



RISC-V Developer Images

Bay Area RISC-V Group

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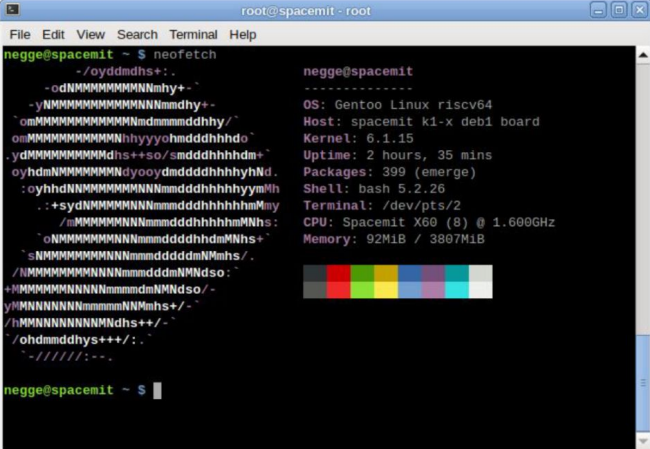
Luca Barbato <lu_zero@gentoo.org>

RISC-V Summit EU - June 2024

- Presented single slide on *manually* prebuilt developer images
- Since then work has focused on build automation

Prebuilt Developer Images

- Facilitate development by providing up-to-date toolchains for building and testing
 - Latest toolchain package versions
 - clang-18.1.5
 - gcc-13.2.1_p20240503
 - rust-1.77.1
 - binutils-2.42
 - cmake-3.29.3
 - python-3.12.3
 - perl-5.38.2
 - git-2.45.1
 - subversion-1.14.3
 - Kendryte K230 and Banana Pi BPI-F3



```
root@spacemit ~ root
File Edit View Search Terminal Help
negge@spacemit ~ $ neofetch
      _/oyddmdhs+/_
     -odNMMMMMMMMNNmhy+-
    -yNMMMMMMMMNNmddhy+-
   omMMMMMMMMNNmddmddhhy/_
  onMMMMMMMMNNhyyohmddhhd+
 ydMMMMMMMMds++so/smdddhhd+
oyhdmNNMMMMNdyyoymdddddhhhyNd.
:oyhhdNNMMMMNNmdddddhhhhhyMh
.:+sydNNMMMMNNmdddddhhhhmMhs+
  /mMMMMMMMMNNmdddddhhhhmMhs+
   oNMMMMMMMMNNmdddddhdMNhs+
    sNMMMMMMMMNNmdddddMmhs+
   /NMMMMMMMMNNmdddmNMdso`
+MMMMMMMMNNmdddmNMdso/-
y/MNMMMMMMMMNNmddmMhs+/-
/hMMMMMMMMNNmddhs+/-
`ohdmdhys+++/.
`-/////:--
negge@spacemit ~ $

negge@spacemit
-----
OS: Gentoo Linux riscv64
Host: spacemit k1-x deb1 board
Kernel: 6.1.15
Uptime: 2 hours, 35 mins
Packages: 399 (emerge)
Shell: bash 5.2.26
Terminal: /dev/pts/2
CPU: Spacemit X60 (8) @ 1.600GHZ
Memory: 92MiB / 3807MiB
```

[1] <https://people.videolan.org/~negge/canaan-3G-2024-04-08.img.xz>
[2] <https://people.videolan.org/~negge/spacemit-4G-2024-05-15.img.xz>

**ROMA II image
coming soon!!**

Project Goals

- Fastest way to create bootable images with **up-to-date** toolchains!
- RISC-V toolchains under active development and move very quickly
 - Bugs are found and fixed continuously, point releases matter!
- Primarily driven by need for tools to enable RVV 1.0 optimizations
 - Finally have widely available hardware e.g. K230, BPI-F3, ROMA II
 - As per Gentoo tradition, would like to build ***all*** packages with full support for available hardware: auto-vectorizer, bitmanip, crypto, etc.
 - Added benefit of assessing compiler readiness, and report gaps [1]

