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# 32-bit Linux in 2025 and beyond

Arnd Bergmann <arnd@linaro.org>

# 32-bit Linux is obsolete

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... but exactly what does that mean, and what can we do about it?



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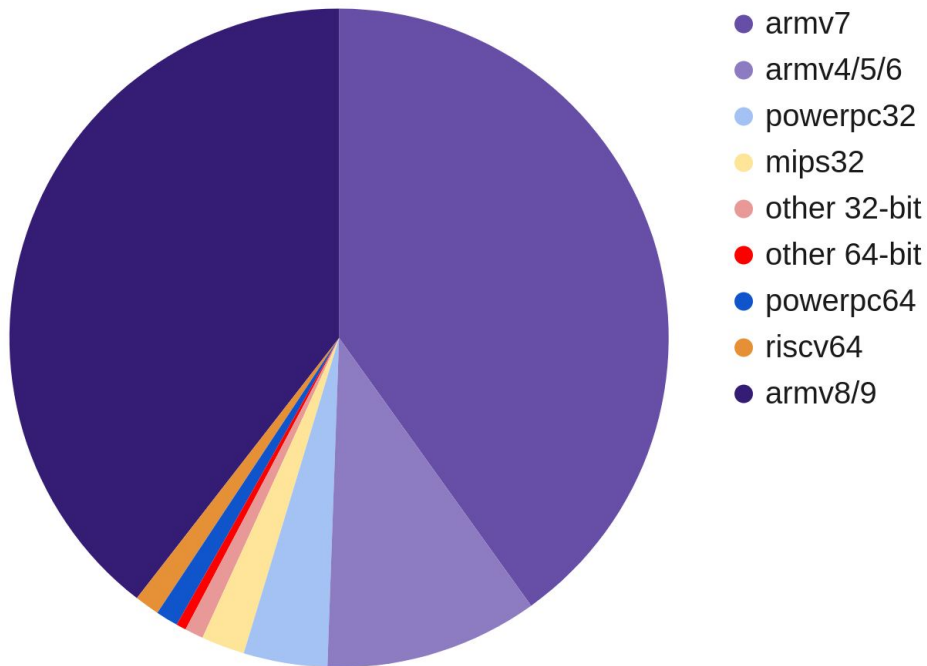
# Types of supported 32-bit platforms

- Desktop/consumer
- MMU-less (microcontroller)
- pre-ARMv7 embedded
- ARMv7 embedded
- Licensed architectures

