0.2.2: seq=4 ttl=255 time=5.225 ms
[ 185.348781] r4l_e1000_demo: Rust for linux e1000 driver demo (net device start_xmit) tdt=8, tdh=8, rdt=5, rdh=6
[ 185.349859] r4l_e1000_demo: Rust for linux e1000 driver demo (handle_irq)
[ 185.351215] r4l_e1000_demo: pending_irqs: 131
[ 185.351561] r4l_e1000_demo: Rust for linux e1000 driver demo (napi poll)
64 bytes from 10.0.2.2: seq=5 ttl=255 time=3.520 ms
[ 186.354303] r4l_e1000_demo: Rust for linux e1000 driver demo (net device start_xmit) tdt=1, tdh=1, rdt=6, rdh=7
[ 186.355841] r4l_e1000_demo: Rust for linux e1000 driver demo (handle_irq)
[ 186.361676] r4l_e1000_demo: pending_irqs: 131
[ 186.365923] r4l_e1000_demo: Rust for linux e1000 driver demo (napi poll)
64 bytes from 10.0.2.2: seq=6 ttl=255 time=15.124 ms
[ 187.371872] r4l_e1000_demo: Rust for linux e1000 driver demo (net device start_xmit) tdt=2, tdh=2, rdt=7, rdh=8
[ 187.377757] r4l_e1000_demo: Rust for linux e1000 driver demo (handle_irq)
[ 187.379817] r4l_e1000_demo: pending_irqs: 131
[ 187.381466] r4l_e1000_demo: Rust for linux e1000 driver demo (napi poll)
64 bytes from 10.0.2.2: seq=7 ttl=255 time=15.011 ms
[ 188.385015] r4l_e1000_demo: Rust for linux e1000 driver demo (net device start_xmit) tdt=3, tdh=3, rdt=8, rdh=1
[ 188.392201] r4l_e1000_demo: Rust for linux e1000 driver demo (handle_irq)
[ 188.394727] r4l_e1000_demo: pending_irqs: 131
[ 188.396898] r4l_e1000_demo: Rust for linux e1000 driver demo (napi poll)
64 bytes from 10.0.2.2: seq=8 ttl=255 time=13.543 ms
[ 189.401331] r4l_e1000_demo: Rust for linux e1000 driver demo (net device start_xmit) tdt=4, tdh=4, rdt=1, rdh=2
[ 189.408096] r4l_e1000_demo: Rust for linux e1000 driver demo (handle_irq)
[ 189.414821] r4l_e1000_demo: pending_irqs: 131
[ 189.411851] r4l_e1000_demo: Rust for linux e1000 driver demo (napi poll)
64 bytes from 10.0.2.2: seq=9 ttl=255 time=14.942 ms
[ 190.426293] r4l_e1000_demo: Rust for linux e1000 driver demo (net device start_xmit) tdt=5, tdh=5, rdt=2, rdh=3
[ 190.430654] r4l_e1000_demo: Rust for linux e1000 driver demo (handle_irq)
[ 190.434830] r4l_e1000_demo: pending_irqs: 131
[ 190.435724] r4l_e1000_demo: Rust for linux e1000 driver demo (napi poll)
64 bytes from 10.0.2.2: seq=10 ttl=255 time=19.777 ms
^C
--- 10.0.2.2 ping statistics ---
11 packets transmitted, 11 packets received, 0% packet loss
round-trip min/avg/max = 3.520/12.749/19.777 ms
# [ 222.344107] r4l_e1000_demo: Rust for linux e1000 driver demo (net device start_xmit) tdt=6, tdh=6, rdt=3, rdh=4
[ 222.348731] r4l_e1000_demo: Rust for linux e1000 driver demo (handle_irq)
[ 222.348391] r4l_e1000_demo: pending_irqs: 3
[ 222.349672] r4l_e1000_demo: Rust for linux e1000 driver demo (napi poll)
```

## 作业3：使用rust编写一个简单的内核模块并运行

### 作业说明：

在上一份作业中，src\_e1000网卡驱动使用了核外模块的方式进行编译，这次，我们将编译一个in-tree的简单的rust模块。

步骤如下：

- 1、 进入到Linux目录下samples/rust文件夹
- 2、 添加一个rust\_helloworld.rs文件
- 3、 在该文件中添加如下内容

```
// SPDX-License-Identifier: GPL-2.0
```

```
//! Rust minimal sample.
```

```
use kernel::prelude::*;
```

```
module! {  
    type: RustHelloWorld,  
    name: "rust_helloworld",  
    author: "whocare",  
    description: "hello world module in rust",  
    license: "GPL",  
}
```

```
struct RustHelloWorld {}
```

```
impl kernel::Module for RustHelloWorld {  
    fn init(_name: &'static CStr, _module: &'static ThisModule) -> Result<Self> {  
        pr_info!("Hello World from Rust module");  
        Ok(RustHelloWorld {})  
    }  
}
```

遇到的问题：



