Orange Pi RISC-V Support

FOSDEM 2026

Michael Opdenacker

Root Commit

Jan. 31, 2026

Michael Opdenacker

root commit

Embedded Linux consultant and trainer

- https://rootcommit.com/about/michael-opdenacker/
- Former founder of Bootlin
- New founder of Root Commit
- Free Software enthusiast and advocate (member of April.org)

April
promouvoir et défendre le logiciel libre

What I Do For a Living — What's Funding This Work

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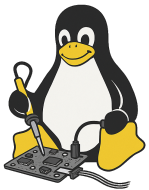
Consulting and engineering work

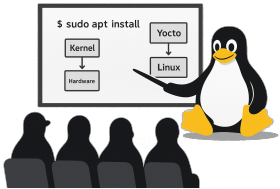
- Yocto Project
  Project reviews, system implementation, new features
- Linux Kernel
  Driver development, board bring-up, debugging
- Embedded Linux
  Boot time, bug fixing, security and other optimizations



Training — https://rootcommit.com/training

- Yocto Project and OpenEmbedded — Free Materials!
- Linux kernel, board support, driver development
  Free Materials after next course!
- Embedded Linux
- Linux Boot Time Reduction

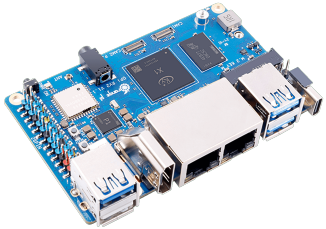
What's special: focus on practical activities, interactivity and learning techniques.



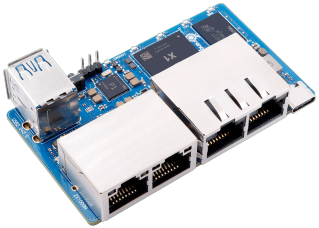
Introduction

Goals

- Contribute to making RISC-V more attractive through real hardware
- Contribute to supporting RISC-V boards in mainline Linux, U-Boot and Yocto
- In this session, to supporting OrangePi RISC-V boards in particular
- Share progress made so far
- Get help for all the things left to do!



Orange Pi RV2



Orange Pi R2S

The Boards

OrangePi RV2 (1)

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Very attractive board with great features

- SpacemiT K1 RISC-V SoC, 8 cores, 2x GB Ethernet, 2x PCIe
- Available in 2 GB, 4 GB and 8 GB versions
- The 8 GB version was 54 EUR when I ordered it in Oct. 2025.
- Now it's 120 EUR, because RAM costs exploded?

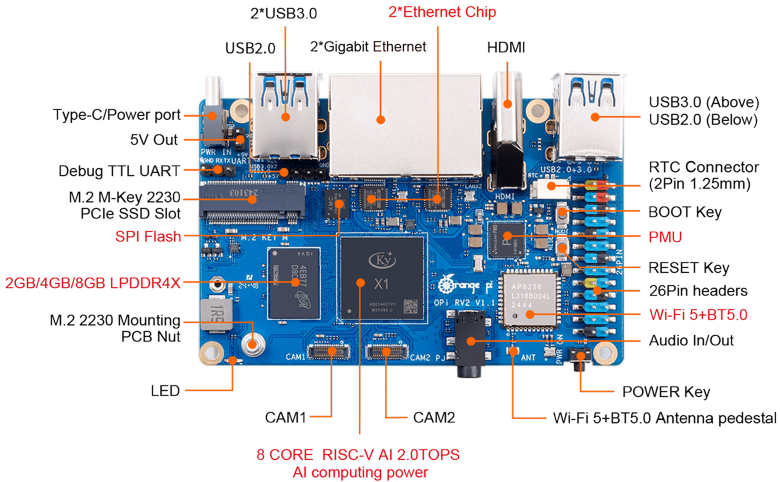
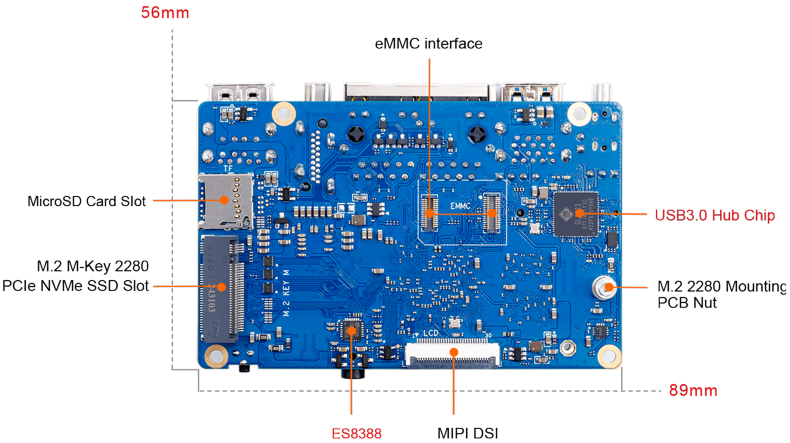


