From Entanglement to Duality:

Preparing a Multi-Ecosystem

Linux strategy at CERN

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On behalf of the CERN IT Linux team, HEPiX Paris - April 15, 2024

Linux at CERN and the role of the CERN Linux team

"… defines and implements the Linux strategy for the organisation, provides support for package and image building, as well as for the deployment and operation of the supported Linux distributions on servers and managed desktops."
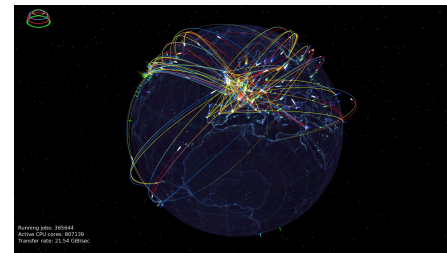
➔ **Support** diverse use case landscape

  ➢ **Data Centres (Compute & Services)**
  ➢ **Accelerator Infrastructure (front- and backend)**
  ➢ **Experiment farms (Online)**
  ➢ **Engineering clusters (Electronics)**
  ➢ **Managed Desktops**

➔ **Member of** WLCG and HEP Communities

Linux Strategy Evolution in the past 10 Years

➡ *2014: Move from SL(C) to CentOS (HEPiX 2014 ⬈)*

➡ *2021: Move from CentOS to Stream*
  - ↳ **Triggered by RedHat's refocus announcement ⬈ in late 2020**
  - ↳ **Together with FNAL ⬈ and WLCG**

➡ *2022: Re-evaluation*
  - ↳ **Experience with Stream in production**
  - ↳ **Together with FNAL in December ⬈ , regular updates to WLCG ⬈**

➡ *2023: Move to RHEL and AlmaLinux*
  - ↳ **In production during Q1, phase-out of CS8/9 during 2023**
  - ↳ **Reasoning for rebuild selection ⬈**

➡ *2023: Source code availability changes*
  - ↳ **Red Hat announced ⬈ they stopped publishing RHEL sources**
  - ↳ **Two-ecosystem strategy … ?**

September 2023
  📅 11. Sept. Linux Future Committee Meeting
Januar 2023
  📅 16. Jan. Linux Future Committee Meeting
Oktober 2022
  📅 28. Okt. Linux Future Committee Meeting
März 2022
  📅 23. März Linux Future Committee Meeting
Dezember 2021
  📅 08. Dez. Linux Future Committee Meeting
September 2021
  📅 15. Sept. Linux Future Committee Meeting
März 2021
  📅 24. März Linux Future Committee Meeting
Februar 2021
  📅 17. Feb. Linux Future Committee Meeting

2014

2024

Supported Linux Distributions at CERN

➡ *Red Hat Enterprise Linux 8 & 9*

    ↳ **CERN has a site-wide license until 2029**

    ↳ **Self-support in general, limited full support**

    ↳ **We negotiated an "Extended Research Network"**

➡ *AlmaLinux 8 & 9*

    ↳ **Free and open-source alternative**

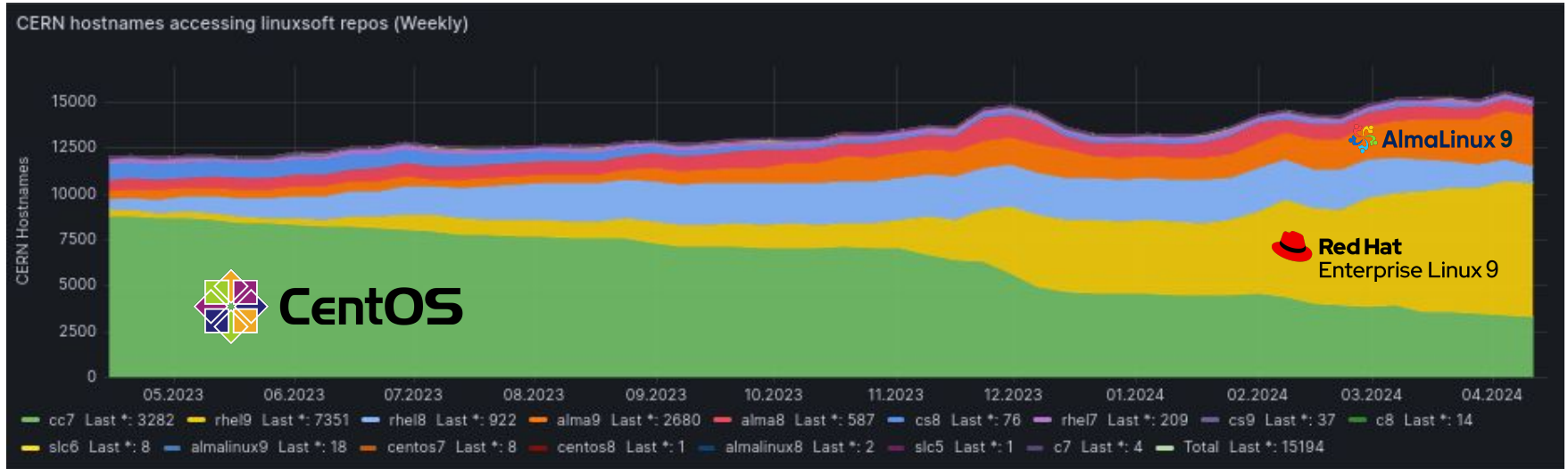   ↳ **Credible fraction of capacity of WLCG services**