```

make[2]: *** [scripts/Makefile.build:500: samples/rust] Error 2
make[1]: *** [scripts/Makefile.build:500: samples] Error 2
make[1]: *** Waiting for unfinished jobs....
make: *** [Makefile:1992: .] Error 2
diwave@diwave:/home/work/rust_cicv/cicv-r4l-diwave1/linux$ make LLVM=1 -j$(nproc)
DESCEND objtool
CALL    scripts/checksyscalls.sh
RUSTC    samples/rust/rust_helloworld.o
error: missing documentation for the crate
--> samples/rust/rust_helloworld.rs:2:1
2 | / use kernel::prelude::*;
3 |
4 | module! {
5 |     type: RustHelloWorld,
...
18 | }
19 | }
    ^
= note: '-D missing-docs' implied by '-D warnings'

error: aborting due to previous error

make[3]: *** [scripts/Makefile.build:307: samples/rust/rust_helloworld.o] Error 1
make[2]: *** [scripts/Makefile.build:500: samples/rust] Error 2
make[1]: *** [scripts/Makefile.build:500: samples] Error 2
make[1]: *** Waiting for unfinished jobs....
make: *** [Makefile:1992: .] Error 2
diwave@diwave:/home/work/rust_cicv/cicv-r4l-diwave1/linux$

```

如何解决问题:

```

1 // SPDX-License-Identifier: GPL-2.0
2 #![rust_minimal_sample]
3
4 use kernel::prelude::*;
5
6 module! {
7     type: RustHelloWorld,
8     name: "rust_helloworld",
9     author: "whocare",
10    description: "hello world module in rust",
11    license: "GPL",
12 }
13
14 struct RustHelloWorld {}
15
16 impl kernel::Module for RustHelloWorld {
17     fn init(_name: &'static CStr, _module: &'static ThisModule) -> Result<()> {
18         pr_info!("Hello World from Rust module");
19         Ok(RustHelloWorld {})
20     }
21 }
22

```

修改samples/rust下的Makefile和Kconfig

我们已经添加了rust\_helloworld.rs源代码，但它还无法参与编译。请根据您学到的知识，在Kconfig和Makefile中添加适当的内容，使得：

- 1、 在menuconfig配置时，可以对该代码进行配置，选择是否编译，以及是否编译成模块；
- 2、 可以根据选择的配置，编译成功（编译进内核、或编译成模块）。

如果你添加的配置正确，那么可以运行

```
make LLVM=1 menuconfig
```

更改该模块的配置，使之编译成模块

Kernel hacking

---> Sample Kernel code

---> Rust samples

---> <M>Print Helloworld in Rust (NEW)

重新编译该内核，并运行src\_e1000/build\_image.sh

## 测试样例和分数说明：

测试样例：

如果一切正常，那么你将在samples/rust下看到一份rust\_helloworld.ko的文件，将该文件复制到仓库中src\_e1000/rootfs目录下，然后重新跑build\_image.sh

==》需配置两个文件：

/home/work/rust\_cicv/cicv-r4l-diwave1/linux/samples/rust/Kconfig

==》配置开关

/home/work/rust\_cicv/cicv-r4l-diwave1/linux/samples/rust/Makefile

==> 需要编译的文件

```
Windows PowerShell x Ubuntu 22.04.2 LTS x + v x
[ 2.312842] printk: console [netcon0] enabled
[ 2.313093] netconsole: network logging started
[ 2.500541] tsc: Refined TSC clocksource calibration: 1992.013 MHz
[ 2.501689] clocksource: tsc: mask: 0xffffffffffffff max_cycles: 0x396d6a8de7f, max_idle_ns: 881590535638 ns
[ 2.503534] clocksource: Switched to clocksource tsc
[ 2.862883] input: ImExPS/2 Generic Explorer Mouse as /devices/platform/i8042/serial/input/input3
[ 2.892092] e1000: eth0 NIC Link is Up 1000 Mbps Full Duplex, Flow Control: RX
[ 2.895085] IPv6: ADDRCONF(NETDEV_CHANGE): eth0: link becomes ready
[ 2.907255] IP-Config: Complete:
[ 2.907660] device=eth0, hwaddr=52:54:00:12:34:56, ipaddr=10.0.2.15, mask=255.255.255.0, gw=10.0.2.1
[ 2.908805] host=10.0.2.15, domain=, nis-domain=(none)
[ 2.909781] bootserver=255.255.255.255, rootserver=255.255.255.255, rootpath=
[ 2.913919] cfg80211: Loading compiled-in X.509 certificates for regulatory database
[ 2.979365] modprobe (65) used greatest stack depth: 14272 bytes left
[ 2.995899] cfg80211: Loaded X.509 cert 'sforshee: 80b28ddf47aef9cea7'
[ 2.997933] platform regulatory.0: Direct firmware load for regulatory.db failed with error -2
[ 2.999004] cfg80211: failed to load regulatory.db
[ 3.000673] ALSA device list:
[ 3.000877] No soundcards found.
[ 3.073946] Freeing unused kernel image (initmem) memory: 1324K
[ 3.078655] Write protecting the kernel read-only data: 24576k
[ 3.081766] Freeing unused kernel image (text/rodata gap) memory: 2032K
[ 3.082791] Freeing unused kernel image (rodata/data gap) memory: 824K
[ 3.249856] x86/mm: Checked W+X mappings: passed, no W+X pages found.
[ 3.250685] Run/sbin/init as init process
[ 3.293520] mount (/70) used greatest stack depth: 13920 bytes left

