

東京
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Linux
PLUMBERS
CONFERENCE

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32bit and noMMU Linux BoF

Still alive and running in the background.

But people use devices with it every day... without knowing it



Hello all !

“Ruinland” ChuanTzu Tsai (Andes Technology, RISC-V 32)

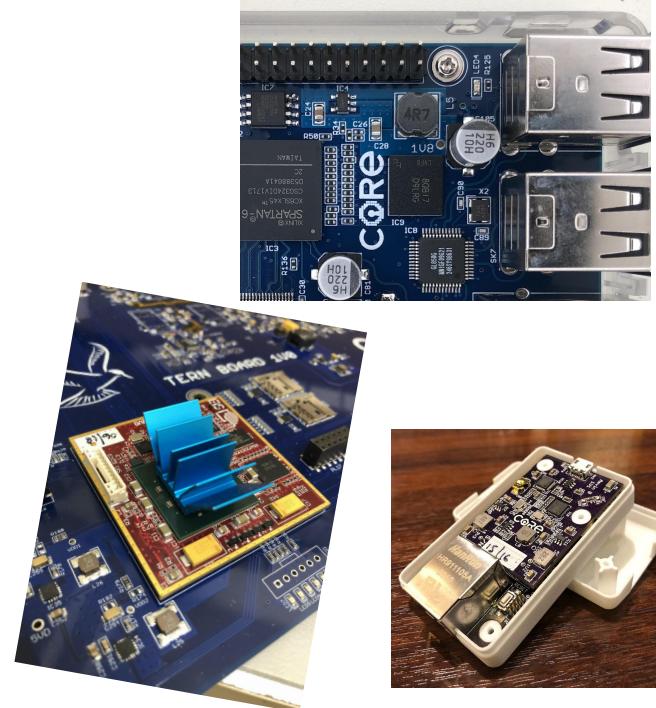
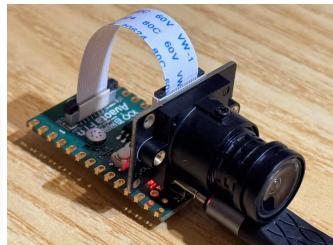
D Jeff Dionne (Coresemi, SuperH, J-Core)

Geert Uytterhoeven (m68k)

32 is the new 8-bit

RISC-V and SuperH are still very well adopted and thriving.

Nanny-cams, automotive controller, low-end internet connecting device a lot of them are running Linux for their tasks.



“Userspace aliveness”

Names carrying weight are pointing fingers on userspace SW ecosystem for coping with 2038 issues - -

- OpenWRT is still well alive and maintaining the healthiness of programs.
- buildroot housed noMMU Linux “distributions.”
- I personally [ported Alpine Linux to RV32](#) and is willing to upgrade it.
- musl libc is of course maintained specifically for such use cases, most things are built on that today

The unmaintained projects simply aren't used by 32bit adopters anymore.

CAN bus driver for STM32 noMMU Linux

FOSDEM 2024 “Linux CAN upstreaming on MMU-less systems” :

<https://github.com/torvalds/linux/commit/f00647d8127be4d3f37f7e07dace24c04689ec63>

stm32f469-disco



Modify Buildroot configuration
Create Linux driver - **dual CAN**

stm32f769-disco



Create Buildroot configuration
Modify Linux driver - **single CAN**

rv64ilp32

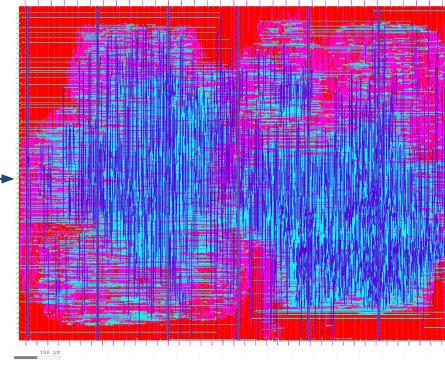
To run 32bit userspace on 64bit hardware :

https://lpc.events/event/17/contributions/1475/attachments/1186/2442/rv64ilp32_%20Run%20ILP32%20on%20RV64%20ISA.pdf

<https://fedoraproject.org/wiki/Architectures/RISC-V/64ILP32>

Small memory footprint is crucial for embedded Linux scenarios.