Image source: https://www.orangepi.org

OrangePi RV2 (2)

- How many of you have it?
- How many would like to buy it?
- How many are waiting for Spacemit K3?



http://www.orangepi.org/html/hardWare/computerAndMicrocontrollers/details/Orange-Pi-RV2.html

OrangePi R2S (1)

Very attractive board with great features

- SpacemiT K1 RISC-V SoC, 8 cores
- 2x GB Ethernet + **2x 2.5 GB Ethernet** (on PCIe)
- Available in 2 GB, 4 GB and 8 GB versions
- The 2 GB version was only 32 EUR when I ordered it in Oct. 2025.
- Now it's 46 EUR

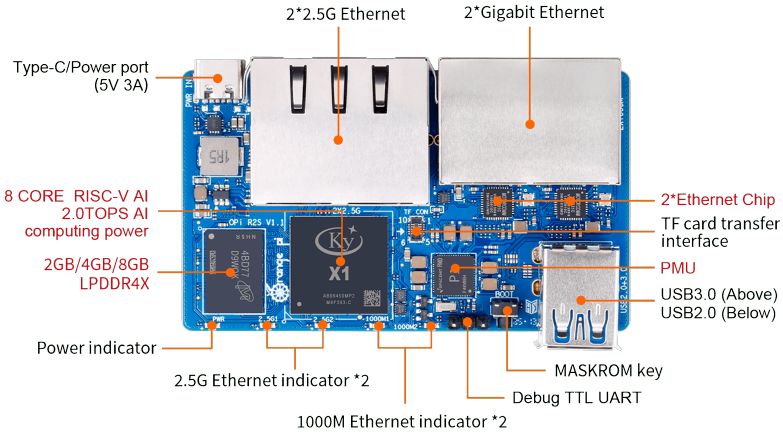


Image source: https://www.orangepi.org

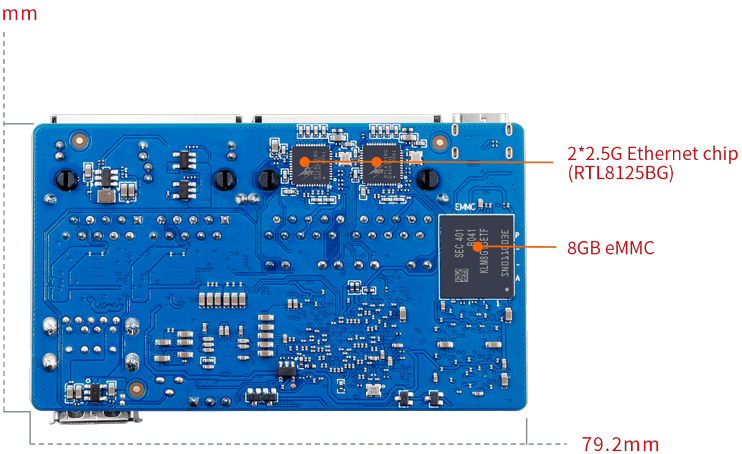
OrangePi R2S (2)

Issues and limitations

- No WiFi (but can be added via USB)
- No MMC/SD (how to use the "TF card" interface?)
- No schematics (asked several times)
- PCIe not exposed (M.2 connector would be nice)

Questions

- How many of you have it?
- How many would like to buy it?



http://www.orangepi.org/html/hardWare/computerAndMicrocontrollers/details/Orange-Pi-RV2.html

Orange Pi RISC-V Boards — Where To Buy?