Please press Enter to activate this console.
~ # insmod rust_helloworld.ko
~ # insmod rust_helloworld.ko
insmod: can't insert 'rust_helloworld.ko': File exists
~ # rmmod rust_helloworld.ko
~ # insmod rust_helloworld.ko
[ 0.364732] rust_helloworld: Hello World from Rust module
~ #
```

==》已经找到原因，为什么第一次无法打印信息，需要卸载后，再挂载才能打印。是由于pr\_info后面，需要增加“\n”

随后在Linux shell下使用ls命令，你将发现一份新的rust\_hellowrold.ko文件

使用insmod命令进行安装该模块

随后你将看到 "Hello World from Rust module"打印输出

- 1、 将上述过程记录在report中
- 2、 请在作业报告中记录您更新的Kconfig和Makefile

分数：本作业占20%分数

# 作业4： 为e1000网卡驱动添加remove代码

作业说明： [linux-fujita + e1000 - r4l](#) ([thy1037.github.io](#))

正如前面所述，e1000网卡的代码仍有非常多不完善的地方。因此需要您加以完善。

在第一次训练营中，我们仅仅实现了stop函数，让他不再能够发包。和第一次训练营不同，这一次我们瞄准了remove函数，该函数的作用和insmod相反，会完全移除该内核模块。因此需要您清理对应的数据结构

需要您做的工作如下：

- 1、 首先需要您将作业2中配置进行修改，禁用Linux内核原生的e1000网卡驱动。
- 2、 其次，在src\_e1000/r4l\_e1000\_demo.rs中有这样的函数

```
fn remove(data: &Self::Data) {
```

```

        pr_info!("Rust for linux e1000 driver demo (remove)\n");
    }

impl driver::DeviceRemoval for E1000DrvPrvData {
    fn device_remove(&self) {
        pr_info!("Rust for linux e1000 driver demo (device_remove)\n");
    }
}

```

目前仅仅是一个打印输出而已，您需要在其中填充代码

注意，您可以参考C版本的e1000网卡的实现，但是请务必弄明白，并非所有C版本的代码都一定要实现一遍。同时，您也未必需要完全遵循demo代码给出的框架，您可以自由发挥，只需要按照测试样例正常跑过即可。

## 测试样例和分数说明：

测试样例：

需要参照作业2的配置方法，运行build\_image.sh脚本之后，进入Linux环境下，随后按照作业2的方法进行配置并ping通。

之后使用

```
rmmod r4l_e1000_demo.ko
```

将该内核模块移除（即，您写的代码将被调用）

如果一切正常，那么重新按照作业2的方法，再次调用insmod命令，再一次安装该模块，能够正常ping通即可。

您需要在您的作业报告中提交关于这些的截图和内容

分数：本作业占20%分数

未对remove处理，挂载出错信息

```
Windows PowerShell x Ubuntu 22.04.2 LTS x + v x
[ 15.130868] Freeing unused kernel image (text/rodata gap) memory: 2832K
[ 15.131326] Freeing unused kernel image (rodata/data gap) memory: 840K
[ 15.304550] x86/mm: Checked M+X mappings: passed, no M+X pages found.
[ 15.305253] Run/sbin/init as init process
[ 15.349157] mount (72) used greatest stack depth: 14160 bytes left
[ 15.491887] mdev (74) used greatest stack depth: 13960 bytes left

Please press Enter to activate this console.
~ #
~ #
~ # ping 192.168.1.1
PING 192.168.1.1 (192.168.1.1): 56 data bytes
ping: sendto: Network is unreachable
[ 33.829277] ping (80) used greatest stack depth: 13920 bytes left
~ # insmod r4l_e1000_demo.ko
[ 37.881234] r4l_e1000_demo: loading out-of-tree module taints kernel.
[ 37.900818] r4l_e1000_demo: Rust for linux e1000 driver demo (init)
[ 37.904376] r4l_e1000_demo: Rust for linux e1000 driver demo (probe): None
[ 38.119092] ACPI: \_SB_.LNKC: Enabled at IRQ 11
[ 38.143083] r4l_e1000_demo: Rust for linux e1000 driver demo (net device get_stats64)
[ 38.146314] insmod (81) used greatest stack depth: 10952 bytes left
~ # rmmod r4l_e1000_demo.ko
[ 56.810707] r4l_e1000_demo: Rust for linux e1000 driver demo (exit)
[ 56.812276] r4l_e1000_demo: Rust for linux e1000 driver demo (remove)
[ 56.813487] r4l_e1000_demo: Rust for linux e1000 driver demo (device_remove)
[ 56.823732] r4l_e1000_demo: Rust for linux e1000 driver demo (net device get_stats64)
~ # ip link set eth0 up
ip: SIOCGIFFLAGS: No such device
~ # insmod r4l_e1000_demo.ko
[ 86.145576] r4l_e1000_demo: Rust for linux e1000 driver demo (init)
[ 86.146783] r4l_e1000_demo: Rust for linux e1000 driver demo (probe): None
[ 86.147612] r4l_e1000_demo 0000:00:03:0: BAR 0: can't reserve [mem 0xf0bc0000-0xf0bdffff]
[ 86.149133] r4l_e1000_demo: probe of 0000:00:03:0 failed with error -16
~ # QEMU: Terminated
diwave@diwave:/home/work/rust_cicv/cicv-r4l-diwave/src_e1000$
```

# 作业5：注册字符设备

## 作业说明：

这一次，我们回到Linux内核中，添加一个samples/rust/rust\_chrdev.rs文件。

在我们给出的代码中的Linux系统中给出了一个 /dev/cicv 字符设备，但是没有绑定驱动

要求修改rust\_chrdev.rs文件，往Linux系统中注册一个字符设备驱动，使得 /dev/cicv 可以完成基本的读写操作。

更改配置：

Kernel hacking

---> Sample Kernel code

---> Rust samples

---> <\*>Character device (NEW)

参考资料：

[Rust for Linux | 用 Rust 写 Linux 内核模块-腾讯云开发者社区-腾讯云 \(tencent.com\)](#)

[kernel - Rust \(rust-for-linux.github.io\)](#)