    ↳ **Containers**

**Plus CERN CentOS7 until June 30, 2024**

Linux at CERN: Status

Hardware support … long-term availability … modern and updated … desktop-friendly … freely available … container usable …

CERN hostnames accessing linuxsoft repos (Weekly)

Legend: cc7 Last *: 3282 | rhel9 Last *: 7351 | rhel8 Last *: 922 | alma9 Last *: 2680 | alma8 Last *: 587 | cs8 Last *: 76 | rhel7 Last *: 209 | cs9 Last *: 37 | c8 Last *: 14 | slc6 Last *: 8 | almalinux9 Last *: 18 | centos7 Last *: 8 | centos8 Last *: 1 | almalinux8 Last *: 2 | slc5 Last *: 1 | c7 Last *: 4 | Total Last *: 15194

Unique CERN internal IPs hitting the Linux repositories in the past 12 months

OpenStack as an O/S Migration Example
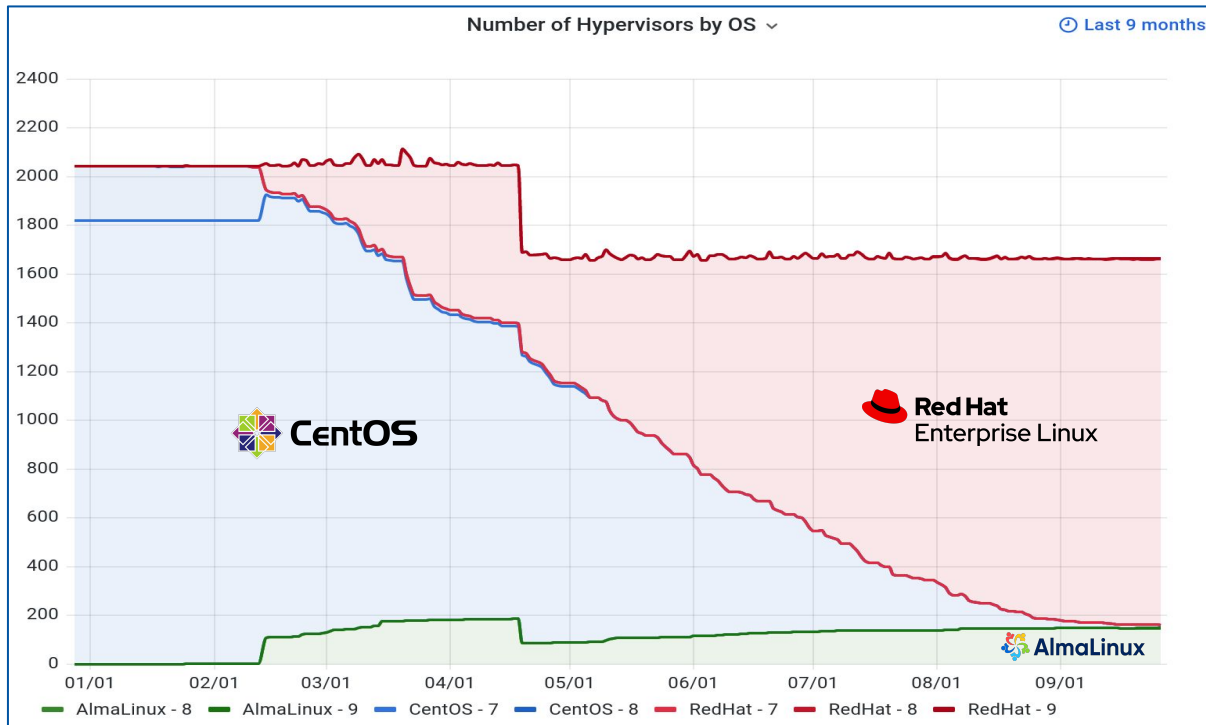
AlmaLinux's ABI Compatibility
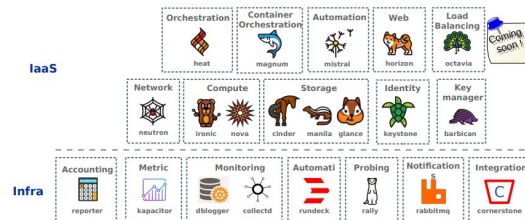
➡️ *RHEL 2023 announcement*🚀 *created a lot of uncertainty*