# Supported non-embedded platforms

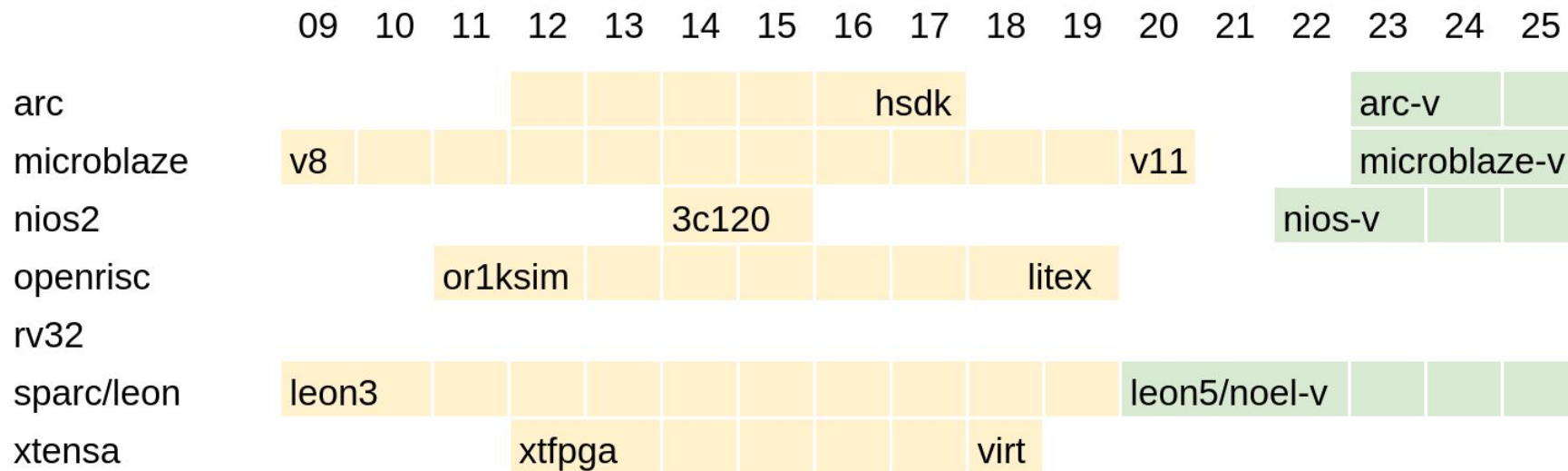
|              | 84   | 85 | 86        | 87    | 88         | 89           | 90     | 91    | 92 | 93   | 94         | 95      | 96      | 97         | 98      | 99        | 00      | 01        | 02     | 03        | 04    | 05         | 06        | 07    | 08    | 09 | 10 | 11 | 12 | 13 | 14 | 15 | 16       | 17         | 18    | 19      | 20        | 21  | 22      | 23 | 24        | 25 | 26          |             |             |
|--------------|------|----|-----------|-------|------------|--------------|--------|-------|----|------|------------|---------|---------|------------|---------|-----------|---------|-----------|--------|-----------|-------|------------|-----------|-------|-------|----|----|----|----|----|----|----|----------|------------|-------|---------|-----------|-----|---------|----|-----------|----|-------------|-------------|-------------|
| PC desktop   |      |    | 386       |       | 486        |              |        |       |    |      | Pentium    | P-II    |         |            | P4      |           |         |           |        | Athlon64  |       |            | Core 2    |       |       |    |    |    |    |    |    |    |          |            | Ryzen |         |           | ADL |         |    |           |    |             |             |             |
| PC server    |      |    | 386       |       | 486        |              |        |       |    |      | PentiumPro | Xeon    | IA64    |            |         |           |         |           |        | Opteron   |       |            | Xeon 5000 |       |       |    |    |    |    |    |    |    |          | Epyc       |       |         |           |     | SPR     |    |           |    |             |             |             |
| PC laptop    |      |    | 386       |       |            | 486          |        |       |    |      |            |         |         | Pentum-MMX |         |           |         |           |        | Pentium-M |       |            | Core 2    |       |       |    |    |    |    |    |    |    |          | Skylake    |       |         |           | ADL |         |    |           |    |             |             |             |
| PC netbook   |      |    |           |       |            |              |        |       |    |      |            |         |         |            |         |           |         |           |        |           |       |            | N270      | N550  | N2700 |    |    |    |    |    |    |    | Goldmont |            |       |         | Gracemont |     |         |    |           |    |             |             |             |
| System/390   | 3090 |    |           |       |            | ES/9000      |        |       |    |      | 8672-g1    |         |         | g6         | z900    |           |         |           |        |           |       | z9         | z10       |       |       |    |    |    |    |    |    |    |          | zBC12      |       |         | Telum     |     |         |    |           |    |             |             |             |
| RS/6000      |      |    |           | RT PC |            |              | POWER1 |       |    |      |            |         | RS64    | POWER3     |         |           |         |           |        |           |       | POWER5     |           |       |       |    |    |    |    |    |    |    |          | POWER8     |       |         |           |     | Power10 |    |           |    |             |             |             |
| Apple        |      |    | Macintosh |       |            | Macintosh II |        |       |    |      | PowerMac   |         |         | G4         |         |           |         |           |        | G5        |       | Xeon       |           |       |       |    |    |    |    |    |    |    |          | SKX        |       |         |           |     | M1      |    |           |    | M4          |             |             |