```
fn read(this: &Self, _file: &file::File, writer: &mut impl kernel::io_buffer::ioBufferWriter, offset: u64,) -> Result<usize>
{
    let buf = &mut *this.inner.lock();
    //let buf: &mut [u8] = &mut *buf;
    pr_info!("RustFile read, offset: {} \n", offset);
    let offset = offset as usize;
```

```
if offset > GLOBALMEM_SIZE {  
    return Err(ENOMEM);  
}  
writer.write_slice(&buf[offset..])?;  
Ok(buf.len())  
}
```

## 测试样例和分数说明：

测试样例：

使用下列命令往字符设备写入内容

```
echo "Hello" > /dev/cicv
```

并使用下列命令读出写入的内容

```
cat /dev/cicv
```

成功后应该返回

```
Hello
```

直接编译后，不添加代码出错信息

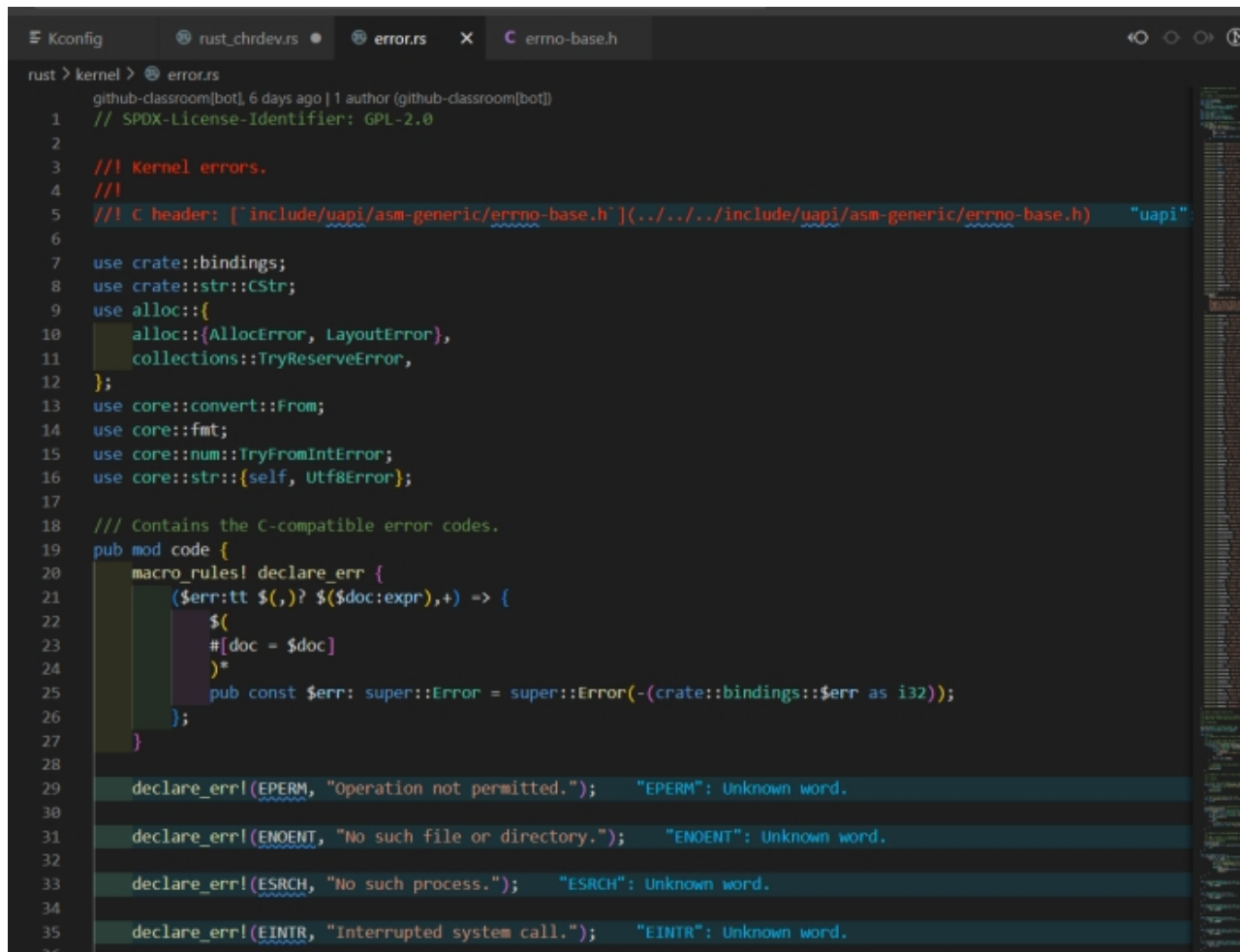
Click or press 'S' to search, '?' for more options...

**Constant kernel::error::code::EPERM** 

```
pub const EPERM: Error;
```

**[E]** Operation not permitted.

上文Rust-kernel错误链接：[kernel::error::code - Rust \(rust-for-linux.github.io\)](https://rust-for-linux.github.io/kernel::error::code)



