Space Grade Linux

Ramón Roche, Linux Foundation
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ELISA
Enabling Linux in Safety Applications

whoami

Ramón Roche

General Manager

Dronecode / Linux Foundation

- (Still) an individual contributor
- 10+ years working in aerial robotics
- PX4 Maintainer
- Co-Lead ROS Aerial Robotics WG
- Co-Lead Space Grade Linux SIG

SGL Primary Mission Objectives

Reduce cost. Reduce error.

- Stop reinventing the wheel.
- Reuse software and collaborate.
- Minimize time to launch.
- Reduce required expertise.
- Leverage collective knowledge base.

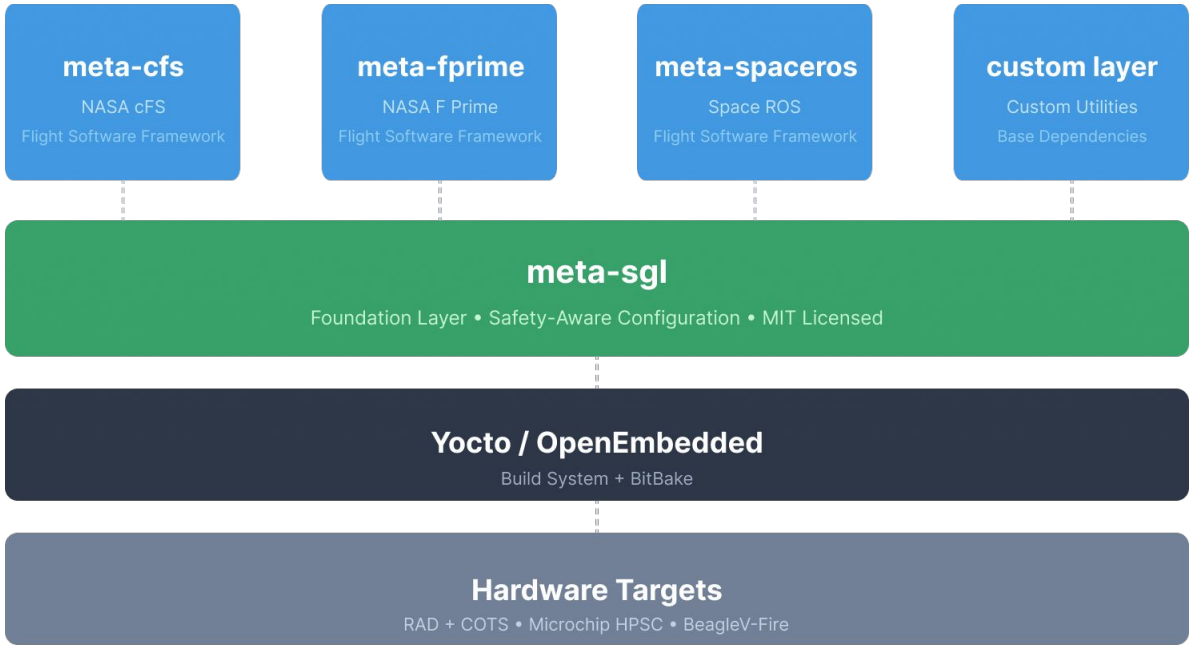
Inspire confidence in Linux

- Establish a trusted ecosystem.
- Demonstrate reliability outside terrestrial applications
- Serve as a baseline for future certification.

Facilitate modern workloads in space

- Prepare for next-gen high performance spacecraft processors.
- Tap into unrivaled performance and software support offered by Linux.
- Support nearly all AI/ML frameworks out of the box.
- Address challenges presented by spacecraft environments.

Inside Space Grade Linux



2025 Conferences & Visibility

IEEE SMC/IT Los Angeles (July)

Technical overview talk, OSS Workshop

OSS EU / ELCE Amsterdam (August)

Full technical talk, packed room, LWN.net coverage

ROSCon Singapore (October)

First live hardware demo (Rob Woolley), Lightning talk

OSS Japan Tokyo

Keynote, The New Stack Coverage (Papermoon?)