[1] [GCC Bug 116242](#) - [meta-bug] Tracker for zvl issues in RISC-V

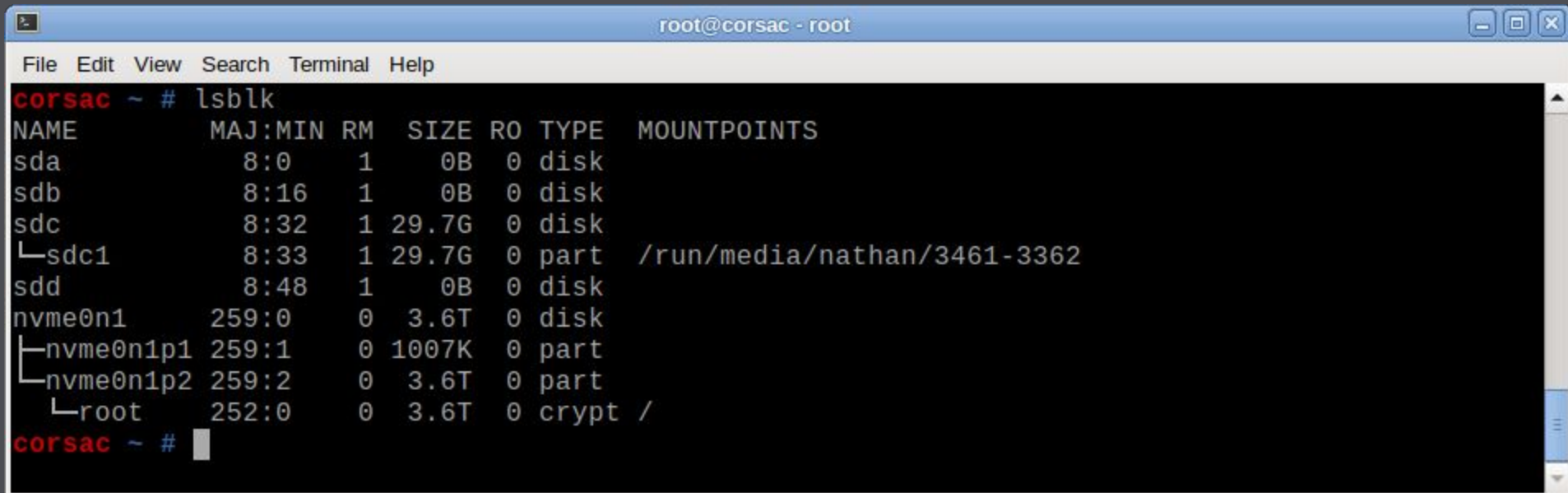
Build scripts

- Traditionally Gentoo builds new images through [Catalyst](#)
 - Images built through stages: `stage1 -> stage2 -> stage3`
 - Every stage is built either on native host or via `qemu-user`
 - Emulation via `qemu-user` adds *large* amount of overhead
- `crossdev-stages` [1] is an experiment on cross compiling
 - It leverages [crossdev](#) to avoid relying on `qemu-user` for RISC-V
 - Much, much faster (6x to 10x) and can be made even faster
 - First attempt building a full `stage3` (300+ packages) took ~343m
 - Building `stage3` + `clang` + additional tools now takes ~305m

[1] <https://github.com/lu-zero/crossdev-stages>

Preparing the Disk

```
$ lsblk
```

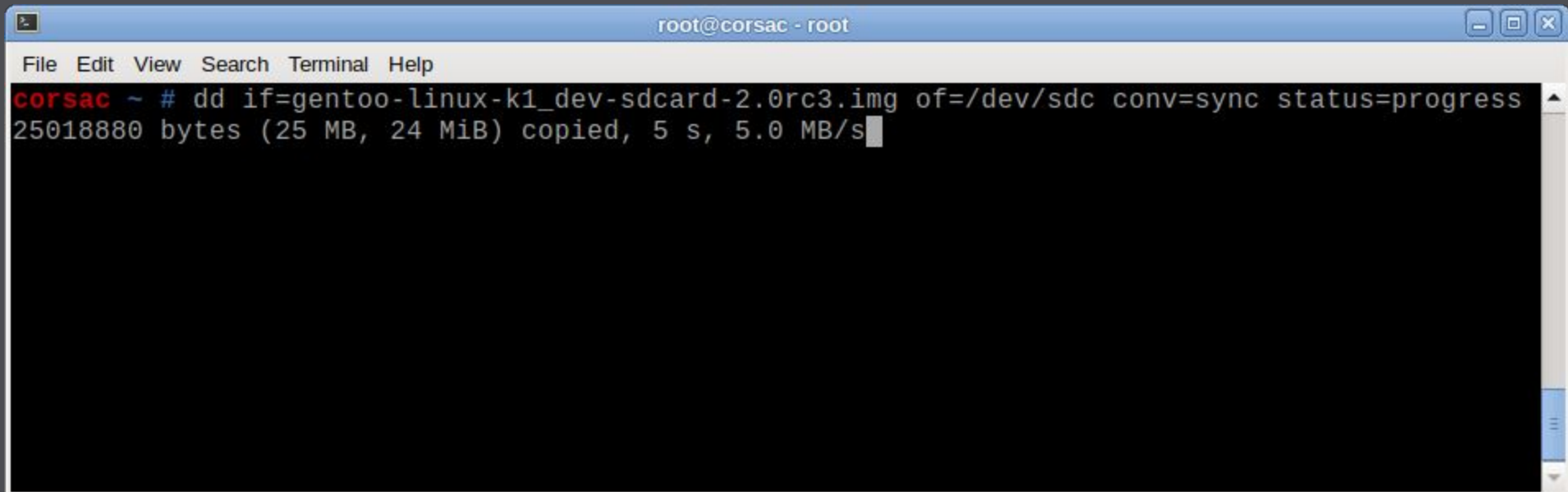


A terminal window titled "root@corsac - root" showing the output of the "lsblk" command. The output is a table with columns: NAME, MAJ:MIN, RM, SIZE, RO, TYPE, and MOUNTPOINTS. The table lists several disks and partitions, including sda, sdb, sdc, sdd, nvme0n1, and their respective partitions. The sdc partition is mounted at /run/media/nathan/3461-3362, and the nvme0n1p2 partition is mounted at /.

```
File Edit View Search Terminal Help
corsac ~ # lsblk
NAME        MAJ:MIN RM  SIZE RO TYPE  MOUNTPOINTS
sda         8:0     1   0B  0 disk
sdb         8:16    1   0B  0 disk
sdc         8:32    1 29.7G 0 disk
└─sdc1      8:33    1 29.7G 0 part  /run/media/nathan/3461-3362
sdd         8:48    1   0B  0 disk
nvme0n1     259:0   0  3.6T 0 disk
├─nvme0n1p1 259:1   0 1007K 0 part
├─nvme0n1p2 259:2   0  3.6T 0 part
└─root      252:0   0  3.6T 0 crypt /
corsac ~ #
```