```
rust > kernel > error.rs
github-classroom[bot], 6 days ago | 1 author (github-classroom[bot])
// SPDX-License-Identifier: GPL-2.0
2
3 /// Kernel errors.
4 ///
5 /// C header: ["include/uapi/asm-generic/errno-base.h"](../../../../include/uapi/asm-generic/errno-base.h) "uapi"
6
7 use crate::bindings;
8 use crate::str::CStr;
9 use alloc::{
10     alloc::{AllocError, LayoutError},
11     collections::TryReserveError,
12 };
13 use core::convert::From;
14 use core::fmt;
15 use core::num::TryFromIntError;
16 use core::str::{self, Utf8Error};
17
18 /// Contains the C-compatible error codes.
19 pub mod code {
20     macro_rules! declare_err {
21         ($err:tt $(,)? $($doc:expr),+) => {
22             $(
23                 #[doc = $doc]
24             )*
25             pub const $err: super::Error = super::Error(-(crate::bindings::$err as i32));
26         };
27     }
28
29     declare_err!(EPERM, "Operation not permitted."); "EPERM": Unknown word.
30
31     declare_err!(ENOENT, "No such file or directory."); "ENOENT": Unknown word.
32
33     declare_err!(ESRCH, "No such process."); "ESRCH": Unknown word.
34
35     declare_err!(EINTR, "Interrupted system call."); "EINTR": Unknown word.
36 }
```

相对应C语言出错代码: `include/uapi/asm-generic/errno-base.h`



Kconfig

rust\_chrdev.rs

errno-base.h X

include &gt; uapi &gt; asm-generic &gt; C errno-base.h

```

1  /* SPDX-License-Identifier: GPL-2.0 WITH Linux-syscall-note */
2  #ifndef _ASM_GENERIC_ERRNO_BASE_H
3  #define _ASM_GENERIC_ERRNO_BASE_H
4
5  #define EPERM          1 /* Operation not permitted */
6  #define ENOENT         2 /* No such file or directory */
7  #define ESRCH          3 /* No such process */
8  #define EINTR          4 /* Interrupted system call */
9  #define EIO            5 /* I/O error */
10 #define ENXIO          6 /* No such device or address */
11 #define E2BIG          7 /* Argument list too long */
12 #define ENOEXEC        8 /* Exec format error */
13 #define EBADF          9 /* Bad file number */
14 #define ECHILD         10 /* No child processes */
15 #define EAGAIN         11 /* Try again */
16 #define ENOMEM         12 /* Out of memory */
17 #define EACCES         13 /* Permission denied */
18 #define EFAULT         14 /* Bad address */
19 #define ENOTBLK        15 /* Block device required */
20 #define EBUSY          16 /* Device or resource busy */
21 #define EEXIST         17 /* File exists */
22 #define EXDEV          18 /* Cross-device link */
23 #define ENODEV         19 /* No such device */
24 #define ENOTDIR        20 /* Not a directory */
25 #define EISDIR         21 /* Is a directory */
26 #define EINVAL         22 /* Invalid argument */
27 #define ENFILE         23 /* File table overflow */
28 #define EMFILE         24 /* Too many open files */
29 #define ENOTTY         25 /* Not a typewriter */
30 #define ETXTBSY        26 /* Text file busy */

```

```

fn write(this: &Self, file: &file::File, reader: &mut impl kernel::io_buffer::IoBufferReader, offset: u64,) -> Result<io::Result<()>, io::Error> {
    Err(EPERM) "EPERM": Unknown word.

```

github-classroom[bot], 6 days ago • Initial commit

```

51 fn read(this: &Self, file: &file::File, writer: &mut impl kernel::io_buffer::IoBufferWriter, offset: u64,) -> Result<io::Result<()>, io::Error> {
52     Err(EPERM) "EPERM": Unknown word.

```





```

///

/// Note that context data is moved, so it will be freed automatically unless the
/// implementation moves it elsewhere.

///

/// Corresponds to the `release` function pointer in `struct file_operations`.
fn release(_data: Self::Data, _file: &File) {}

/// Reads data from this file to the caller's buffer.

///

/// Corresponds to the `read` and `read_iter` function pointers in `struct file_operations`.
fn read(
    _data: <Self::Data as PointerWrapper>::Borrowed<'__>,
    _file: &File,
    _writer: &mut impl IoBufferWriter,
    _offset: u64,
) -> Result<usize> {
    Err(EINVAL)
}

/// Writes data from the caller's buffer to this file.

///

/// Corresponds to the `write` and `write_iter` function pointers in `struct file_operations`.
fn write(
    _data: <Self::Data as PointerWrapper>::Borrowed<'__>,
    _file: &File,
    _reader: &mut impl IoBufferReader,
    _offset: u64,
) -> Result<usize> {
    Err(EINVAL)
}

/// Changes the position of the file.

///

/// Corresponds to the `llseek` function pointer in `struct file_operations`.
fn seek(
    _data: <Self::Data as PointerWrapper>::Borrowed<'__>,
    _file: &File,

```

```

    _offset: SeekFrom,
) -> Result<u64> {
    Err(EINVAL)
}

```

/// Performs IO control operations that are specific to the file.

///

/// Corresponds to the `unlocked\_ioctl` function pointer in `struct file\_operations`.

```

fn ioctl(
    _data: <Self::Data as PointerWrapper>::Borrowed<'_,>,
    _file: &File,
    _cmd: &mut IoctlCommand,
) -> Result<i32> {
    Err(ENOTTY)
}

```

/// Performs 32-bit IO control operations on that are specific to the file on 64-bit kernels.

///

/// Corresponds to the `compat\_ioctl` function pointer in `struct file\_operations`.

