Intel GFX CI
Doing validation the Linux Way

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Agenda

- Linux’s unique development model
- How to prevent regressions from getting in?
- Case study: Intel GFX CI
- Conclusion
Linux and its unique development model

- The Linux kernel is massive:
  - 1000s of drivers in one tree and 10000+ configuration parameters
  - 1600+ developers, 10+% of hobbyists and 250 companies contribute each release (Intel #1)
  - ~17M lines of code across 50k files
  - 100s of integration trees and 5 stable trees
  - 63 to 70 days between releases
  - ~14k commits per release
  - 7.8 commits per hour in average in the main tree
Linux and its unique development model

- The Linux kernel has no architects, but it has rules:
  - No user-visible regression: if updating breaks a program, the change is reverted.
  - No new kernel feature without an open source userspace (especially true for DRM).

- These rules made Linux go from a niche Operating System, to the most used one:
  - Strictly-improving Software means each new contribution increases the user base

- However, in practice, regressions do come in:
  - This is why your phone is still running prehistoric kernels
  - This dilutes the development of Linux, and is equivalent to forking it
How to prevent regressions?
Why do regressions get in?

- **Upstream Linux is a validation nightmare:**
  - Single code-base, with high-level of code sharing between drivers
  - One version every 2-3 months
  - Developers typically can only test their code on one machine
  - General lack of test suites ready for automated-testing
  - Few unit tests (although there is a project for this)
  - Few kernel self tests (fewer than 1000)

- **Traditional human-powered QA falls short:**
  - Too many HW/SW configurations, use cases, and unwritten expectations
  - By the time a test cycle is done, the tree is already outdated
  - Instead, Linux relies on user-testing during -rc cycles, but few users test these
Why do we need Continuous Integration (CI)?

- Pre-merge testing allows putting the cost of integration on the person making changes:
  - less time spent on bug fixing in post merge (where reverts are hard to get accepted);
  - provides better global understanding to developers;
  - keeps the integration tree in working condition at all time;
  - it scales better with the number of developers!

- Challenges:
  - The test system needs to be fast, so as patches don’t get merged before being tested
  - The test system needs to run public tests which are ready for automated testing
  - Keeping the integration tree working is difficult:
    - back merges from Linux bring thousands of line of code without integration testing.
  - Filtering known issues to provide curated pre-merge testing reports
Providing useful pre-merge reports to developers

- Provide all the necessary information to understand failures:
  - Machine information (dmidecode, kernel logs, connected displays, …)
  - Full logs of the test execution (stdout, stderr, dmesg)
  - Push each tested version of a component as a tag in a public repo
  - Store the compiled versions of each components

- Concentrate on what the developer changed:
  - Integration testing is extremely noisy (especially when involving boot and suspend)
  - Known issues need to be labeled and/or filtered out
  - Show the list of components that changed
How to filter known issues?

- We need a tool allowing:
  - Post-merge issues’ signatures/filters to be created automatically or manually
  - Signatures/Filters need to be associated to bugs tracking them
  - Filtered pre-merge reports to use the signatures to filter out the known issues
  - Developers to prioritize fixing issues based on their impact
  - Bonus: trigger an auto-bisection using the CI idle time of machines

- Such a tool is not a utopia:
  - CI Bug Log was created with these goals in mind one year ago
  - Led to myself filing over 700 bugs last year, and reducing the pre-merge noise level
  - Open sourced a week ago: https://gitlab.freedesktop.org/gfx-ci/cibuglog
CI Bug Log: Example of a report

CI Bug Log - changes from CI_DRM_5488 -> Patchwork_12046
==================================================================
SUCCESS
No regressions found.
External URL: https://patchwork.freedesktop.org/api/1.0/series/55750/re...