| Apple laptop |      |    |           |       |            | Portable     |        | Pb180 |    |      | Powerbook  |         |         | iBook      |         |           |         |           |        | G4        |       | Core       |           |       |       |    |    |    |    |    |    |    |          | SKL        |       |         |           |     | M1      |    |           |    | M4          |             |             |
| Amiga        |      |    | 1000      |       |            |              | 2500   |       |    |      |            | PowerUP |         |            |         | AmigaOne  |         |           |        |           |       |            |           |       |       |    |    |    |    |    |    |    |          | X1000      |       |         |           |     |         |    |           |    | A1222       |             |             |
| ARM desktop  |      |    |           |       | Archimedes |              |        |       |    |      |            | RiscPC  |         |            |         | Netwinder |         |           |        |           |       |            |           |       |       |    |    |    |    |    |    |    |          | i.MX5      |       | Exynos5 | MT8173    |     | M1      |    |           |    |             |             |             |
| ARM mobile   |      |    |           |       |            |              |        |       |    |      | ARM610     |         |         | SA-1100    |         |           |         |           | PXA    |           | i.MX3 |            |           | OMAP3 |       |    |    |    |    |    |    |    |          | MSM8992    |       |         |           |     |         |    | MT6983    |    |             |             |             |
| Loongson     |      |    |           |       |            |              |        |       |    |      |            |         |         |            |         |           |         |           | Godson |           |       | Loongson2E |           |       |       |    |    |    |    |    |    |    |          | Loongson2G |       |         |           |     |         |    | LoongArch |    |             |             |             |
| Sun          |      |    | sun3      |       |            | sun4c        |        |       |    |      | sun4m      | sun4u   |         |            |         |           |         |           |        |           |       | sun4v      |           |       |       |    |    |    |    |    |    |    |          |            |       |         |           |     |         |    |           |    | M8          |             |             |
| HP           |      |    |           | 300   |            | 800          |        |       |    |      | PA-7000    |         | PA-8000 |            | PA-8600 |           | PA-8800 | Integrity |        |           |       |            |           |       |       |    |    |    |    |    |    |    |          |            |       |         |           |     |         |    |           |    |             |             |             |
| Digital      |      |    | VAX       |       |            |              | 3100   | 5000  |    | EV45 | EV56       |         | EV6     |            |         |           |         |           |        |           | EV7   |            |           |       |       |    |    |    |    |    |    |    |          |            |       |         |           |     |         |    |           |    | 32-bit CISC | 64-bit CISC |             |
| SGI          |      |    | Iris      |       |            | Iris 4D      |        |       |    |      | Indigo2    |         |         |            | Octane  | Origin    |         | 3000      | Prism  |           |       |            |           |       |       |    |    |    |    |    |    |    |          |            |       |         |           |     |         |    |           |    |             | 32-bit RISC | 64-bit RISC |
| Atari        |      |    | ST        |       |            |              |        | TT    |    |      | Falcon     |         |         |            |         |           |         |           |        |           |       |            |           |       |       |    |    |    |    |    |    |    |          |            |       |         |           |     |         |    |           |    |             | 64-bit VLIW |             |