Other Relevant 2025 Events

- **RISC-V in Space (Feb)**
- **SmallSat Utah (August)**
- **AMD Space Day (August)**

LWN Article

https://lwn.net/Articles/1036168/

The New Stack

https://thenewstack.io/papermoon-a-space-grade-linux-for-the-newspace-era/

Technical Decisions made in 2025

January: Foundational Decisions

- Licensing: MIT for Source Code & CC-BY-SA 4.0 for documentation
- DCO chosen over CLA for lower barrier to entry
- Target hardware: BeagleV-Fire selected (RISC-V, ~$140, accessible)

April: First Pull Request Merged

- meta-sgl-core skeleton layer
- KAS for layer management
- Scarthgap LTS as base Yocto release
- Two distro approach: tiny (minimal) + systemd-based (robust)
- QEMU + BeagleV-Fire as initial targets

May: Roadmap Defined

- Skeleton Layer
- CI/CD Pipeline
- Documentation
- SBOM generation
- Footprint tracking/analysis

June: CI/CD Pipeline

- GitHub Actions + AWS infrastructure
- Sponsored by ELISA
- Building every commit + pr
- AMD64 + ARM64
- S3 layer caching for faster tests

Technical Research Presented

Red Hat containers/space-grade-linux (February)

- Douglas Landgraf presented Podman-based approach
- Rocket Launch Simulator demo
- Plan to integrate with Yocto builds

BYU SHREC Radiation Testing (July/August)

- Garrett Smith presented Linux radiation testing on AMD Versal FPGA
- Key findings: Cache ECC helped, processor hangs difficult to diagnose
- DDR bitflips corrected with ECC and scrubbing
- Linux OCM EDAC driver needed patching for actual correction
- Andrew Wilson: Also tested Linux on TMR Soft RISC-V processors

Technical Research Presented

University of Luxembourg Research (September)

- Aditya Bhattacharya: Linux boot failures under proton irradiation
- NXP IMX 8M module tested
- Errors cascade from early boot (firmware, device tree) to later phases
- ECC not initialized during kernel core phase caused downstream issues
- Working on QEMU fault injection to simulate these errors

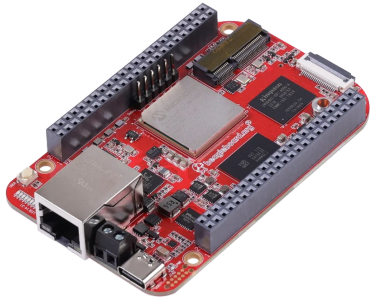
RAUC OTA Updates Discussion (October)

- A/B partition update mechanism for unreliable links
- Supports uboot, barebox, grub, UEFI
- Adaptive streaming for resource-constrained environments

ROSCon Hardware Demo

First Live Hardware Demo - October 2025

- Rob Woolley (Wind River) demonstrated SGL + Space ROS on Microchip hardware
- Video: https://vimeo.com/1136204579
- Branch with changes: github.com/robwoolley/meta-ros/tree/spaceros-preview
- Next up: cFS integration work