   ↳ **"Is AlmaLinux still a good choice"?**

   ↳ **CERN Linux team in constant touch with AlmaLinux upstream team**

   ↳ **Decided to keep course**

➡️ *Today: AlmaLinux is ~RHEL*

   ↳ **95% from Stream + 5% from upstream projects**

   ↳ **Kernels are exactly the same**

   ↳ **We observed no issues so far**

   ↳ **Next checkpoint: Stream8 deprecation in May 2024**

Unexpected Side-effects of "ABI Freedom"

➡️ *Faster patches*

- ↳ **x86/mmu: Fix a sign-extension bug with mmu_seq that hangs vCPUs**
  - ○ **Patched in AlmaLinux 8 on 2023-12-04, RHEL 8 on 2024-01-10**

- ↳ **CVE-2024-1086: Important security vulnerability**
  - ○ **Patched in AlmaLinux 8 and 9 on 2023-04-01 (in testing), then RHEL 8 on 2024-04-03**
  - ○ **Still no patch for RHEL 9**

➡️ *Re-Support of deprecated hardware* (under discussion!)

- ↳ **Re-enabling certain PCI IDs so external drivers will continue to work on RHEL 9.4**
- ↳ **Re-enabling disabled in-kernel drivers in AlmaLinux 8.10 and 9.4**
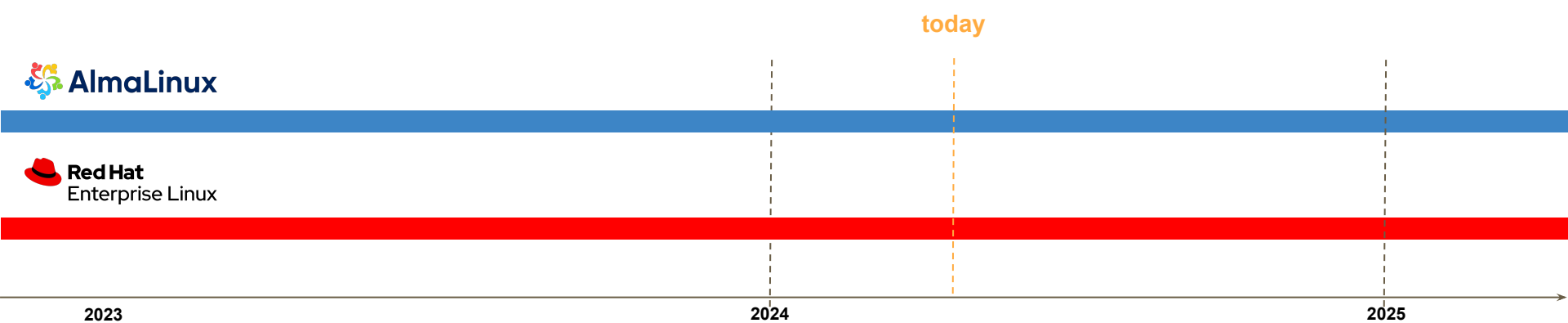- ↳ **Lowering the micro-architecture level in AlmaLinux 10**