```

fn compat_ioctl(
    _data: <Self::Data as PointerWrapper>::Borrowed<'_,>,
    _file: &File,
    _cmd: &mut IoctlCommand,
) -> Result<i32> {
    Err(ENOTTY)
}

```

/// Syncs pending changes to this file.

///

/// Corresponds to the `fsync` function pointer in `struct file\_operations`.

```

fn fsync(
    _data: <Self::Data as PointerWrapper>::Borrowed<'_,>,
    _file: &File,
    _start: u64,
    _end: u64,
    _datasync: bool,
) -> Result<u32> {

```

```

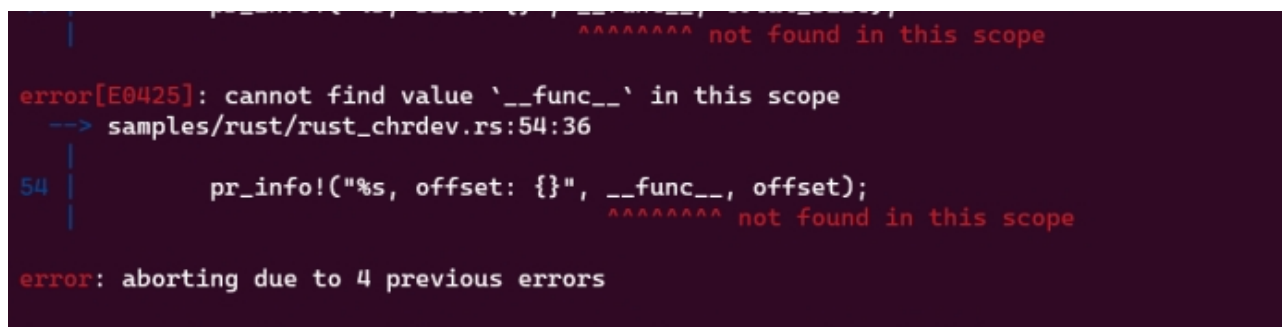
    Err(EINVAL)
}

/// Maps areas of the caller's virtual memory with device/file memory.
///
/// Corresponds to the `mmap` function pointer in `struct file_operations`.
fn mmap(
    _data: <Self::Data as PointerWrapper>::Borrowed<'_>,
    _file: &File,
    _vma: &mut mm::virt::Area,
) -> Result {
    Err(EINVAL)
}

/// Checks the state of the file and optionally registers for notification when the state
/// changes.
///
/// Corresponds to the `poll` function pointer in `struct file_operations`.
fn poll(
    _data: <Self::Data as PointerWrapper>::Borrowed<'_>,
    _file: &File,
    _table: &PollTable,
) -> Result<u32> {
    Ok(bindings::POLLIN | bindings::POLLOUT | bindings::POLLRDNORM | bindings::POLLWRNORM)
}
}

```

留下一个问题:



```

          ^^^^^^^^^ not found in this scope
error[E0425]: cannot find value `__func__` in this scope
--> samples/rust/rust_chrdev.rs:54:36
54 |         pr_info!("%s, offset: {}", __func__, offset);
    |                                     ^^^^^^^^^ not found in this scope
error: aborting due to 4 previous errors

```

```
const GLOBALMEM_SIZE: usize = 0x10;
```

出现内存溢出

Please press Enter to activate this console.

```
~ # insmod rust_chrdev.ko
```

```
[ 12.519592] rust_chrdev: Rust character device sample (init)
```

```
[ 12.522700] insmod (78) used greatest stack depth: 13864 bytes left
```

```
~ # echo "123456789012345678" > /dev/cicv
```

```
[ 29.037748] rust_chrdev: RustFile open
```

```
[ 29.040397] rust_chrdev: RustFile write, size: 19
```

```
[ 29.042650] rust_kernel: panicked at 'range end index 19 out of range for slice of length 16',
```

```
/home/diwave/.rustup/toolchains/1.62.0-x86_64
```

```
[ 29.045773] -----[ cut here ]-----
```

```
[ 29.046178] kernel BUG at rust/helpers.c:47!
```

```
[ 29.048185] invalid opcode: 0000 [#1] PREEMPT SMP NOPTI
```

```
[ 29.050577] CPU: 0 PID: 74 Comm: sh Not tainted 6.1.0-rc1 #9
```

```
[ 29.051280] Hardware name: QEMU Standard PC (i440FX + PIIX, 1996), BIOS rel-1.16.1-0-g3208b098f51a-  
prebuilt.qemu.org 04/01/2014
```

```
[ 29.052807] RIP: 0010:rust_helper_BUG+0x0/0x10
```

```
[ 29.054350] Code: c6 b0 48 c7 44 24 30 00 00 00 00 48 8d 7c 24 08 48 c7 c6 b0 c6 c6 b0 e8 be 41 88 00 0f 0b  
00 00 cc cc 00 00 cc cc 00 00 cc6
```

```
[ 29.057092] RSP: 0018:ffff9d59001c7cc0 EFLAGS: 00000286
```

```
[ 29.057942] RAX: 0000000000000000cc RBX: ffff986d42417a00 RCX: 0000000000000001
```

```
[ 29.059656] RDX: 0000000000000000 RSI: 0000000000000004 RDI: 00000000ffffff
```

```
[ 29.060642] RBP: ffff986d42417a68 R08: 0000000000000000 R09: ffffffff1281880
```