Installing the image [1]

```
$ dd if=gentoo-linux-k1_dev-sdcard-2.0rc3.img of=/dev/sdc conv=sync status=progress
```

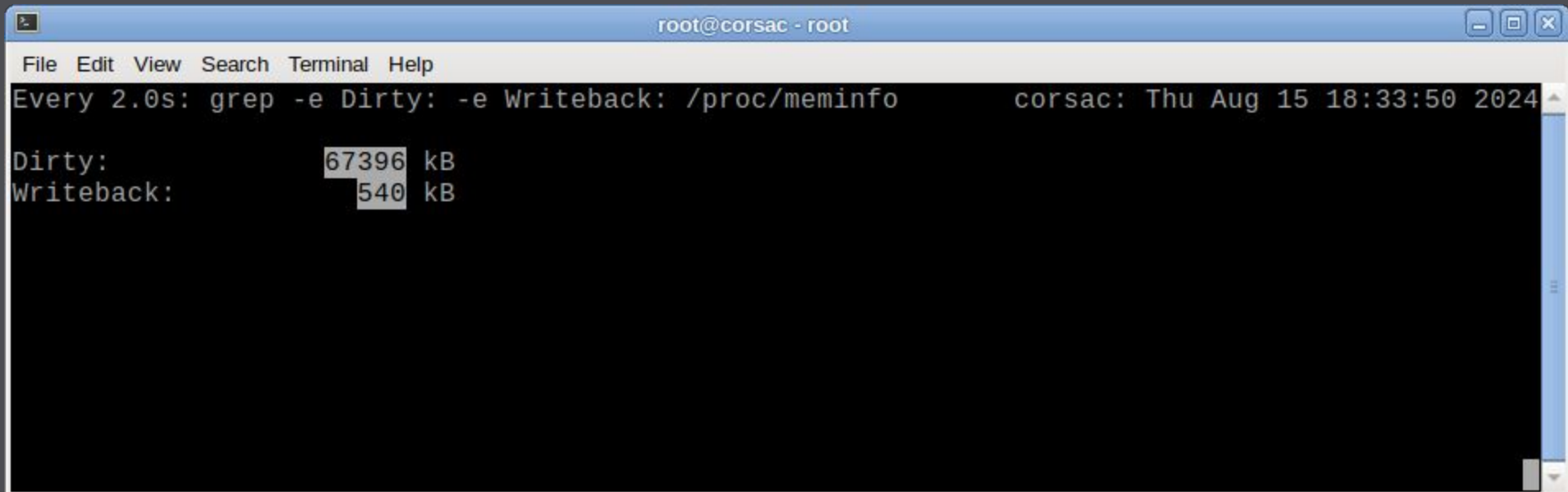
A terminal window titled "root@corsac - root" with a menu bar containing "File", "Edit", "View", "Search", "Terminal", and "Help". The terminal output shows the command `dd if=gentoo-linux-k1_dev-sdcard-2.0rc3.img of=/dev/sdc conv=sync status=progress` being executed, followed by the output `25018880 bytes (25 MB, 24 MiB) copied, 5 s, 5.0 MB/s`.

```
root@corsac - root
File Edit View Search Terminal Help
corsac ~ # dd if=gentoo-linux-k1_dev-sdcard-2.0rc3.img of=/dev/sdc conv=sync status=progress
25018880 bytes (25 MB, 24 MiB) copied, 5 s, 5.0 MB/s
```

[1] https://dev.gentoo.org/~lu_zero/gentoo-linux-k1_dev-sdcard-2.0rc3.img.xz

Check the dirty page cache

```
$ watch -d grep -e Dirty: -e Writeback: /proc/meminfo
```