J32+FPU
130nm



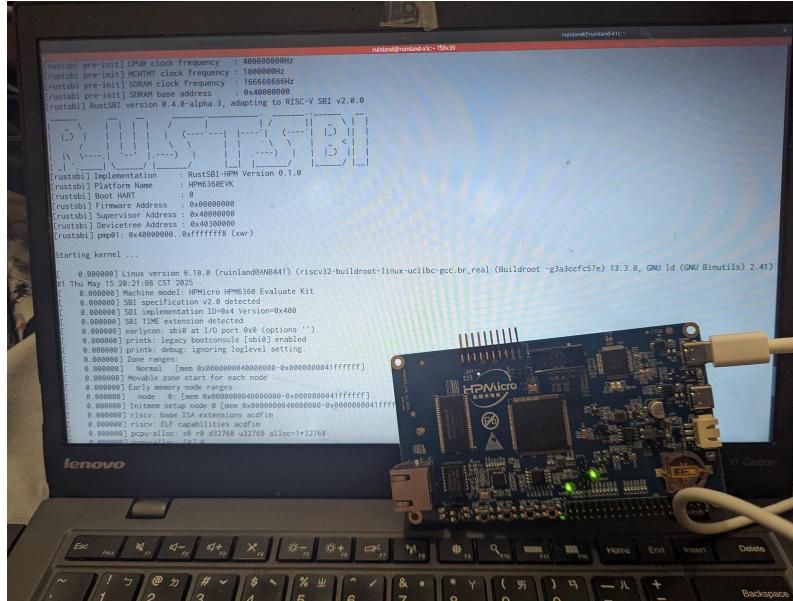
- Memory footprint and bandwidth are a major driver for hardware designs.
- Don't forget the process node the chips are fabricated in is important too
 - An application specific Linux capable RV32 or J-Core design can be fabricated for \$15,000
 - All open hardware, prototyped on your desk. Your chip, your hardware, your security.

noMMU Linux on newly manufactured RV32 hardware

Automotive platforms are very keen to small but power efficient controllers.

Compare to noMMU Linux, RTOSes requires a tons of work to effort to port complicated programs.

buildroot src



Educational purpose

TinyTapeout kianV SoC : end-to-end open source-ly manufactured IC, running 32bit noMMU mainline Linux (with minimal driver modifications).



```
[ 0.000000] mm: auto-alloc: stack:0x11, heap: alloc:0x11, heap: free:0x11
[ 0.000000] Memory: 5324K/818K available (1618 kernel code, 299K rwdata,
[ 0.000000]           SLUB: KMalloc=618 Order=3-10, objects=0, CPUs=1, Nodes=1
[ 0.000000] NMI: 0 handlers, 0 pending, 0 scheduled, 0 pre-empted, 0 traps: 0
[ 0.000000] ISCV: 0 active, 32 local interrupts masked
[ 0.000000] clint: clint@10000000: timer running at 10000 Hz
[ 0.000000] clocksource: clint@clocksource: mask: 0xffffffffffff max_cycles: 0x10000000000000000
[ 0.001200] sched_clock: 64 bits at 10Hz, resolution 100000ns, wraps every 0x10000000000000000
[ 0.003000] Console: colour dummy device 002x25
[ 0.379700] Calibrating delay loop (skipped), value calculated using timer f
[ 0.462500] pid_max: default: 4096 minimum: 301
[ 0.462500] CPU: 0: 1000MHz 1: 1000MHz 2: 1000MHz 3: 1000MHz
[ 0.723900] Mountpoint-cache hash table entries: 1024 (order: 0, 4096 bytes, linear)
[ 2.828800] devtmpfs: initialized
[ 5.382900] clocksource: jiffies: mask: 0xffffffff max_cycles: 0xffffffff, max_delta: 1347749000 ns
[ 5.467000] futex: hash table entries: 16 (order: -5, 192 bytes, linear)
[ 6.518000] cpuid: Ratio of byte access time to unaligned word access is 4.75.
[ 9.441100] clocksource: Switched to clocksource clint@clocksource
[ 23.860000] clocksource: 32khz: mask: 0xffffffff max_cycles: 0xffffffff, max_order=11 bucket_order=0
[ 31.197100] Serial: 0250/10550 driver: 1 port, 16 serial ports sharing disabled
[ 34.116300] printk: legacy console [ttyS0] disabled
[ 34.093700] 19000000.uart: ttyS0 at MMIO 0x1000000000 (irq = 0, base_baud = 1960
[ 35.030200] printk: legacy console [ttyS0] enabled
[ 35.132600] printk: legacy console [ttyS0] enabled
[ 35.132700] printk: legacy console [uart0s2] [uart0s2] disabled
[ 35.132700] printk: legacy bootstrap [uart0s2] [uart0s2] disabled
[ 55.422200] clk: Disabling unused clocks
[ 6.288 0000000000000000] ran insdire mg lmea rooy [ 6.630 hasciert osnthy enlmnr rctin
[ 6.630 0000000000000000] [ 6.580 EMlnx
init started: BusyBox v1.36.1 (2024-12-23 19:45:54 UTC)
starting pid 19, tty :: '/bin/mount -t proc proc /proc'
starting pid 20, tty :: '/bin/mount -o remount,rw /'
starting pid 21, tty :: '/bin/mkdir -p /dev/pts /dev/shm'
starting pid 22, tty :: '/bin/mkdir -p /run/lock/subsys'
starting pid 23, tty :: '/bin/mkdir -p /etc/init.d/rcS'
starting pid 26, tty :: '/etc/init.d/rcS'
starting pid 31, tty :: '/bin/cat /etc/motd'

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Don't forget hobbyist works. This is where innovation comes from

Mackerel boards, made by maykish, the M68Ks are still booting Linux :

<https://github.com/crmaykish/mackerel-68k>

And he even has gotten a basic port of the latest Linux kernel (v6.17) running on Mackerel-30. It boots to userspace and has a Toybox-based init and interactive shell !

<https://hackaday.io/project/183861-mackerel-68k-linux-sbcs/log/244041-linux-617-on-mackerel-30>