# Embedded devicetree files by architecture





# Licensable architectures

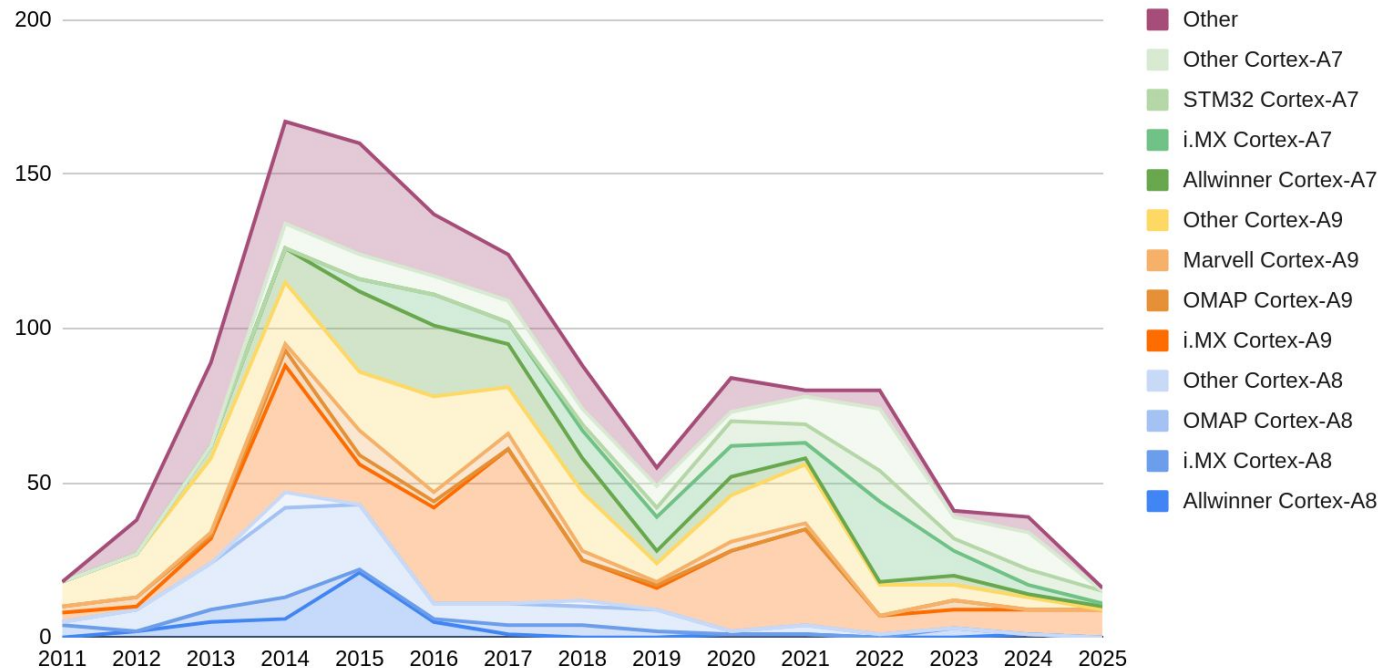


# Pre-Armv7 embedded SoC families

| Family         | CPU       | Replacement | Boards | EOL    | 01      | 02      | 03         | 04      | 05       | 06     | 07      | 08      | 09         | 10       | 11         | 12        | 13       | 14     | 15      | 16      | 17 | 18   | 19      | 20    | 21    | 22 | 23      | 24  | 25 | 26 |
|----------------|-----------|-------------|--------|--------|---------|---------|------------|---------|----------|--------|---------|---------|------------|----------|------------|-----------|----------|--------|---------|---------|----|------|---------|-------|-------|----|---------|-----|----|----|
| at91           | ARMv4     | armv7       | 58     | active |         |         | at91rm9000 |         | at91sam9 |        |         |         |            |          |            |           | sama5    |        |         |         |    |      | sam9x60 |       | sama7 |    | sam9x7  |     |    |    |
| ast2xxx        | ARMv5     | armv7/v8    | 42     | active |         |         |            |         | ast2xxx  |        |         |         |            |          |            |           | ast2500  |        |         |         |    |      | ast2600 |       |       |    | ast2700 |     |    |    |
| bcm2835        | ARMv6     | armv7/v8    | 8      | 2030   |         |         |            |         |          |        |         |         |            |          |            |           | bcm2835  |        |         | bcm2836 |    |      | bcm2711 |       |       |    | bcm2712 |     |    |    |
| cirrus         |           |             | 4      | 2023   |         |         |            |         |          |        | ep93xx  |         |            |          |            |           |          |        |         |         |    |      |         |       |       |    |         |     |    |    |
| davinci        |           | armv7/v8    | 4      | active |         |         |            |         |          |        | davinci |         |            | dm81xx   |            | am5k2     |          |        |         |         |    | am6x |         |       |       |    |         |     |    |    |
| gemini         |           | eol         | 10     | 2015   |         |         |            |         | cs3516   |        |         |         |            |          |            | cs7522    |          |        | EOL     |         |    |      |         |       |       |    |         |     |    |    |
| imx1/2/3       |           | armv7/v8/v9 | 18     | 2023   | imx1    | imx2    | imx3       |         |          |        |         |         | imx5       |          |            | imx6      | imx7     | imx8   |         |         |    |      |         | imx9  |       |    |         |     |    |    |
| ixp4xx         |           | x86-64      | 18     | 2005   | ixp4xx  |         |            |         |          |        |         |         |            |          |            | atom      |          |        |         |         |    |      |         |       |       |    |         |     |    |    |
| lpc32xx        |           | eol         | 2      | 2019   |         |         |            |         |          |        |         |         | lpc32xx    |          |            |           |          |        |         |         |    |      | EOL     |       |       |    |         |     |    |    |
| mxs            |           | armv7/v8/v9 | 32     | 2025   |         |         |            |         |          |        |         |         |            | stmp3780 |            | imx6      | imx7     | imx8   |         |         |    |      |         | imx9  |       |    |         |     |    |    |
| omap1/2        |           | armv7       | 10     | 2013   |         | omap1   | omap2      |         |          | omap3  |         |         |            | omap4    |            |           |          |        |         |         |    |      |         |       |       |    |         |     |    |    |
| orion/kirkwood |           | armv7/v8    | 91     | 2016   |         |         |            |         |          | orion  |         |         | kirkwood   |          |            | armada xp |          |        |         |         |    |      |         |       |       |    |         |     |    |    |
| sa11xx/pxa     |           | eol         | 10     | 2016   |         |         |            | pxa210  |          |        |         |         | pxa955     |          |            |           |          |        | EOL     |         |    |      |         |       |       |    |         |     |    |    |