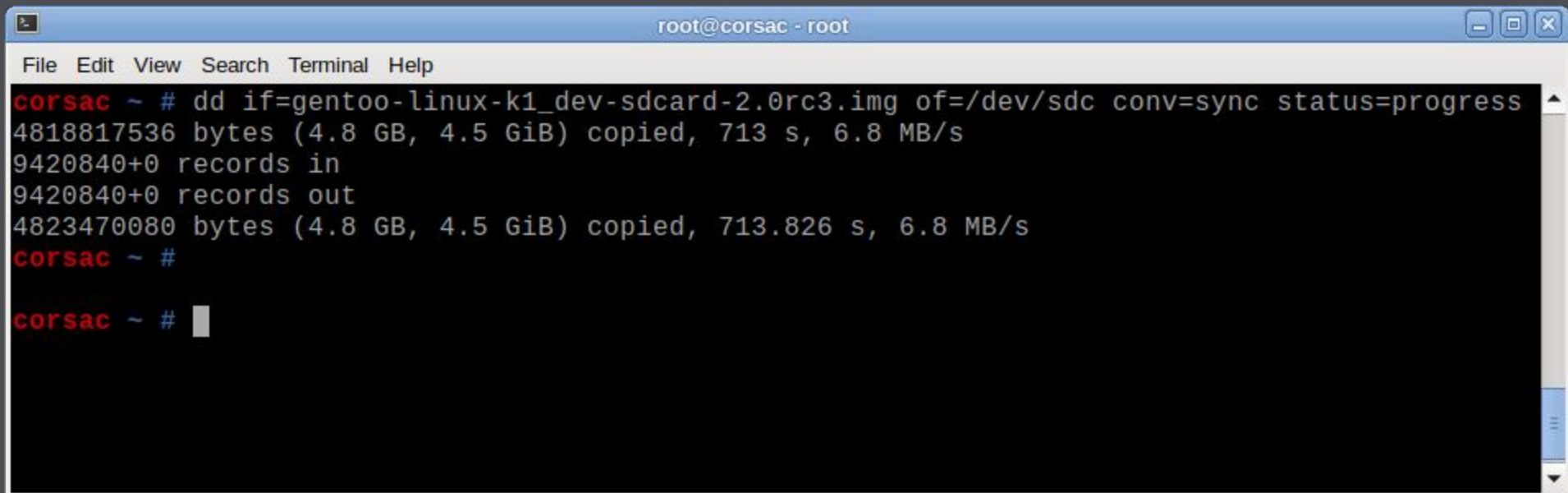


A terminal window titled "root@corsac - root" with a menu bar (File, Edit, View, Search, Terminal, Help). The terminal displays the output of the command `watch -d grep -e Dirty: -e Writeback: /proc/meminfo`. The output shows the dirty page cache and writeback statistics. The timestamp is "corsac: Thu Aug 15 18:33:50 2024".

```
Every 2.0s: grep -e Dirty: -e Writeback: /proc/meminfo      corsac: Thu Aug 15 18:33:50 2024
Dirty:                67396 kB
Writeback:             540 kB
```

Looks like it is done ...

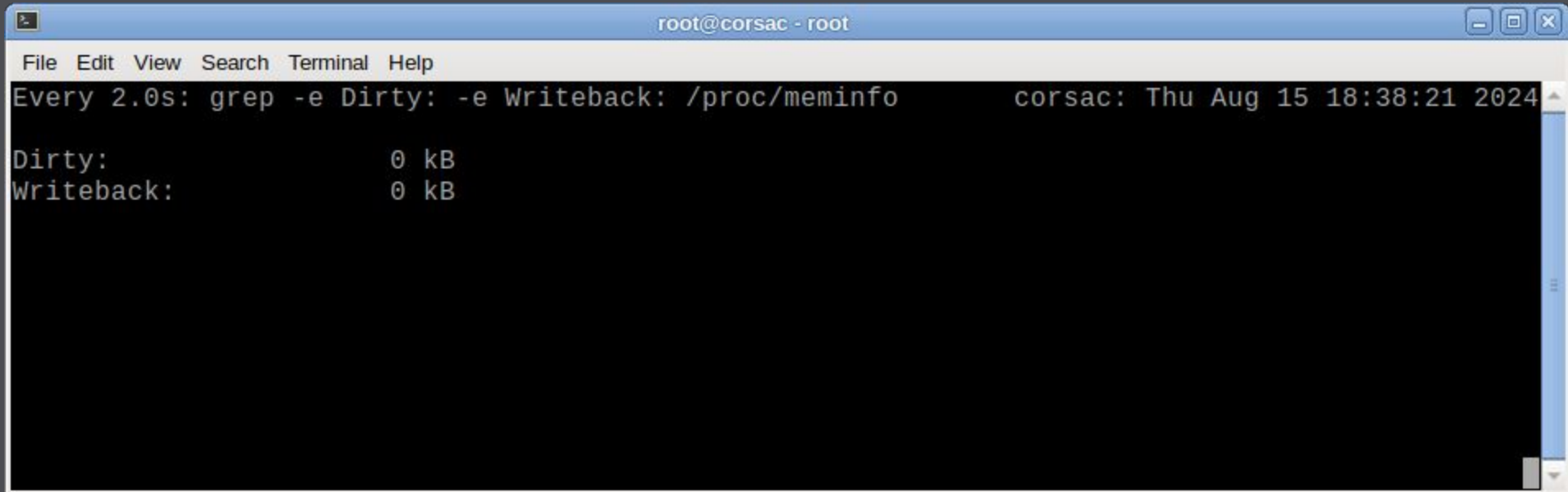
```
$ dd if=gentoo-linux-k1_dev-sdcard-2.0rc3.img of=/dev/sdc conv=sync status=progress
```

A terminal window titled "root@corsac - root" with a menu bar containing "File", "Edit", "View", "Search", "Terminal", and "Help". The terminal output shows the execution of a dd command: "dd if=gentoo-linux-k1_dev-sdcard-2.0rc3.img of=/dev/sdc conv=sync status=progress". The output indicates that 4818817536 bytes (4.8 GB, 4.5 GiB) were copied in 713 seconds at 6.8 MB/s. It also shows 9420840+0 records in and out, and a final summary of 4823470080 bytes (4.8 GB, 4.5 GiB) copied in 713.826 seconds at 6.8 MB/s. The prompt "corsac ~ #" is shown twice, indicating the command has finished and the user is back at the shell.

```
root@corsac - root
File Edit View Search Terminal Help
corsac ~ # dd if=gentoo-linux-k1_dev-sdcard-2.0rc3.img of=/dev/sdc conv=sync status=progress
4818817536 bytes (4.8 GB, 4.5 GiB) copied, 713 s, 6.8 MB/s
9420840+0 records in
9420840+0 records out
4823470080 bytes (4.8 GB, 4.5 GiB) copied, 713.826 s, 6.8 MB/s
corsac ~ #
corsac ~ # █
```


... but now you can unplug

```
$ watch -d grep -e Dirty: -e Writeback: /proc/meminfo
```