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- Follow the links on the product pages
- Unfortunately, found no retailer outside China
- Amazon is slow and expensive (and evil!)
- Need to buy through AliExpress (2-3 weeks of delay)
  - Recommending the store from the board maker: Shenzhen Xunlong (reliable)
  - Beware of other vendors on AliExpress, especially with lower prices

OrangePi RV2 and R2S — Vendor Support

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- Linux 6.6
  https://github.com/orangepi-xunlong/linux-orangepi/tree/orange-pi-6.6-ky
  No change since published (Mar. 18, 2025)
- U-Boot 2022.10
  https://github.com/orangepi-xunlong/u-boot-orangepi/tree/v2022.10-ky
  No change since published (Mar. 11, 2025)

Vendor OS images:

- OpenWRT
- OrangePi OS (Open Harmony, on RV2 only)
- Ubuntu 24.04

Who wants to use a distro without kernel updates and maybe even without updates at all? 🤢

Mainlining Efforts

Mainline Linux commits

OrangePi RV2:

```
$ git log --pretty=format:"%h %s | %an | %ad" --date=short arch/riscv/boot/dts/spacemit/k1-orangepi-rv2.dts
981339507835 riscv: dts: spacemit: add Ethernet and PDMA to OrangePi RV2 | Michael Opdenacker | 2025-10-22
bab8dea25910 riscv: dts: spacemit: Add OrangePi RV2 board device tree | Hendrik Hamerlinck | 2025-08-13
```

OrangePi R2S:

```
$ git log --pretty=format:"%h %s | %an | %ad" --date=short arch/riscv/boot/dts/spacemit/k1-orangepi-r2s.dts
63e572b11464 riscv: dts: spacemit: Add OrangePi R2S board device tree | Michael Opdenacker | 2025-11-12
```

But A Lot of Groundwork

root commit

```
$ git log --pretty=format:"%h %s | %an | %ad" --date=short | grep spacemit
2c84959167d6 net: spacemit: Check for netif_carrier_ok() in emac_stats_update() | Vivian Wang | 2026-01-23
e351836a54e3 i2c: spacemit: drop IRQF_ONESHOT flag from IRQ request | Yixun Lan | 2026-01-22
99f0c3a654c4 regulator: spacemit: Align input supply name with the DT binding | Javier Martinez Canillas | 2025-12-06
16bd954c9336 rtc: spacemit: MFD_SPACEMIT_P1 as dependencies | Troy Mitchell | 2025-11-18
25faa5364638 i2c: spacemit: fix detect issue | Troy Mitchell | 2025-11-13
388f9a600f10 Merge branch 'pci/controller/spacemit-k1' | Bjorn Helgaas | 2025-12-03
441bd1568064 Merge tag 'spacemit-dt-for-6.19-1' of https://github.com/spacemit-com/linux into soc/dt | Arnd Bergmann...
23b2d2fb1369 clk: spacemit: Set clk_hw_onecell_data::num before using flex array | Charles Mirabile | 2025-11-17
ff64e078e45f PCI: spacemit: Add SpacemiT PCIe host driver | Alex Elder | 2025-11-13
a812b09a6b59 dt-bindings: pci: spacemit: Introduce PCIe host controller | Alex Elder | 2025-11-13
2e12d91cbf3d clk: spacemit: fix comment typo | Encrow Thorne | 2025-11-11
5a97a38c2279 riscv: dts: spacemit: define all missing I2C controller nodes | Troy Mitchell | 2025-11-05
3b70f972b6fb riscv: dts: spacemit: reorder i2c2 node | Troy Mitchell | 2025-11-05
63e572b11464 riscv: dts: spacemit: Add OrangePi R2S board device tree | Michael Opdenacker | 2025-11-12
323256d11e01 dt-bindings: riscv: spacemit: Add OrangePi R2S board | Michael Opdenacker | 2025-11-12
41d34e0b5497 riscv: dts: spacemit: enable K1 SoC QSPI on BPI-F3 | Alex Elder | 2025-10-27
e32c402533cc ASoC: spacemit: fix incorrect error check for sspa clock | Goko Mell | 2025-11-06
0ee59934662d riscv: dts: spacemit: add MusePi Pro board device tree | Troy Mitchell | 2025-10-23
2cc22890635d dt-bindings: riscv: spacemit: add MusePi Pro board | Troy Mitchell | 2025-10-23
5556f23478e6 net: spacemit: Check netif_running() in emac_set_pauseparam() | Vivian Wang | 2025-11-03
28124cc0fb8c driver: reset: spacemit-p1: add driver for poweroff/reboot | Aurelien Jarno | 2025-11-03
060028c7fcdd ASoC: spacemit: fix build warning and error | Mark Brown | 2025-10-28
f034c16a4663 ASoC: spacemit: add failure check for spacemit_i2s_init_dai() | Troy Mitchell | 2025-10-24
...
```

Supported in Mainline Linux — Lots to Build!

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OrangePi RV2

- Already in mainline:
  - UART
  - Ethernet
  - GPIO LEDS
- On its way to mainline:
  - I2C
  - AT24 EEPROM
- Should be close:
  - PCIe
  - Wi-Fi and Bluetooth (external AP6256 chip)
  - eMMC (optional module)
  - USB 2.0 and 3.0
- Looks harder:
  - MMC/SD
  - Other modules (HDMI, Camera,...)?