CERN Linux Strategy

- ## RHEL & AlmaLinux

  - ### Cover our use cases and roles

  - ### Proven to work, recent events give confidence

  - ### Still: same ecosystem entanglement

today

AlmaLinux

Red Hat
Enterprise Linux

2023   2024   2025

The Special Case of Accelerator Front-ends

➡ **~65% of FECs won't be able to run RHEL10**

   ↳ **x86-64-v3 <u>microarchitecture level</u> & replacement impossible**

➡ *Linux Team provides Limited Debian Support*

   ↳ **Special agreement to support accelerator systems**

➡ *Repository mirroring + snapshots*

   ↳ **Plus a few CERN specific packages**

➡ *Exploring community contribution*

   ↳ **LTS support**

Adding Limited Debian Support (for FECs)

- **Front-end computers: embedded machines currently using CC7**

- **Limited scope, well defined use-case**

today
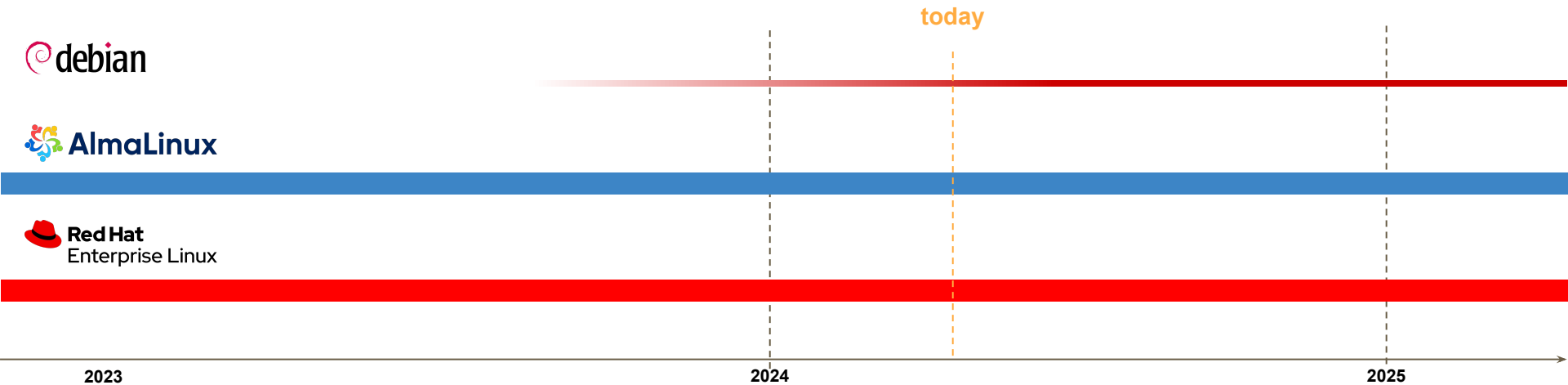
debian

AlmaLinux

Red Hat
Enterprise Linux

2023   2024   2025

The Risk of a Single Ecosystem

2014   **2024**

➤ *The recent past has been quite eventful*

  ↳ **This created** **uncertainty in our user communities**

  ↳ **It also demonstrated** **lack of control and resilience**

Red Hat Enterprise Linux

AlmaLinux

➤ *We should consider options to reduce our risks*

  ↳ **Entanglement** **of supported distributions is a contributor**

  ↳ **First action: engagement (among us and with upstream)**

New board members!

AlmaLinux

Potential Future Scenario: Dual Ecosystem

PROPOSAL

- **Ramp up Debian support to match Red Hat / AlmaLinux**
  - Credible exit strategy for multiple risk scenarios