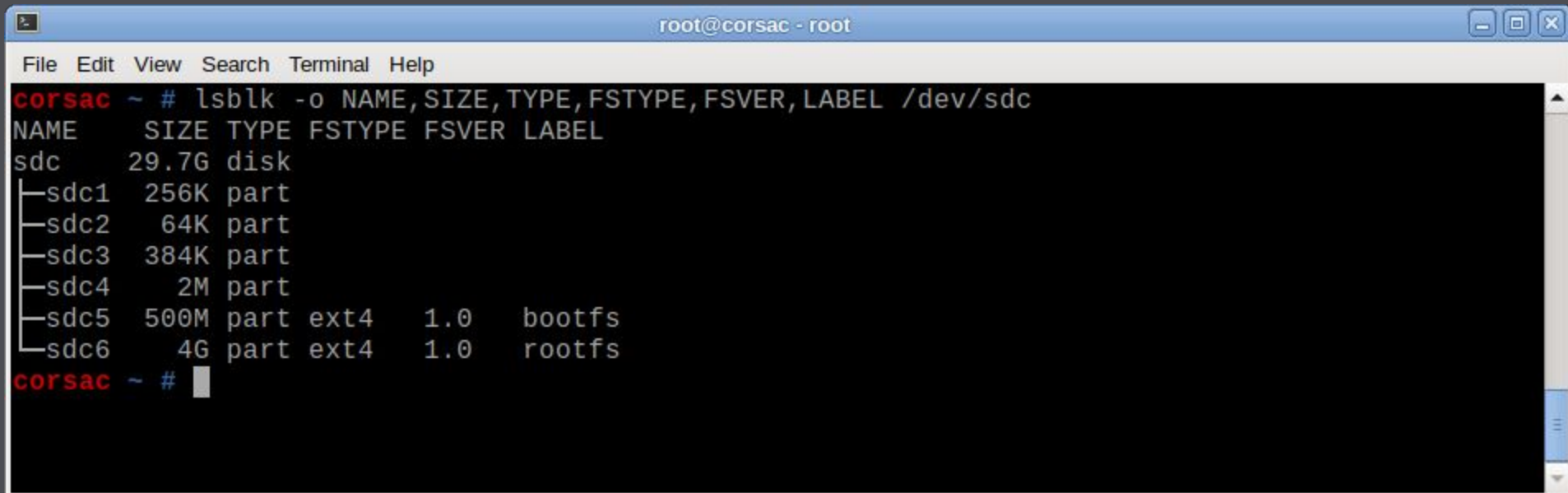


A terminal window titled "root@corsac - root" with a menu bar (File, Edit, View, Search, Terminal, Help). The terminal displays the output of the command `watch -d grep -e Dirty: -e Writeback: /proc/meminfo`. The output shows the command being executed every 2.0 seconds. The current output is:

```
Every 2.0s: grep -e Dirty: -e Writeback: /proc/meminfo      corsac: Thu Aug 15 18:38:21 2024  
Dirty:                0 kB  
Writeback:            0 kB
```

Check that image was written

```
$ lsblk -o NAME,SIZE,TYPE,FSTYPE,FSVER,LABEL /dev/sdc
```



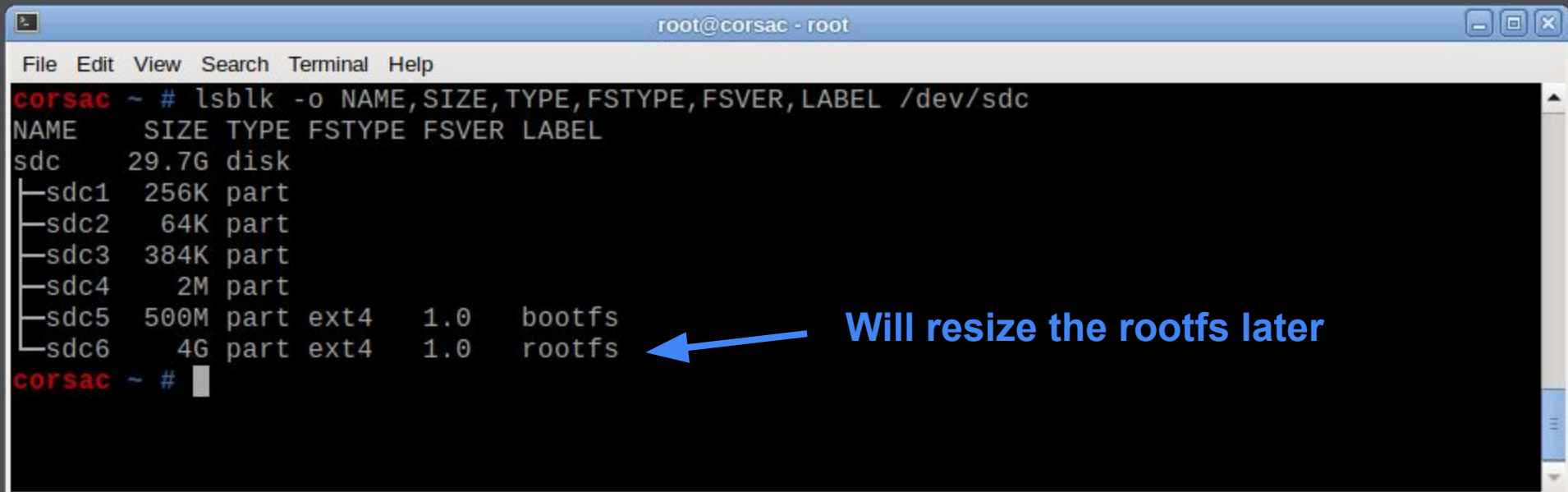
A terminal window titled "root@corsac - root" showing the output of the command `lsblk -o NAME,SIZE,TYPE,FSTYPE,FSVER,LABEL /dev/sdc`. The output is a table with columns for NAME, SIZE, TYPE, FSTYPE, FSVER, and LABEL. The table lists the main disk `sdc` and its partitions `sdc1` through `sdc6`.