OrangePi R2S:

- Already in mainline:
  - UART
  - 1 GB Ethernet
  - eMMC
- On its way to mainline:
  - I2C
  - AT24 EEPROM
- Should be close:
  - PCIe
  - USB 2.0 and 3.0

What's in Line for 6.20 (Arnd Bergmann's "soc" tree)

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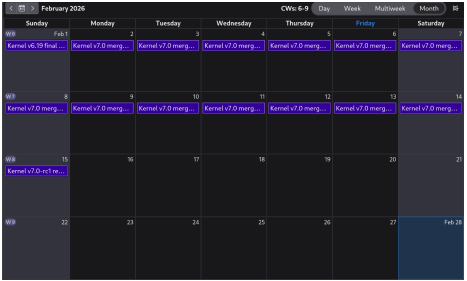
```
Merge tag 'spacemit-dt-for-6.20-1' of https://github.com/spacemit-com/linux into soc/dt
RISC-V SpacemiT DT changes for 6.20

- Disable Ethernet PHY auto sleep mode
- Add pinctrl IO power support
- Add K3 Pico-ITX board
- Add support for K3 SoC
- Add DWC USB support
- Add reset for eMMC(sdhci)/I2C
- Add PCIe support
- Support PMIC for Jupiter board

* tag 'spacemit-dt-for-6.20-1' of https://github.com/spacemit-com/linux:
  riscv: dts: spacemit: Disable ETH PHY sleep mode for OrangePi
  riscv: dts: spacemit: pinctrl: update register and IO power
  riscv: dts: spacemit: add K3 Pico-ITX board support
  riscv: dts: spacemit: add initial support for K3 SoC
  dt-bindings: riscv: spacemit: add K3 and Pico-ITX board bindings
  dt-bindings: interrupt-controller: add SpacemiT K3 IMSIC
  dt-bindings: interrupt-controller: add SpacemiT K3 APLIC
  dt-bindings: timer: add SpacemiT K3 CLINT
  dt-bindings: riscv: add SpacemiT X100 CPU compatible
  riscv: dts: spacemit: k1: Add "b" ISA extension
  riscv: dts: spacemit: Enable USB3.0 on BananaPi-F3
  riscv: dts: spacemit: Add DWC3 USB 3.0 controller node for K1
  riscv: dts: spacemit: Add USB2 PHY node for K1
  riscv: dts: spacemit: sdhci: add reset support
  riscv: dts: spacemit: add reset property
  riscv: dts: spacemit: PCIe and PHY-related updates
  riscv: dts: spacemit: Add a PCIe regulator
  riscv: dts: spacemit: Define the P1 PMIC regulators for Milk-V Jupiter
  riscv: dts: spacemit: Define fixed regulators for Milk-V Jupiter
  riscv: dts: spacemit: Enable i2c8 adapter for Milk-V Jupiter
Signed-off-by: Arnd Bergmann <arnd@arndb.de>
```

Mainline Linux: How You Can Help

- Quite a lot of low-hanging fruit!
- Wait for Linux 6.20-rc1 (to have a well identified base)
- Should be fun to experiment with lots of new features
- Please help supporting MMC/SD. Already works partially in read-only mode (with bugs), but looks more complicated that that. See https://lore.kernel.org/linux-riscv/20251215-k1-boards-add-mmc-v1-0-d68dc87d4aab@rootcommit.com/.
- Use the b4 tool to prepare and send your patches to the `linux-riscv` mailing list:
  - http://lists.infradead.org/mailman/listinfo/linux-riscv
  - Archives: https://lore.kernel.org/linux-riscv/



Tip: subscribe to the Kernel Release calendar
https://www.kernel.org/releases-calendar.ics

Mainline U-Boot Support

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OrangePi R2V

- Not much done yet
- Mainline U-Boot used successfully with `bananapi-f3_defconfig`.
- Create `defconfig` for this board, and/or a SpacemiT K1 generic configuration too?
- No support for MMC/SD either (Linux should come first)
- Linux loaded from RAM by the vendor U-Boot SPL so far
- Also need some logic to detect the board model (2GB, 4GB or 8GB)

OrangePi R2S

- Not tried yet (please do)
- Mainline U-Boot should work too
- Create `defconfig` for this board
- Port the SDHCI driver from Linux to boot from eMMC (already working in Linux)
- Linux loaded from RAM by the vendor U-Boot SPL so far
- Also need some logic to detect the board model (2GB, 4GB or 8GB)

