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Linux Kernel Graphics CI

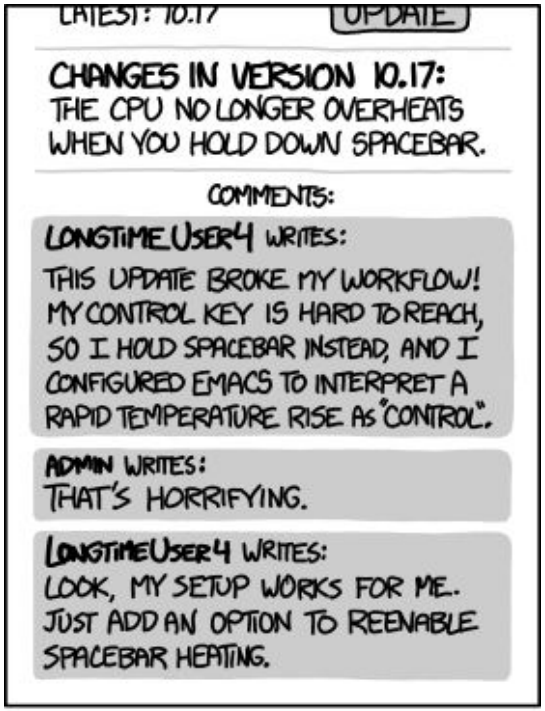
Standardizing the testing of Linux's graphics subsystem

Why testing has to be standardized?

Benefits of a standardized testing environment

Why standardize?

- Linux's UAPI needs to be backwards compatible, so better make sure it is used correctly!
- Manual testing is:
  - Hard to document/reproduce
  - Subjective
  - Unable to meet the rate of change of Linux
- Automated testing brings consistency:
  - Documents the expected behaviour
  - Enables enforcement of this behaviour
  - Provides documentation on how to use features



Source: https://xkcd.com/1172/

Test suites

Standardizing behaviour between drivers and HW generations

IGT GPU Tools - Testing the kernel UAPI

- Started as Intel GPU Tools in 2009 as a repository for i915-related tools
- Grew to become a test suite for Intel Hardware
- Expanded focus to entire DRM subsystem
  - Hardware-agnostic tests got reworked to run on other drivers
  - Hardware-specific tests got moved to their own folders (i915, amdgpu, vc4, v3d)
- Now the official test suite of new UAPI for Linux's DRM subsystem

Testing the userspace conformance

- Displays are increasingly complex:
  - Hotplugging of displays, connectors (DP MST), and GPUs (USB / thunderbolt)
  - Unreliable cables (link status handling)
  - Plenty of HW planes, but with weird limitations (alignments, memory bandwidth)
- Need a way to check that our userspace is able to use the latest features:
  - Graceful degradation in case of missing features or exceeding limits
- We need to write a HW-agnostic test suite: Let's use VKMS?

HW-assisted testing

Standardizing the hardware needed for validation

Linux Graphics drivers are tough to validate

- Devices under test need to reboot on the tested kernel which may fail to boot:
  - Power cutters can be used if the machine fails to show up
  - Grub-reboot can be used to fallback to a safe kernel then collect the logs

- Display connectors:
  - Many display standards and features, exposed through EDIDs / regs
  - Can be hotplugged, multiplexed, and cary non-graphics streams (Audio, USB, ...)
  - Mostly require external hardware for validation

Google's Chamelium - Connector validation

- Open Source/Hardware ChromeOS validation vehicle for Video, Audio, Network
- Integration in IGT by Lyude (Red Hat), extended by Paulk and Emersion (Intel)
- Now can handle most of the DP/HDMI conformance testsuite

- Problems:
  - Not cheap: ~$500 per unit (requires a beefy FPGA)
  - Outdated receivers: DP 1.2, HDMI 1.4
  - No support for panels (eDP / DSI), nor thunderbolt / type-C displays
  - Impossible to source receivers as a John Doe

Chamelium is unsuitable outside of the corporate world

Testing infrastructures

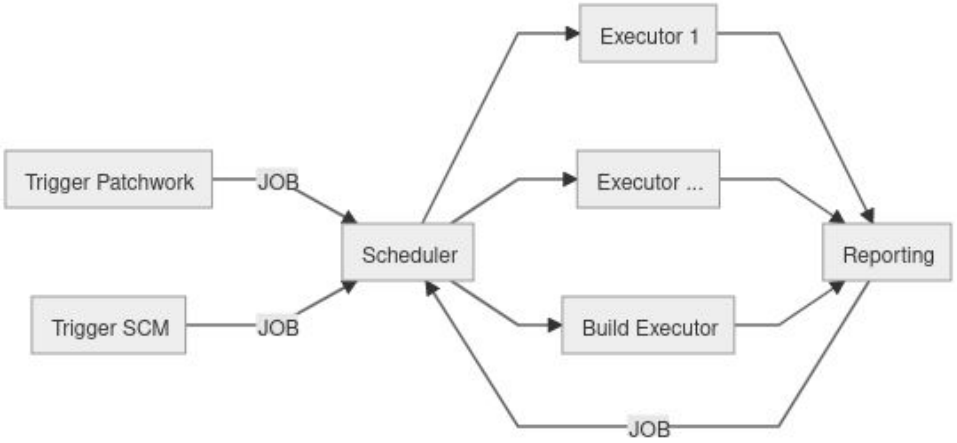
Standardizing workflows to simplify contributions

Current Linux testing infrastructures

Infrastructure	Trigger	Latency	Test Suites	Arch	Response
0-day	post-merge	Weeks	Build, boot	x86	Email
Kernel CI	post-merge	Hours	Build, boot	Mostly ARM	Email, Web UI
Linux Kernel Functional Testing	post-merge	Hours	Build, boot, selftests, non-IGT testsuites	ARM, x86	Email, Web UI
Intel GFX CI	pre/post merge	Hours	Build, boot, IGT, i915/DRM selftests, Piglit	Intel iGPU from 2004+	Email, Web UI

Automated testing is nice, but we live in a jungle of inconsistent reports!

Generic testing flow



See gfx-ci/i915-infra#39 for more information.
Will move to gfx-ci/documentation when agreed.

- Trigger: creates a job when a certain condition is met
- Job: run's metadata and results
- Scheduler: decides which job should be executed next
- Executor: executes a test suite container on a HW pool
- Reporting: Filters the results then reports back to developers. May trigger a new job in response.

Defining clear interfaces

- Well-defined interfaces promote standardization and collaboration:
  - Make it easy for sub-projects to discuss and cross-report bugs
  - Reduce the cost of development / maintenance of the testing infra

- Challenges:
  - Test suites need to all look the same from an executor PoV. Containers?
  - Test results need to be stored in common format. Piglit?
  - Known failures need to be identified and maintained through:
    - Commit IDs via automated bisecting (MesaCI style)
    - Bug via manual or automatic filter creation (CI Bug Log style)
  - Individual users need to be able to check if failures are known or not
  - Reporting needs to be somewhat consistent between projects

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https://intel-gfx-ci.01.org/

Freedesktop GFX-CI projects

- Documentation: Defining the objectives and architecture of a CI system
- CI Bug Log: Results visualization, comparisons, quality metrics, bug tracking
- EzBench: Automated bisecting of unit tests, performance, and rendering
- i915-infra: Good parts of the Intel GFX CI which are not yet split
- Tracie: Reference-frame-based rendering checks for Mesa