- **Long-term project, major effort from multiple parties**
  - Requires management approval and commitment
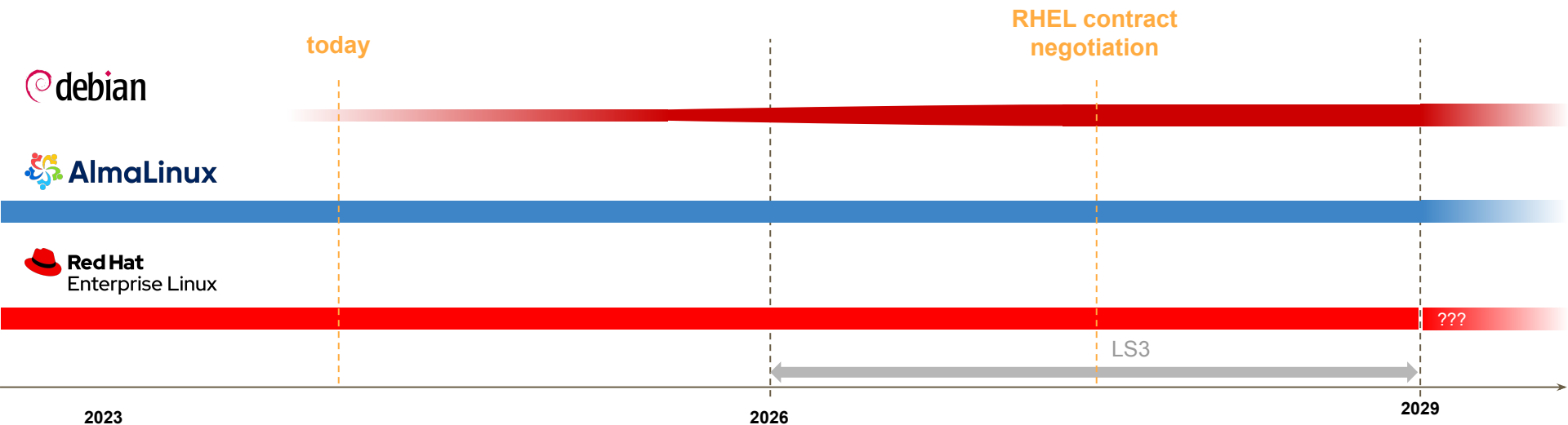
Linux at CERN: Status & Future Summary

➡️ *RHEL and AlmaLinux are the supported distributions*

- ↳ **8 & 9 for now ... 10 added most likely during H1/2025**
- ↳ **Combination covers our use cases and roles**
- ↳ **Excellent experience**

➡️ *Discussing risk mitigation by adding Debian*

- ↳ **RHEL contract ends in 2029 + AlmaLinux and RHEL are entangled**
- ↳ **Can we build up a credible alternative in case we need one?**
- ↳ **A lot of effort** *... mostly beyond the CERN IT Linux team!*
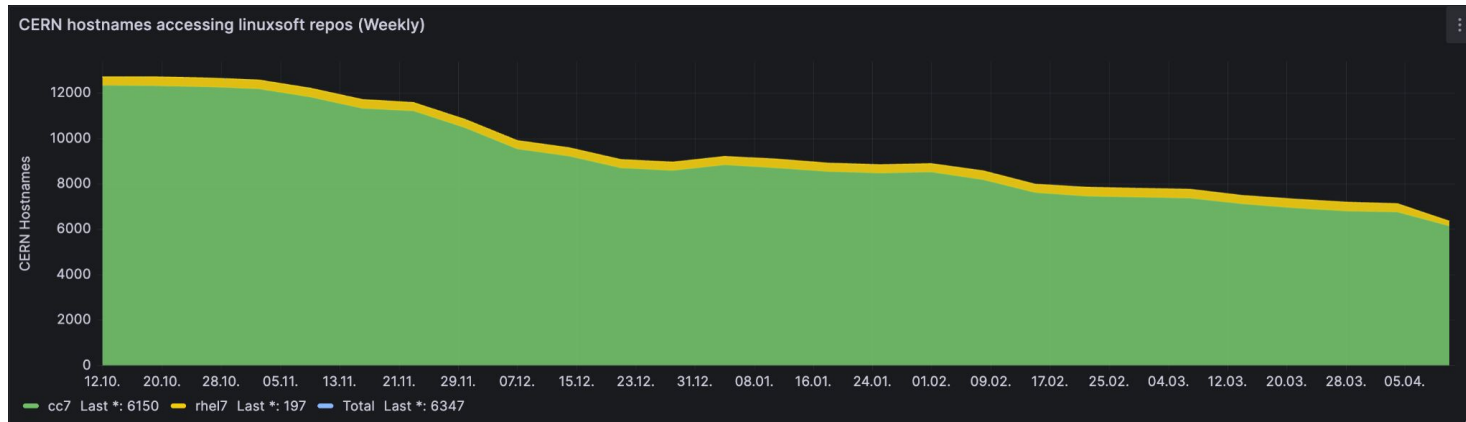
CentOS 7 EOL