Known issues
---------
Here are the changes found in Patchwork_12046 that come from known issues:

### IGT changes ###
#### Issues hit ####
* igt@gem_exec_suspend@basic-s4-devices:
  - fi-blb-e6850: PASS -> INCOMPLETE [fdo#107718]
* igt@kms_chamelium@hdmi-hpd-fast:
  - fi-kbl-7500u: PASS -> FAIL [fdo#108767]

#### Possible fixes ####
* igt@kms_chamelium@dp-edid-read:
  - fi-kbl-7500u: WARN -> PASS
* igt@kms_pipe_crc_basic@read-crc-pipe-b-frame-sequence:
  - fi-byt-clapper: FAIL [fdo#103191] / [fdo#107362] -> PASS +1

Participating hosts (44 -> 40)
-------------------------------
Missing (4): fi-kbl-soraka fi-ilk-m540 fi-byt-squawks fi-bsw-cyan

Build changes
-------------
* Linux: CI_DRM_5488 -> Patchwork_12046
  CI_DRM_5488: f13e66b9d7200f09d764a80a3b6f @ git://anongit.freedesktop.org/gfx-ci/linux
  IGT_4790: dcdf4b04e16312f8f52ad389388d834f9d74b8f0 @ git://anongit.freedesktop.org/xorg/app/intel-gpu-tools
  Patchwork_12046: 6f40b811103eee129743c6465e987be7a51e7596 @ git://anongit.freedesktop.org/gfx-ci/linux

== Linux commits ==
6f40b811103e drm/i915/execlists: Suppress redundant preemption
2ee9b7413598 drm/i915/execlists: Suppress preempting self
0cf0a44086c4 drm/i915: Rename execlists->queue_priority to preempt_priority_hint

[fdo#103191]: https://bugs.freedesktop.org/show_bug.cgi?id=103191
[fdo#107362]: https://bugs.freedesktop.org/show_bug.cgi?id=107362
[fdo#107718]: https://bugs.freedesktop.org/show_bug.cgi?id=107718
[fdo#108767]: https://bugs.freedesktop.org/show_bug.cgi?id=108767
CI Bug Log: Example of a filter

Select the tags

Ignored
Empty list
Filter

Selected
Showing all 1
Filter

Select the machines

Ignored
Showing all 1
Filter

Selected
Showing all 1
Filter

Select the tests

Ignored
Showing 2063
Filter

Selected
Showing all 1
Filter

Select the statuses

Ignored
Showing 14
Filter

Selected
Showing all 1
Filter

Slidout regex
Regular expression that needs to be matched on the test's standard output. Leave empty to ignore.

Sliderr regex
Failed assertion: timercmp(&reply.ts, &o->flip_state.last_ts, ==). Lasterno: 25, Inappropriate ioctl for device

Dmesg regex
Regular expression that needs to be matched on the kernel logs. Leave empty to ignore.

Matches 0/564 unknown failures: 0 tag(s), 0 machine(s), 0 machine tag(s), 0 test(s), and 0 status(es) - Apply filter
## CI Bug Log: Open bugs needing attention