```
[ 29.061931] R10: 0000000000000000 R11: 00000000ffffdfff R12: 0000000000b620a0
```

```
[ 29.063207] R13: 0000000000000013 R14: ffff9d59001c7ef0 R15: ffffffff01f0000
```

```
[ 29.063859] FS: 0000000000b543c0(0000) GS: ffff986d47800000(0000) knlGS:0000000000000000
```

```
[ 29.064956] CS: 0010 DS: 0000 ES: 0000 CR0: 0000000080050033
```

```
[ 29.066137] CR2: 00000000005caed0 CR3: 000000000247c000 CR4: 000000000000006f0
```

```
[ 29.067825] Call Trace:
```

```
[ 29.069629] <TASK>
```

```
[ 29.070029] rust_begin_unwind+0x66/0x80
```

```
[ 29.070824] ?
```

```
_RNvXsP_NtCs3yuwAp0waWO_4core3fmtRhNtB5_5Debug3fmtCsfATHBUcknU9_6kernel+0x50/0x50
```

```
[ 29.071830] ? _RNvNtCs3yuwAp0waWO_4core9panicking9panic_fmt+0x2c/0x30
```

```
[ 29.073312] ? _RNvNtNtCs3yuwAp0waWO_4core5slice5index27slice_end_index_len_fail_rt+0x73/0x80
```

```
[ 29.074342] ? _RNvXs4_NtNtNtCs3yuwAp0waWO_4core3fmt3num3impXNtB9_7Display3fmt+0x20/0x20
```

```

[ 29.075268] ? _RNvXs4_NtNtNtCs3yuwAp0waWO_4core3fmt3num3impXNtB9_7Display3fmt+0x20/0x20
[ 29.076223] ?
_RNvYNvNtNtCs3yuwAp0waWO_4core5slice5index27slice_end_index_len_fail_rtINtNtNtB8_3ops8function6FnOn
ceTjjEE9call_onceB8_+0x6/00
[ 29.078900] ?
_RINvNtCs3yuwAp0waWO_4core10intrinsics17const_eval_selectTjjENvNtNtB4_5slice5index27slice_end_index_le
n_fail_ctNvBY_27slice_e0
[ 29.080544] ? _RNvNtNtCs3yuwAp0waWO_4core5slice5index24slice_end_index_len_fail+0x6/0x10
[ 29.081957] ?
_RNvMs3_NtCsfATHBUcknU9_6kernel4fileINtB5_16OperationsVtableINtNtB7_6chrdev12RegistrationKj2_ENtCsbz
7zR1RBgyO_11rust_chrdev8R]
[ 29.086709] ? _RNvXs4_NtNtNtCs3yuwAp0waWO_4core3fmt3num3impXNtB9_7Display3fmt+0x20/0x20
[ 29.087663] ? vfs_write+0x124/0x380
[ 29.087885] ? handle_mm_fault+0x69/0x160
[ 29.088251] ? ksys_write+0x50/0xa0
[ 29.088869] ? do_syscall_64+0x43/0x90
[ 29.089436] ? entry_SYSCALL_64_after_hwframe+0x63/0xcd
[ 29.090221] </TASK>
[ 29.090491] Modules linked in: rust_chrdev
[ 29.091985] ---[ end trace 0000000000000000 ]---
[ 29.093403] RIP: 0010:rust_helper_BUG+0x0/0x10
[ 29.093822] Code: c6 b0 48 c7 44 24 30 00 00 00 00 48 8d 7c 24 08 48 c7 c6 b0 c6 c6 b0 e8 be 41 88 00 0f 0b
00 00 cc cc 00 00 cc cc 00 00 cc6
[ 29.096830] RSP: 0018:ffff9d59001c7cc0 EFLAGS: 00000286
[ 29.098035] RAX: 0000000000000000cc RBX: ffff986d42417a00 RCX: 0000000000000001
[ 29.101106] RDX: 0000000000000000 RSI: 0000000000000004 RDI: 00000000ffffff
[ 29.102857] RBP: ffff986d42417a68 R08: 0000000000000000 R09: ffffffff1281880
[ 29.104449] R10: 0000000000000000 R11: 00000000ffffdfff R12: 0000000000b620a0
[ 29.106316] R13: 0000000000000013 R14: ffff9d59001c7ef0 R15: ffffffff01f0000
[ 29.107163] FS: 0000000000b543c0(0000) GS:ffff986d47800000(0000) knlGS:0000000000000000
[ 29.108487] CS: 0010 DS: 0000 ES: 0000 CR0: 0000000080050033
[ 29.109828] CR2: 00000000005caed0 CR3: 000000000247c000 CR4: 0000000000000060
[ 29.119667] sh (74) used greatest stack depth: 13232 bytes left

```

Please press Enter to activate this console.

需要在write对输入数据大小作判断

```

fn write(this: &Self, _file: &file::File, reader: &mut impl kernel::io_buffer::ioBufferReader, _offset: u64,) ->
Result<usize> {
    let total_size = reader.len();

    pr_info!("RustFile write, size: {}\n", total_size);

    if total_size > GLOBALMEM_SIZE {
        return Err(ENOMEM);
    }

    let buf = &mut this.inner.lock();

    reader.read_slice(&mut buf[..total_size])?;

    Ok(total_size)
}
==》

```

```

[ 4.973823] Run/sbin/init as init process
[ 5.016794] mount (70) used greatest stack depth: 13920 bytes left