NAME	SIZE	TYPE	FSTYPE	FSVER	LABEL
sdc	29.7G	disk			
├─sdc1	256K	part			
├─sdc2	64K	part			
├─sdc3	384K	part			
├─sdc4	2M	part			
├─sdc5	500M	part	ext4	1.0	bootfs
└─sdc6	4G	part	ext4	1.0	rootfs

The terminal prompt is `corsac ~ #` with a cursor.

Check that image was written

```
$ lsblk -o NAME,SIZE,TYPE,FSTYPE,FSVER,LABEL /dev/sdc
```



```
root@corsac - root
File Edit View Search Terminal Help
corsac ~ # lsblk -o NAME,SIZE,TYPE,FSTYPE,FSVER,LABEL /dev/sdc
NAME      SIZE TYPE FSTYPE FSVER LABEL
sdc       29.7G disk
├─sdc1    256K part
├─sdc2     64K part
├─sdc3    384K part
├─sdc4     2M part
├─sdc5    500M part ext4   1.0   bootfs
└─sdc6     4G part ext4   1.0   rootfs
```

Will resize the rootfs later

Boot process

```
U-Boot SPL 2022.10spacemit (Aug 14 2024 - 20:15:22 -0000)
DDR type LPDDR4X
lpddr4_silicon_init consume 11ms
Change DDR data rate to 2400MT/s
Boot from fit configuration k1-x_deb1
## Checking hash(es) for config conf_2 ... OK
## Checking hash(es) for Image uboot ... crc32+ OK
## Checking hash(es) for Image fdt_2 ... crc32+ OK
## Checking hash(es) for config config_1 ... OK
## Checking hash(es) for Image opensbi ... crc32+ OK
```

```
U-Boot 2022.10spacemit (Aug 14 2024 - 20:15:22 -0000)

CPU:      rv64imafdcv
Model:    spacemit k1-x deb1 board
DRAM:     DDR size = 4096 MB
DDR size = 4096 MB
DDR size = 4096 MB
```

```
## Loading kernel from FIT Image at 11000000 ...
Using 'conf-default' configuration
Verifying Hash Integrity ... OK
Trying 'kernel' kernel subimage
  Description: Linux 6.6.36+
  Type:        Kernel Image
  Compression: gzip compressed
  Data Start:  0x110000bc
  Data Size:   14255955 Bytes = 13.6 MiB
  Architecture: RISC-V
  OS:          Linux
  Load Address: 0x00200000
  Entry Point:  0x00200000
  Hash algo:    crc32
  Hash value:   7c3065e0
Verifying Hash Integrity ... crc32+ OK
## Flattened Device Tree blob at 31000000
Booting using the fdt blob at 0x31000000
Uncompressing Kernel Image
```

Boot process (con't)

OpenRC 0.54.2 is starting up Gentoo Linux (riscv64)

```
* Mounting /proc ...
[ ok ]
* Mounting /run ...
[ ok ]
* /run/openrc: creating direct
* /run/lock: creating director
* /run/lock: correcting owner
* Caching service dependencies
[ 5.445256] usb 2-1.5: new h
[ ok ]
* Mounting /sys ...
[ ok ]
* Mounting debug filesystem ..
[ ok ]
* Mounting config filesystem .
[ ok ]
* Mounting fuse control filesy
* Create Volatile Files and Directories ...
[ ok ]
INIT: Entering runlevel: 3
* Starting metalog ...
[ ok ]
* Starting DHCP Client Daemon ...
dhcp_vendor: No such process
[ ok ]
* Mounting network filesystems ...
[ ok ]
* Starting sshd ...
[ ok ]
* Starting local ...
[ ok ]
This is localhost (Linux riscv64 6.6.36+) 21:56:52
localhost login: █
```

Full Gentoo Linux System \o/

```
localhost ~ # neofetch
```

```
  -/oyddmdhs+:.
    -odNNNNNNNNNNmhy+-`
      -yNNNNNNNNNNNNrmdhy+-
        `omNNNNNNNNNNmddrmmddhhy/`
          omNNNNNNNNNNhhyyyohmdddhhhd`
            .ydNNNNNNNNMdhso/smdddhhhhdm+`
              oyhdmNNNNNNMdyooydmddddhhhhhyhNd.
                :oyhhdNNNNNNNNNNrmddddhhhhhyymMh
                  .: +sydNNNNNNNNrmmdddhhhhhhmMmy
                    /mNNNNNNNNrmmdddhhhhhhmMNs:
                      `oNNNNNNNNrmmdddhhdmMNs+`
                        `sNNNNNNNNrmmdddmdmMmhs/.
                          /NNNNNNNNNNrmmdddmNMNdso:`
                            +MMMMNNNNNNrmmrdmNMNdso/-
                              yMNNNNNNNNrmmmmNNMmhs+/-`
                                /hMMMMNNNNNNMdhso+/-`
                                  `/ohdmmddhys+++/:.`
                                    `-////////:--.
```

```
root@localhost
```

```
-----
```

```
OS: Gentoo Linux riscv64
```

```
Host: spacemit k1-x deb1 board
```

```
Kernel: 6.6.36+
```

```
Uptime: 23 mins
```

```
Packages: 330 (emerge)
```

```
Shell: bash 5.2.32
```

```
Terminal: /dev/console
```

```
CPU: Spacemit X60 (8) @ 1.600GHz
```

```
Memory: 207MiB / 3808MiB
```