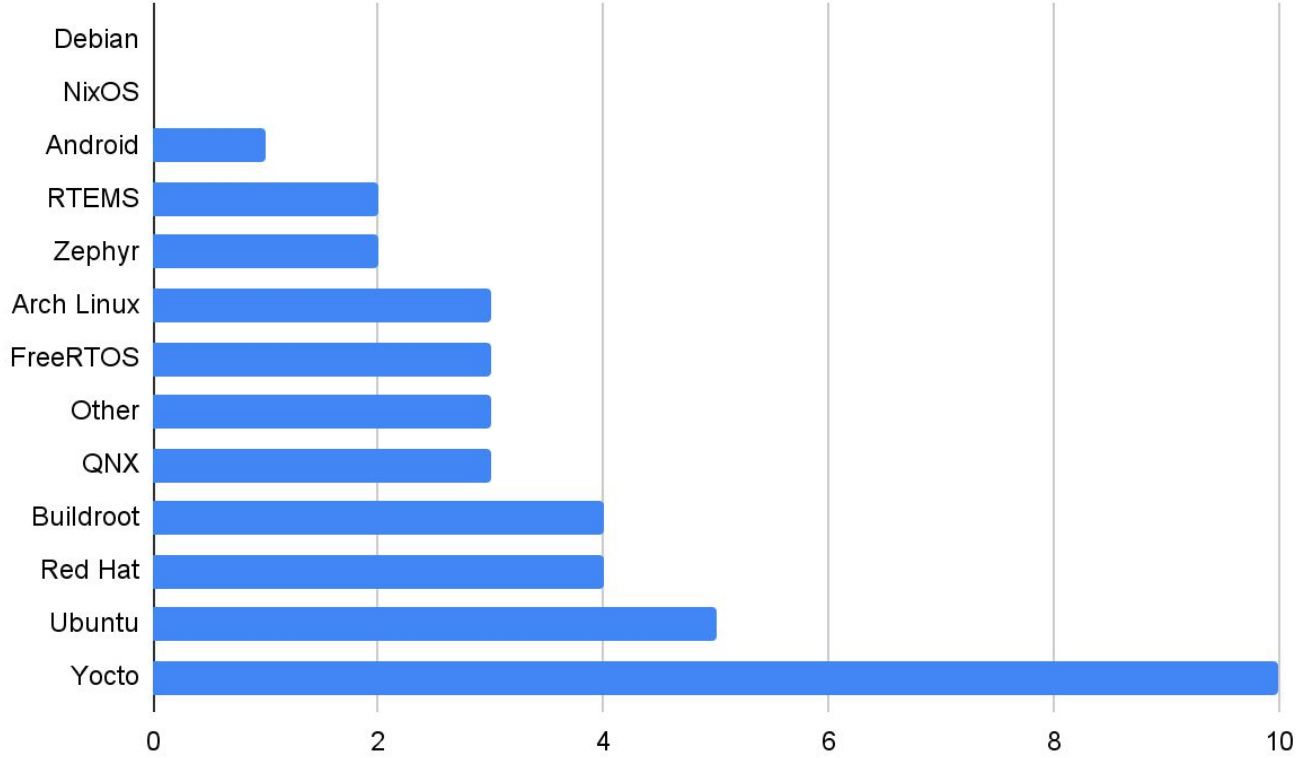


Update Results on Formation Survey Coming Soon!

Linux fragmentation in the industry

Q4 2024

Question:
Which of the following distributions are you currently using



Linux fragmentation in the industry

Q1 2026

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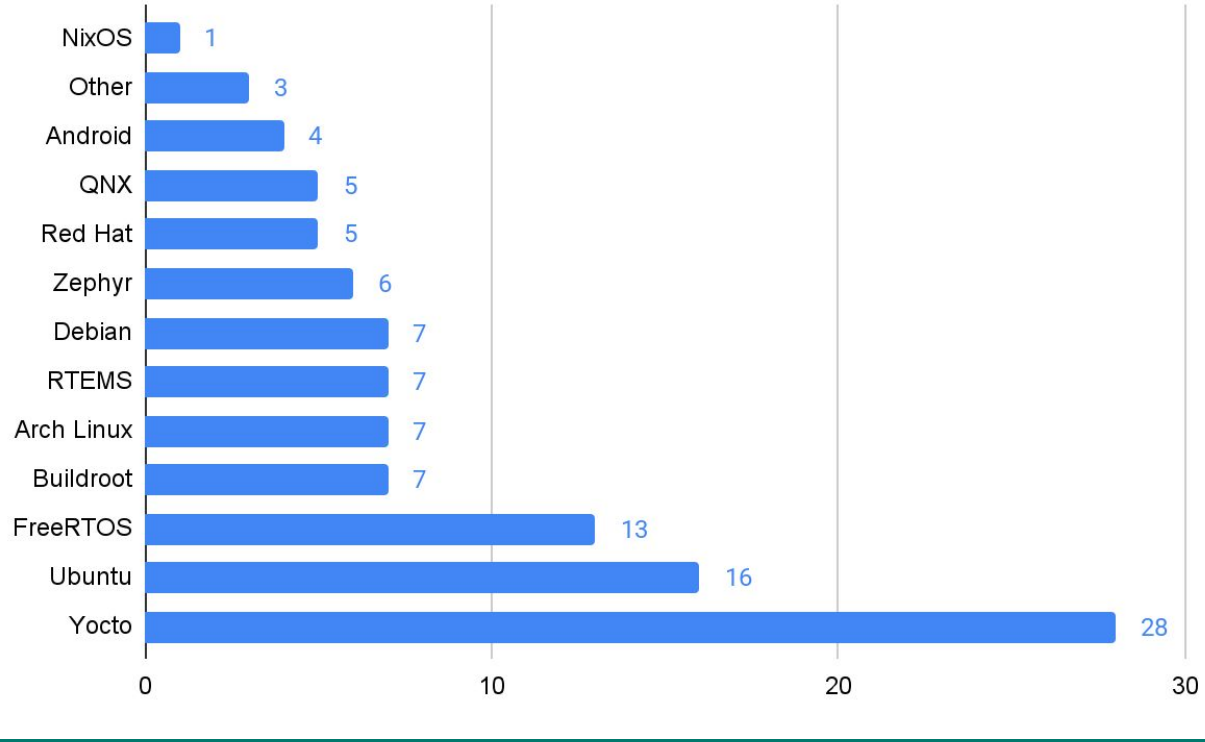