Please press Enter to activate this console.
~ # insmod rust_chrdev.ko
[ 11.671440] rust_chrdev: Rust character device sample (init)
[ 11.677861] insmod (78) used greatest stack depth: 13864 bytes left
~ # echo "12345678901234567890" > /dev/cicv
[ 29.947493] rust_chrdev: RustFile open
[ 29.949749] rust_chrdev: RustFile write, size: 21
sh: write error: Cannot allocate memory
~ # echo "1234567890123456" > /dev/cicv
[ 41.232047] rust_chrdev: RustFile open
[ 41.232465] rust_chrdev: RustFile write, size: 17
sh: write error: Cannot allocate memory
~ # echo "123456789012345" > /dev/cicv
[ 45.079137] rust_chrdev: RustFile open
[ 45.080390] rust_chrdev: RustFile write, size: 16
~ # cat /dev/cicv
[ 50.651869] rust_chrdev: RustFile open
[ 50.653801] rust_chrdev: RustFile read, offset: 0
123456789012345
[ 50.656450] rust_chrdev: RustFile read, offset: 16
123456789012345
[ 50.659179] rust_chrdev: RustFile read, offset: 32
cat: read error: Cannot allocate memory
~ #

```

出现一个问题，cat时，出现 offset 还在输出数据。

修改

```

fn read(this: &Self, _file: &file::File, writer: &mut impl kernel::io_buffer::ioBufferWriter, offset: u64,) -> Result<usize>
{
    let buf = &mut *this.inner.lock();

    pr_info!("RustFile read, offset: {}\n", offset);

    let offset = offset as usize;

    if offset >= GLOBALMEM_SIZE {

```

```

    return Err(ENOMEM);
}

writer.write_slice(&buf[offset..])?;

Ok(buf.len())
}

```

```

[ 3.313727] cfg80211: Loading compiled-in X.509 certificates for regulatory database
[ 3.395915] modprobe (65) used greatest stack depth: 14272 bytes left
[ 3.415210] cfg80211: Loaded X.509 cert 'sforshee: 00b28ddf47aef9cea7'
[ 3.417350] platform regulatory.0: Direct firmware load for regulatory.db failed with error -2
[ 3.418319] cfg80211: failed to load regulatory.db
[ 3.419879] ALSA device list:
[ 3.420150]   No soundcards found.
[ 3.585781] Freeing unused kernel image (initramfs) memory: 1324K
[ 3.586699] Write protecting the kernel read-only data: 24576k
[ 3.511739] Freeing unused kernel image (text/rodata gap) memory: 2032K
[ 3.513424] Freeing unused kernel image (rodata/data gap) memory: 824K
[ 3.694955] x86/mm: Checked W*X mappings: passed, no W*X pages found.
[ 3.695789] IPv6: ADDRCONF(NETDEV_CHANGE): eth0: link becomes ready
[ 3.698274] Run/sbin/init as init process
[ 3.776357] mount (78) used greatest stack depth: 14160 bytes left
[ 3.930514] ndev (72) used greatest stack depth: 13960 bytes left

Please press Enter to activate this console.
~ # insmod rust_chrdev.ko
[ 11.170822] rust_chrdev: Rust character device sample (init)
[ 11.173840] insmod (78) used greatest stack depth: 13864 bytes left
~ # echo "0123456789012345" > /dev/cicv
[ 30.928355] rust_chrdev: RustFile open
[ 30.930700] rust_chrdev: RustFile write, size: 17
sh: write error: Cannot allocate memory
~ # echo "012345678901234" > /dev/cicv
[ 37.843936] rust_chrdev: RustFile open
[ 37.845684] rust_chrdev: RustFile write, size: 16
~ # cat /dev/cicv
[ 42.812482] rust_chrdev: RustFile open
[ 42.815441] rust_chrdev: RustFile read, offset: 0
012345678901234
[ 42.818886] rust_chrdev: RustFile read, offset: 16
cat: read error: Cannot allocate memory
~ #

```

/dev/cicv的绑定方式，在启动时，  
 echo "mknod /dev/cicv c 248 0" >> etc/init.d/rcS



```
$ build_image.sh X
$ build_image.sh
9  echo $base_path
10 if [ ! -d $rootfs ]; then
11     mkdir $rootfs
12 fi
13 cp $busybox_folder/_install/* $rootfs/ -rf
14 cp $work_dir/r4l_e1000_demo.ko $work_dir/$rootfs/
15 cd $rootfs
16 if [ ! -d proc ] && [ ! -d sys ] && [ ! -d dev ] && [ ! -d etc/init.d ]; then
17     mkdir proc sys dev etc etc/init.d
18 fi
19
20 if [ -f etc/init.d/rcS ]; then
21     rm etc/init.d/rcS
22 fi
23 echo "#!/bin/sh" > etc/init.d/rcS
24 echo "mount -t proc none /proc" >> etc/init.d/rcS
25 echo "mount -t sysfs none /sys" >> etc/init.d/rcS
26 echo "/sbin/mdev -s" >> etc/init.d/rcS
27 echo "mknod /dev/cicv c 248 0" >> etc/init.d/rcS
28 chmod +x etc/init.d/rcS
29 if [ -f $rootfs_img ]; then
30     rm $rootfs_img
31 fi
32
33 cd $work_dir
34
35 cd $rootfs
36 find . | cpio -o --format=newc > $rootfs_img
37
38 cd $work_dir
```

[linux mknod命令解析-CSDN博客](#)

您需要在您的作业报告中提交关于这部分的内容