CentOS7 EOL

➡ *Phase-out message consistently passed since 2019*

➡ *More directly since EOL-1y (June 2023)*

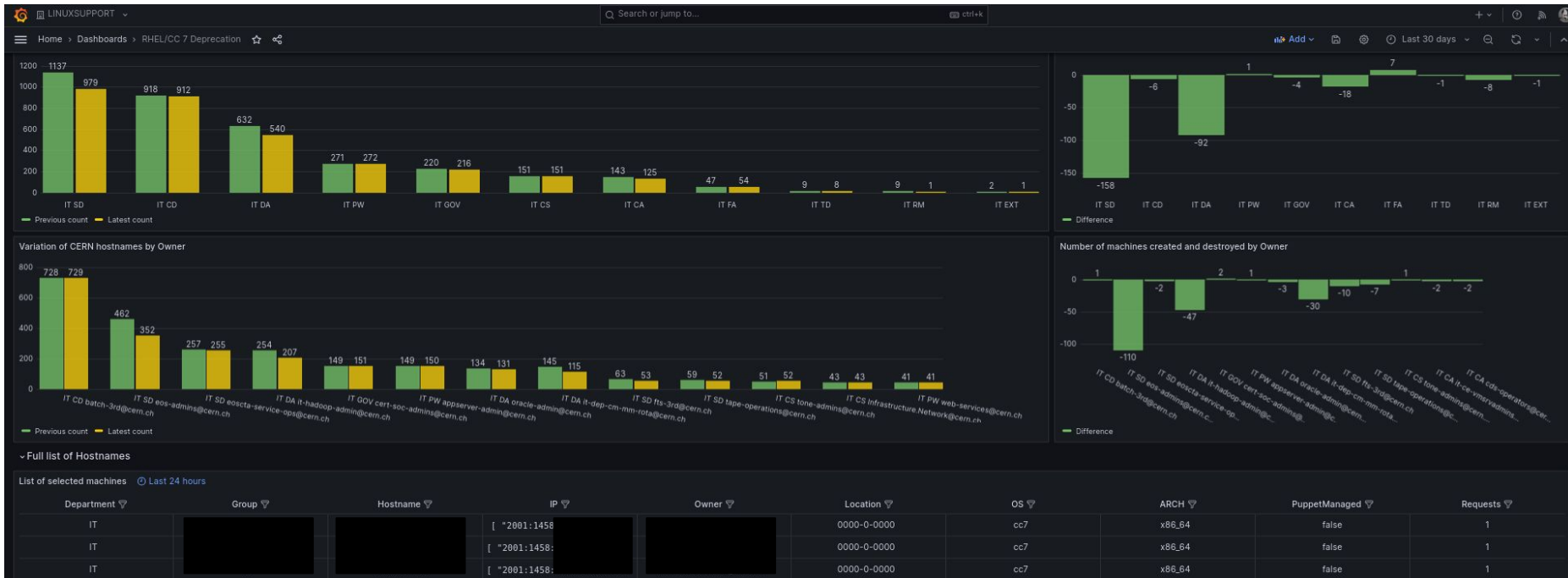↳ **Status board message, IT User meetings, email campaigns**

CERN hostnames accessing linuxsoft repos (Weekly)

cc7 Last *: 6150   rhel7 Last *: 197   Total Last *: 6347

Dominated by batch migration, so way too slow …

CentOS7 EOL: Tracking Dashboard

Following up with individual teams (self-service) …

CentOS7 EOL: LxPlus Usage per O/S

Tracking CentOS usage in services …

CentOS7 EOL: What will happen on July 1?

➡️ **Base repository *mirrors* will stop seeing updates!**

 ↳ **ELS until June 2026 (now 2028), separate repo**

 ↳ **for CERN accelerator sector only!**

➡️ **Selected repository *mirrors* will remain available, but frozen!**

 ↳ **No needed for reinstallations** ☝️

 ↳ **Issue: No updates!**

➡️ **CentOS7 support will stop!**

 ↳ **For Linux itself: no new CentOS7 cloud/container images, no ticket handling**

 ↳ **For surrounding services, in particular Puppet**

CentOS7 EOL: Containers as a way out?

➠ *May* work for self-sufficient and isolated containers

➠ Most likely: not sustainable longer term in general

 ↳ Containers will get stale and present a security risk

 ↳ Clients will see no updates and may even hamper server-side infra

CentOS7 EOL at CERN: Summary

➡ **CERN Linux team is provider of O/S (not operator)**

↳ **No control over migration, but in the path in case of delay**

➡ **Intensive and direct communication since mid 2023**

↳ **June 2024 EOL already in go-live announcement in 2014**

↳ **Phase-out reminders since 2019**

➡ **Special ELS offer for Accelerator Sector until June 2026**

➡ **More and more late migrations & delay announcements …**

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