Community & Participation

Regular Meeting Attendees (sampling from minutes):

Organizations actively participating in 2025:

- **Space Industry:** NASA (Ames, Goddard, Langley, Marshall Space Flight Center), JPL/Caltech, Space Cubics, CesiumAstro, Stoke Space, TelePIX
- **Aerospace:** Boeing, L3Harris, Collins Aerospace, VZLU Aerospace, The Exploration Company
- **Tech Companies:** Wind River, Red Hat, Sony, Microchip, Vorago Technologies, Ampere, Timesys/Lynx
- **Academia:** BYU SHREC, TUHH, KTH, Technical University of Liberec, KAIST, University of Luxembourg
- **Open Source:** OpenEmbedded, OpenSDR, Linux Foundation
- **Other:** TII (UAE), Accenture, NRB

🚀 **contributors to meta-sgl repo:** mrpollo, robwoolley, balister, asimonov, tbird20d, csmith608

Intent to Form Foundation

Direction chosen:

- AGL model (reference distribution, not just a spec)
- Yocto-based recipes, not binary distribution
- Start with cubesat-class missions, build toward higher assurance levels
- Flight software focus initially, ground systems later

Still under discussion:

- Zephyr RTOS integration
- HPSC as primary rad-hard target
- Security model for remote deployments

Current Status:

- Incubating as SIG under ELISA
- Intent to spin off with own governance
- Seeking founding members

SGL Project / Foundation

Currently seeking founding members

We're forming a standalone foundation modeled after Automotive Grade Linux to provide neutral governance and long-term sustainability.

Your investment funds:

- Full-time development resources
- CI/CD build infrastructure and hardware lab
- Documentation and testing capabilities
- Event sponsorship and community coordination

Founding members get a seat at the table:

- Board of Directors representation
- Direct influence on technical roadmap
- Voice in governance and direction
- Shape the standard before it ships

Why the AGL model works:

- Neutral collaboration enables industry buy-in
- Shared investment, shared benefit
- Proven track record (AGL now has 150+ automotive members)

Target: Q2 2026 founding member commitments

What’s Next / Where We Need Help

User Space Layers Needed:

- meta-ros (exists)
- meta-spaceros (merged 🚀)
- meta-cfs (github.com/jphickey/yocto-meta-cfecfs)
- meta-fprime (early work at BroncoSpace-Lab)
- meta-px4

Documentation Gaps (GitHub Issue #6):

- Getting started guide
- BeagleV-Fire specific docs
- How to flash hardware
- Hardware porting guide

Hardware Expansion

- Raspberry Pi CM4/5
- Microchip HPSC + QEMU

Research Areas:

- QEMU fault injection for radiation simulation
- Footprint optimization
- SBOM generation integration

How to Get Involved

Mailing Lists

https://lists.elisa.tech/g/space-grade-linux/

Discord

https://chat.elisa.tech/

Website

https://sgl.elisa.tech/

GitHub - meta-sgl

https://github.com/elisa-tech/meta-sgl

GitHub - SIG

https://github.com/elisa-tech/sig-sgl

Contact For More Information:

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