```
starting pid 39, tty ``: '/bin/mkdir /var/tmp'
starting pid 40, tty ``: '/bin/mkdir /var/log'
starting pid 41, tty ``: '/bin/mkdir /var/run'
starting pid 42, tty ``: '/bin/mkdir /var/lock'
starting pid 43, tty ``: '/bin/cat /etc/motd'

Welcome to ucLinux on
[...]
[MC68KDRIVE]
github.com/crmaykish/mackerel-68k

starting pid 43, tty ``: '/bin/cttyhack /bin/nsh'
# cat /proc/cpuinfo
CPU:          MC68000
MMU:          none
TBU:          none
Clocking:    4.8MHz
BogoMips:    0.60
Calibration: 381700 loops
# cat /random: nonblocking pool is initialized

#
#
#
# cat /etc/os-release
cat: can't open '/etc/os-release': No such file or directory
# uname -a
uclinux mackerel-10 4.4.0-ucl #1 Mon Sep 22 20:27:27 EDT 2025 m68k ucLinux
#
```

Current issues for maintenance

Real Hardware for testing :

- SuperH J-Core in FPGA and on multiple silicon processes, in multiple hardware is available.
- m68k are still well-stocked and there are other new hardware, such as Apollo 68080.
- RISC-V has plenty of hardware manufactured.

Workforce perspective :

- Hardware vendors are tend to maintain only a few releases of Linux.
 - It's important for the community to pay attention to what embedded engineers actually use
- SLTS from CIP is what many vendors are looking for.
- Regular clean-up and testing are needed.

32 is the new 8-bit

RISC-V and SuperH are still very well adopted and thriving.

Cams, automotive controller, energy monitors, critical infrastructure, real time devices, other IIoT devices

A lot of them are running Linux for their tasks.

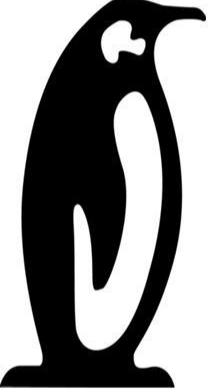
But it's important to understand that the reason is it is easy to build things with this technology

You can get OpenHardware/Gateware versions of all of this, that are supported in mainline Linux

Development boards and kits are available

Yes, there is commercial support... but the community drives the innovation

To suggest that 32bit and nommu is irrelevant today is just incorrect.



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Backup

Place holders

Place holders