| suniv          |           | armv7/v8    | 3      | 2024   |         |         |            |         |          | f1c100 |         |         |            | a10      |            |           | a80      |        |         | a63     |    |      |         |       |       |    | a523    |     |    |    |
| coldfire-v4    | m68000    | armv7/v8/v9 | 2      | 2025   |         |         |            |         |          |        |         |         | i.mx5      |          |            | imx6      | imx7     | imx8   |         |         |    |      |         | imx9  |       |    |         |     |    |    |
| alchemy        | MIPS32    | eol         | 13     | 2011   |         |         |            |         | au1200   |        |         |         |            | au1300   |            | EOL       |          |        |         |         |    |      |         |       |       |    |         |     |    |    |
| ath79          |           | active      | 6      | active |         |         |            |         |          |        | ar71xx  |         |            |          |            |           | qca95xx  |        | ipq40xx | ipq80xx |    |      |         |       |       |    |         |     |    |    |
| bcm47          |           | armv7/v8    | 8      | 2019   |         | bcm4710 |            |         |          |        |         |         |            |          |            |           | bcm47081 |        |         | bcm4906 |    |      |         |       |       |    |         |     |    |    |
| bcm63          |           | armv7/v8    | 7      | 2019   |         |         |            |         |          |        |         | bcm63xx |            |          |            |           |          |        |         | bcm63xx |    |      |         |       |       |    |         |     |    |    |
| ingenic        |           | active      | 7      | active |         |         | jz47xx     |         |          |        |         |         |            |          |            |           |          |        | x1000   |         |    |      |         | x2000 |       |    |         |     |    |    |
| mscc           |           | armv7/v8    | 8      | active |         |         |            |         |          |        |         | mscc    |            |          |            |           |          |        |         |         |    |      |         |       |       |    | lan966x |     |    |    |
| ralink         |           | armv7/v8    | 10     | active |         |         |            |         |          |        | rt27xx  |         |            |          |            |           | mt7621   | mt7623 |         |         |    |      |         |       |       |    |         |     |    |    |
| ppc4xx         | PowerPC32 | armv8/v9    | 24     | 2018   |         |         |            |         | ppc460   |        |         |         |            | ppc470   | x-gene     |           |          |        |         |         |    |      |         |       |       |    |         |     |    |    |
| ppc6xx         |           | ppc64/armv8 | 40     | 2019   |         |         |            | mpc86xx |          |        |         |         |            |          |            | qoriq p5  | ls1048a  |        |         |         |    |      |         |       |       |    |         |     |    |    |
| ppc8xx         |           | ppc64/armv8 | 4      | 2018   |         |         |            |         |          |        |         |         |            |          |            | qoriq p5  | ls1048a  |        |         |         |    |      |         |       |       |    |         |     |    |    |
| e500           |           | ppc64/armv8 | 67     | 2021   | mpc85xx |         |            |         |          |        |         |         |            |          |            | qoriq p5  | ls1048a  |        |         |         |    |      |         |       |       |    |         |     |    |    |
| sh77xx         | SuperH    | armv7/v8    | 38     | 2025   |         |         |            |         |          |        |         |         |            | sh73     | r-car      | h3        |          |        |         |         |    |      |         |       |       |    |         |     |    |    |
| geode          | x86-32    | x86-64      | 4      | 2026   |         |         |            |         |          |        |         |         |            |          | amd fusion |           |          |        |         |         |    |      |         |       |       |    |         |     |    |    |
| rdc/vortex86   |           | x86-64      | 0      | active |         |         |            |         |          |        |         |         | vortex86dx |          |            |           |          |        |         |         |    |      | ex2     |       |       |    |         | ex3 |    |    |