Up-to-date Toolchains!

```
localhost ~ # clang --version
```

```
clang version 18.1.8
```

```
Target: riscv64-unknown-linux-gnu
```

```
Thread model: posix
```

```
InstalledDir: /usr/lib/llvm/18/bin
```

```
Configuration file: /etc/clang/riscv64-unknown-linux-gnu-clang.cfg
```

```
localhost ~ # gcc --version
```

```
gcc (Gentoo 14.2.0 p4) 14.2.0
```

```
Copyright (C) 2024 Free Software Foundation, Inc.
```

```
This is free software; see the source for copying conditions. There is NO  
warranty; not even for MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.
```

```
localhost ~ # /usr/lib/ld-linux-riscv64-lp64d.so.1 --version
```

```
ld.so (Gentoo 2.40 (patchset 1)) stable release version 2.40.
```

```
Copyright (C) 2024 Free Software Foundation, Inc.
```

```
This is free software; see the source for copying conditions.
```

```
There is NO warranty; not even for MERCHANTABILITY or FITNESS FOR A  
PARTICULAR PURPOSE.
```

```
localhost ~ # █
```

← 2024 Jun 20

← 2024 Aug 1

← 2024 Jul 22

Wifi and ethernet just work out of the box

```
localhost ~ # modprobe 8852bs
localhost ~ # /etc/init.d/wpa_supplicant start
* Starting WPA Supplicant Daemon ...
Successfully initialized wpa_supplicant [ ok ]
localhost ~ # ifconfig wlan0
wlan0: flags=4163<UP,BROADCAST,RUNNING,MULTICAST> mtu 1500
    inet 192.168.9.202 netmask 255.255.255.0 broadcast 192.168.9.255
    inet6 fd1a:637d:f215:0:d7e5:b531:88fc:b12e prefixlen 64 scopeid 0x0<gl
obal>
    inet6 fd95:b4c7:7c8b:0:300c:64b3:c757:b96f prefixlen 64 scopeid 0x0<gl
obal>
    inet6 fd8d:88cb:94f4:0:b5d0:53e4:4cf:2073 prefixlen 64 scopeid 0x0<glo
bal>
    inet6 fe80::b7a2:5296:db95:fe64 prefixlen 64 scopeid 0x20<link>
    inet6 fd1a:637d:f215::93c prefixlen 128 scopeid 0x0<global>
    ether c0:4b:24:36:6b:af txqueuelen 1000 (Ethernet)
    RX packets 12326 bytes 51588926 (49.1 MiB)
    RX errors 0 dropped 0 overruns 0 frame 0
    TX packets 12397 bytes 696222 (679.9 KiB)
```


Emerge packages

```
localhost ~ # ldconfig
```

```
localhost ~ # emerge-webrsync -q
```

```
* Latest snapshot date: 20240814
```

```
*
```

```
* Approximate snapshot timestamp: 1723682700
```

```
* Current local timestamp: 1723682400
```

```
*
```

```
* The current local timestamp is possibly identical to the  
* timestamp of the latest snapshot. In order to force sync, use  
* the --revert option or remove the timestamp file located at  
* '/var/db/repos/gentoo/metadata/timestamp.x'.
```

```
localhost ~ # getuto && emerge -g neofetch
```

```
* IMPORTANT: 18 news items need reading for repository 'gentoo'.
```

```
* Use eselect news read to view new items.
```

```
Local copy of remote index is up-to-date and will be used.
```

```
Calculating dependencies... done!
```

Resize the partition

```
localhost ~ # parted /dev/mmcblk0
```

```
GNU Parted 3.6
```

```
Using /dev/mmcblk0
```

```
Welcome to GNU Parted! Type 'help' to view a list of commands.
```

```
(parted) p Model: SD GC1S5 (sd/mmc)
```

```
Warning: Not all of the space available on Disk /dev/mmcblk0: 64.1GB
```

```
can fix the GPT to use all of the space. You can use the 'fix' command to
```

```
with the current setting? Partition Table: gpt
```

```
Fix/Ignore? Fix Disk Flags:
```

```
Model: SD GC1S5 (sd/mmc)
```

```
Disk /dev/mmcblk0: 64.1GB
```

```
Sector size (logical/physical): 512B/512B
```

```
Partition Table: gpt
```

```
Disk Flags:
```

Number	Start	End	Size	File system	Name	Flags
1	131kB	393kB	262kB		fsbl	
2	393kB	459kB	65.5kB		env	
3	459kB	852kB	393kB		opensbi	
4	852kB	2949kB	2097kB		uboot	
5	4194kB	528MB	524MB	ext4	bootfs	
6	528MB	4823MB	4295MB	ext4	rootfs	

```
(parted) resizepart 6
```

```
Warning: Partition /dev/mmcblk0p6 is being used. Are you sure you want to continue?
```

```
Yes/No? Yes
```

```
End? [4823MB]? 20G
```