Mainlining DRAM Training Support

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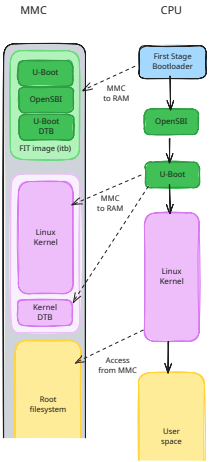
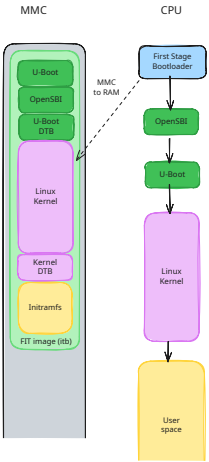
- Daniel Maslowski has reversed engineered the K1 DRAM training.
- This should be a way to stop depending on vendor code for `FSBL.bin`
- Also test the recent U-Boot FSBL patches:
  `[PATCH 00/17] Add board support for Spacemit K1 SoC in SPL`
  https://lore.kernel.org/u-boot/20260117190231.977686-1-raymondmaoca@gmail.com/

See https://github.com/oreboot/oreboot/pull/767

Using Mainline U-Boot without MMC support



- Used the vendor first stage bootloader (FSBL) supporting MMC, to load everything to RAM from there!
- Just put more things into the FIT image loaded by the FSBL.
- This way this sequence works:
  Vendor FSBL →**Mainline OpenSBI** →**Mainline U-Boot** →**Mainline Linux**
- But limited to 64 MB according to my experiments



Yocto Support

Why Yocto is useful

- Makes it easy to build any kind of image for a new machine
- Aggregating knowledge acquired by the community
- This abstracts the SoC specific storage layout and boot sequence, if your main interest is to contribute to the kernel or bootloader.
- Though you could also hack an existing vendor image to replace the kernel by a manually compiled one.

OrangePi R2S and RV2 `MACHINE`s in `meta-riscv`:

- `orangepi-rv2`: with vendor kernel and bootloader (Alper Ak)
- `orangepi-rv2-mainline`: with mainline opensbi, u-boot and kernel, booting from RAM and through NFS. Just keeping the vendor FSBL (First Stage Bootloader) for DRAM training.
- `orangepi-r2s`: with vendor kernel and bootloader (Vlad Banea)

Upcoming work:

- Integrate new kernel features as they become available (next: Linux 6.19 and 6.20-rc1)
- Generate fully flashable image (manual step to deploy a critical file at the very beginning of storage)
- Recipe cleanups and consolidation with other RISC-V boards (lots of board specific customizations as Yocto allows them)

https://github.com/riscv/meta-riscv

Help Needed

Flashing the eMMC on R2S, especially if eMMC is bricked

- OrangePi has a proprietary flasher for Windows
- Also a proprietary TitanFlash tool for Linux
- Based on `adb` / `fastboot`, but didn't manage to see the board from Linux (because of custom bits?)
- Anyone tried to use Bootlin's Snagboot on the SpacemiT K1 SoC?

Some details on https://bianbu-linux.spacemit.com/en/device/boot/

Other needs

- Find the OrangePi R2S schematics!
- Other needs and ideas?

Mainlining for RV2 and R2S — What to remember?

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- Top priority: widen kernel support. A good amount of low-hanging fruit.
- You can also learn from other K1-based boards (like BananaPi F3, MilkV Jupiter...)
- MMC support critically missing
- Then you can contribute to mainline bootloader
- Yocto support helps to expand the user and contributor community.

Useful Links

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- Marcel Ziswiler's talk at FOSDEM 2026:
  https://fosdem.org/2026/schedule/event/LX3NNU-upstream-embedded-linux-on-risc-v-sbcs/
- Yocto's `meta-riscv` documentation for indivicual boards:
  https://github.com/riscv/meta-riscv/blob/master/docs/orangepi-r2s.md
  https://github.com/riscv/meta-riscv/blob/master/docs/orangepi-rv2-mainline.md

Thank you

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Questions? Comments?

- mo@rootcommit.com
- https://fosstodon.org/@MichaelOpdenacker
- XMPP: omichael@conversations.im
- Signal: rootcommit.01
- Slides available under the CC-By-SA 4.0 license
  https://rootcommit.com/pub/conferences/2026/fosdem/orange-pi-riscv-support/
- Sources (LaTeX):
  https://gitlab.com/rootcommit/orange-pi-riscv-support

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