# Number of ARMv7 boards added per year



# MMU-less microcontroller

|          |                                             |
|----------|---------------------------------------------|
| ARMv7-M: | STM32F4/F7/H7, i.MX-RT, LPC18xx/43xx, SAMv7 |
| m68k:    | Coldfire v2/v3/v4, DragonBall               |
| SuperH:  | sh7619, sh72xx, j2                          |
| xtensa:  | KC705/DE212, (ESP32)                        |
| RISC-V:  | K210                                        |

# 32-bit pain points

- highmem support
- sparsemem support
- y2038 compatible userspace
- distro support



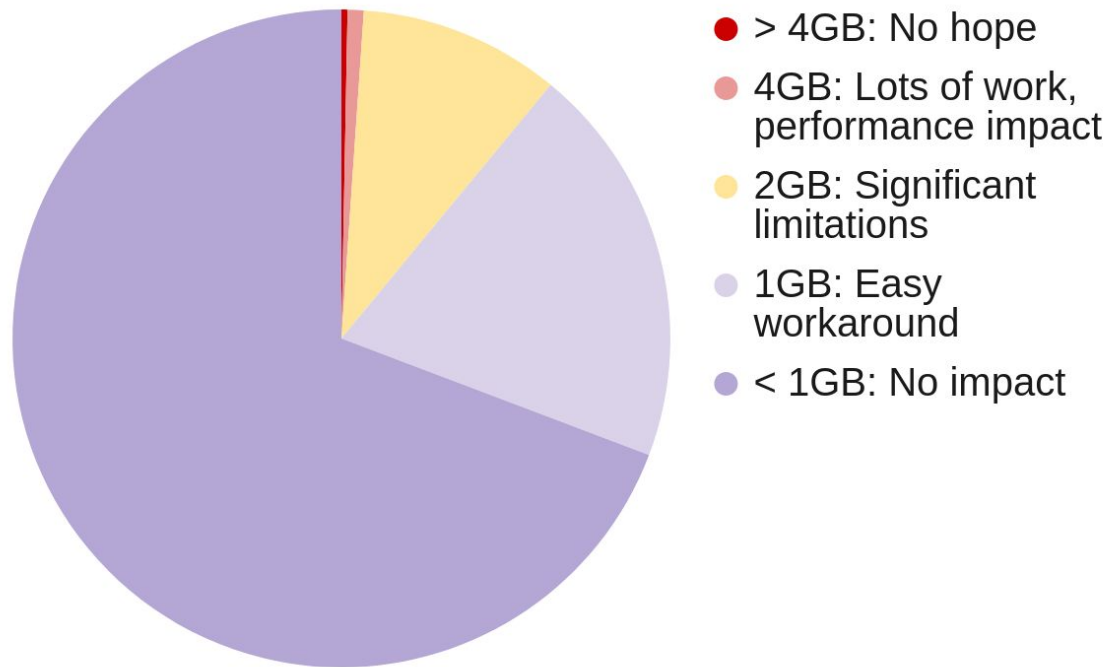
# 32-bit userspace on 64-bit kernel

- Replaces 32-bit low-end SoCs
- Needed for memory constrained systems
- 50% lower memory usage on Arm CPUs
- Unavailable from Cortex-A320/A520/A715 and Neoverse-V2

# Highmem

- Allows more than 800MB RAM easily
- up to 16GB total on 32-bit Arm
- Needs to die

# Impact of Highmem removal





# Highmem ideas

## Densemем

- Up to 2GB
- Needed for replacing sparsemem
- Variable vmsplit reduces user addresses

## VMSPLIT\_4G

- Up to 3.75GB
- Switching user vs lowmem
- Under discussion for years
- not much progress
- performance impact

## zRAM-only HIGHMEM

- Reduced complexity
- dropping HIGHMEM from page cache, highpte, drivers, ...
- reduces impact

# Highmem removal

Affected products with 4GB,  
known examples:

- Chromebook (EOL)
- In-flight entertainment
- Fire alarm system
- Digital signage

Platforms with >4GB

- Amazon/Annapurna Alpine
- Calxeda Midway
- HiSilicon HiP04
- Marvell Armada XP
- Intel/LSI axm55xx
- TI 66AK2Hxx

# y2038 update

- 2020 kernel
  - 2020 musl libc
  - 2021 glibc
  - 2025 Debian, Ubuntu 64-bit time\_t
- 
- Unresolved bugs in many packages
  - Direct syscalls cause issue
  - Often broken for language bindings: python, rust, ...

# Side quest: big-endian

- Equally obsolete as 32-bit
- Embedded ppc32, ixp4xx (arm), ath79 (mips32), lantiq (mips32), rtl838x (mips32), bcm63xx (mips32), openrisc, leon (sparc32)
- UNIX workstation/server (mips, sparc, parisc, powerpc, m68k)
- IBM z mainframes (s390)

# Removal under discussion

- Early ARMv4 (DEC/Intel StrongARM)
- Early ARMv6 (OMAP2, i.MX31)
- Most Arm board files (non-devicetree)
- Cortex-M
- Intel i486
- KVM support on all 32-bit hosts

# Summary: 32-bit endgame

- ARMv7 support needed for at least 10 more years, possibly much longer
- Everything else possibly shorter
- ARMv4 as long as ARMv5
- Highmem removal maybe 2027
- NOMMU removal maybe 2027

# Thank You!