Demo

```
[ 5.604091] cam_inf:smc (cam_sensor_probe 1463): camera sensor0 probed
[ 5.611104] cfb09211: Loading compiled-in X.509 certificates for regulatory database
[ 5.623439] Loaded X.509 cert 'sforashe:00120d4f4ac93cea7'
[ 5.629362] Loaded X.509 cert 'wens:61c938651aabd3f94b6ac7ff06c7248db18c500'
[ 5.638466] clk: Not disabling unused clocks
[ 5.643662] (drm) spacemit_dpu_bind()
[ 5.647793] spacemit-dpu-drv soc:port0c9440000: assigned reserved memory node
dpu_rescrv0c9440000
[ 5.657327] (drm) dpu plane init ok
[ 5.669313] spacemit-drm-drv c9440000.display-subsystem-hdmi: bound soc:port0
c9440000 (ops dpu_component_ops)
[ 5.671534] spacemit-drm-drv c9440000.display-subsystem-hdmi: bound soc:port0
hdmi (ops spacemit_hdmi_ops)
[ 5.681189] (drm) spacemit_hdmi_connector_detect() hdmi status connected
[ 5.689400] (drm) initialized spacemit 1.0.0 28231115 for c9440000.display-su
bsystem-hdmi on minor 1
[ 5.697752] (drm) spacemit_hdmi_connector_detect() hdmi status connected
[ 5.704540] (drm) spacemit_hdmi_get_edid_block() len 128
[ 5.720915] hub 3-1:1.0: USB hub found
[ 5.731666] (drm) spacemit_hdmi_get_edid_block() len 128
[ 5.732835] hub 3-1:1.0: 4 ports detected
[ 5.744293] (drm) spacemit_crtc_atomic_enable(power on)
[ 5.744334] (drm) dpu init
[ 5.744369] (drm) spacemit_hdmi_encoder_enable()
[ 5.744386] (drm) spacemit_hdmi_setup() id 0xa2f501, hdmi 0bpc
[ 5.744629] (drm) DSI type 0 id 2 Start!
[ 5.761356] Console: switching to colour frame buffer device 240x67
[ 5.831460] spacemit-drm-drv c9440000.display-subsystem-hdmi: (drm) fb0: spacemitdrm frame buffer device
[ 5.839491] enter spacemit_snd_spa_pdev_probe
[ 5.836312] ALSA device list:
[ 5.840453]   No soundcards found.
[ 6.231626] usb 2-1.2: new low-speed USB device number 3 using xhci-hcd
[ 6.405103] input: smd-sst325 Headset Jack as /devices/platform/smd-card0/sound/card1/input1
[ 6.558979] input: Logitech USB Keyboard as /devices/platform/smd-card0/sound/card1/input1
[ 6.624153] hid-generic 0003:046d:c31c:0001: input: USB HID v1.10 Mouse [Logitech USB Keyboard] on usb-xhci-hcd:0-auto/nub32-1-2-1.2-1.2:1.0-0003:046d:c31c:0001/input1/2
[ 6.643223] input: Logitech USB Keyboard Consumer Control as /devices/platform/smd-card0/sound/usb3/c0e0000.duc3/xhci-hcd:0-auto/nub32-1-2-1.2-1.2:1.1-0003:046d:c31c:0002/input1/3
[ 6.719262] input: Logitech USB Keyboard System Control as /devices/platform/smd-card0/sound/usb3/c0e0000.duc3/xhci-hcd:0-auto/nub32-1-2-1.2-1.2:1.1-0003:046d:c31c:0002/input1/3
[ 6.827131] hid-generic 0003:046d:c31c:0002: input,hiddev96: USB HID v1.10 Mouse [Logitech USB Keyboard] on usb-xhci-hcd:0-auto/nub32-1-2-1.2-1.2:1.1-0003:046d:c31c:0002/input1/4
[ 6.859129] md: Waiting for all devices to be available before autodetect
[ 6.857085] md: If you don't use raid, use raid=noautodetect
[ 6.763241] md: Autodetecting RAID arrays.
[ 6.767563] md: autoran ...
[ 6.770624] md:   autoran DONE.
[ 6.781403] EXT4-fs (mxcblk0p6): mounted filesystem 7f0fe0b-34f7-4d41-9cc7-6627676b04b0 ro with ordered data mode. Quota mode: none.
[ 6.791823] UFS: Mounted root (ext4 filesystem) readonly on device 179:6.
[ 6.802214] devtmpfs: mounted
[ 6.806179] Freeing unused kernel image (initramfs) memory: 2300K
[ 6.812241] Run /sbin/init as init process
[ 6.816081]   with arguments:
[ 6.820904]   sbin/init
[ 6.823984]   with environment:
[ 6.828241]   HOME=/
[ 6.829954]   TERM=linux
[ 6.830623] usb 2-1.4: new low-speed USB device number 4 using xhci-hcd
[ 7.891211] input: Logitech USB Optical Mouse as /devices/platform/smd-card0/sound/usb3/c0e0000.duc3/xhci-hcd:0-auto/nub32-1-2-1.2-1.4-1.1-0-0003:046d:c077:0003/input1/5
[ 7.892701] hid-generic 0003:046d:c077:0003: input: USB HID v1.11 Mouse [Logitech USB Optical Mouse] on usb-xhci-hcd:0-auto/1-4/input5
[ 7.893640] usb 2-1.5: new high-speed USB device number 5 using xhci-hcd

This is localhost (Linux riscv64 6.6.36) 00:03:31
localhost login: root
Last login: Sat Jan 1 00:00:34 -00 2000 on tty1
localhost ~ #
```



Future Work

- Experiment with alternate whole system build configs
 - Crossdev already supports **riscv64-unknown-linux-musl** as target
 - Paves the way to build the whole system using **clang**
- Build everything with **-O3 -march=rv64gcv_zvl256b**
 - Blocked on gcc bugs, but may work with clang
- Improve the overall cross-building experience
 - This project already found many bugs
 - Few packages (e.g. perl) already got some fixes
 - Crossdev has a pending patch to make it profile-aware
 - Possible to reduce the overall build time further
 - Using specific portage features already improved the overall build time by around 10%
 - Some packages do not take advantage of all available cores
 - Portage can build different packages in parallel as long they are independent

Questions?