### Overdue Bugs (40 / 642)

### Deadline Bugs (45 / 642)

<table>
<thead>
<tr>
<th>Bug ID #103486</th>
<th>Status</th>
<th>Summary</th>
<th>Component</th>
<th>Features</th>
<th>Platforms</th>
<th>Assignee</th>
<th>Priority</th>
<th>Involving (dev, user)</th>
<th>Created</th>
<th>Last Updated by user</th>
<th>Last Updated by dev</th>
<th>SLA (days)</th>
<th>SLA deadline</th>
</tr>
</thead>
<tbody>
<tr>
<td>id #103486</td>
<td>ASSIGNED</td>
<td>Loading 615 kernel module breaks NVMe PCI device on the new Coffee Lake box</td>
<td>DRM/Intel</td>
<td>No features selected</td>
<td>CFL</td>
<td>intel GFX Bugs mailing list <a href="mailto:integfx-bugs@lists.freedesktop.org">integfx-bugs@lists.freedesktop.org</a></td>
<td>medium</td>
<td>1. Takashi Itoh <a href="mailto:takashi@soke.de">takashi@soke.de</a> (17) 2. Rodrigo Visi <a href="mailto:rodrigo.visi@gmail.com">rodrigo.visi@gmail.com</a> (6) 3. Lakhmi <a href="mailto:lakhminarayana.yudum@intel.com">lakhminarayana.yudum@intel.com</a> (2) 4. Jari Nikula <a href="mailto:jari.nikula@intel.com">jari.nikula@intel.com</a> (1) 5. Ville Syrjala <a href="mailto:ville.syrjala@linux.intel.com">ville.syrjala@linux.intel.com</a> (1)</td>
<td>Oct. 25, 2018, 6:44 a.m.</td>
<td>66 days, 2:22:08 ago</td>
<td>59 days, 16:11:53 ago</td>
<td>60</td>
<td>7:48:07</td>
</tr>
<tr>
<td>id #103107</td>
<td>REOPENED</td>
<td>[C] [kms_frontbuffer_tracking] - fail - CRC mismatch</td>
<td>DRM/Intel</td>
<td>display/Other</td>
<td>BXT CFL CNL GLK HSW ICL KBI SKL SNB</td>
<td>Maarten Lankhorst <a href="mailto:bugs@redblankhorst.nl">bugs@redblankhorst.nl</a></td>
<td>high</td>
<td>1. Marta Lofstedt <a href="mailto:marta.lofstedt@intel.com">marta.lofstedt@intel.com</a> (41) 2. Maarten Lankhorst <a href="mailto:bugs@redblankhorst.nl">bugs@redblankhorst.nl</a> (9) 3. Hector Velazquez <a href="mailto:hctor.velazquez.cliente@intel.com">hctor.velazquez.cliente@intel.com</a> (3) 4. Jari Saarinen <a href="mailto:jari.saarinen@intel.com">jari.saarinen@intel.com</a> (3) 5. Martin Peres <a href="mailto:martin.peres@free.fr">martin.peres@free.fr</a> (2) 6. Francesco Balestrieri <a href="mailto:francesco.balestrieri@intel.com">francesco.balestrieri@intel.com</a> (1)</td>
<td>Oct. 9, 2017, 12:47 p.m.</td>
<td>never</td>
<td>6 days, 22:17:39 ago</td>
<td>7</td>
<td>1:52:21</td>
</tr>
<tr>
<td>id #103494</td>
<td>NEEDINFO</td>
<td>Inescapable system freeze on initial X startup drm/i915</td>
<td>DRM/Intel</td>
<td>GPU hang</td>
<td>BSW/CHT</td>
<td>intel GFX Bugs mailing list <a href="mailto:integfx-bugs@lists.freedesktop.org">integfx-bugs@lists.freedesktop.org</a></td>
<td>medium</td>
<td>1. <a href="mailto:ayn.swick@gmail.com">ayn.swick@gmail.com</a> (10) 2. Jari Saarinen <a href="mailto:jari.saarinen@intel.com">jari.saarinen@intel.com</a> (4) 3. <a href="mailto:omega@online.de">omega@online.de</a> (3) 4. Lakhmi <a href="mailto:lakhminarayana.yudum@intel.com">lakhminarayana.yudum@intel.com</a> (3) 5. Mika Kuopala <a href="mailto:mika.kuopala@intel.com">mika.kuopala@intel.com</a> (2) 6. Chris Wilson <a href="mailto:chris@chris-wilson.co.uk">chris@chris-wilson.co.uk</a> (1) 7. Ville Syrjala <a href="mailto:ville.syrjala@linux.intel.com">ville.syrjala@linux.intel.com</a> (1) 8. Francesco Balestrieri <a href="mailto:francesco.balestrieri@intel.com">francesco.balestrieri@intel.com</a> (1)</td>
<td>Oct. 28, 2017, 3:30 a.m.</td>
<td>87 days, 21:43:32 ago</td>
<td>59 days, 7:08:10 ago</td>
<td>60</td>
<td>16:51:50</td>
</tr>
</tbody>
</table>
Intel GFX CI
## What are the available test systems for Linux?

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Available hardware</th>
<th>Results latency</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-day</td>
<td>Mostly build testing, Intel proprietary</td>
<td>Intel servers</td>
<td>Days to weeks</td>
</tr>
<tr>
<td>Kernel-CI</td>
<td>Post-merge distributed build and boot testing. Reports mostly through emails.</td>
<td>Any HW you might want to plug to</td>
<td>Minutes to hours</td>
</tr>
<tr>
<td>Snowpatch</td>
<td>Open source tools for running tests using Jenkins in response to emails.</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Intel GFX CI</td>
<td>Build and boots, then run IGT (including a lot of suspend testing) and piglit.</td>
<td>130 machines (all Intel gens starting from 2004)</td>
<td>30 minutes for BAT 6 hours for full results</td>
</tr>
</tbody>
</table>
Objectives of Intel-GFX-CI

- Provide an accurate view of the state of the HW/SW (all supported combinations).

- Results should be:
  - transparent: Should contain the full HW and SW configuration;
  - fast: Basic results in under 30 minutes, complete ones in half a day;
  - visible: make the results public and hard to miss (reply in ML);
  - stable: noise level should be zero (be aggressive at blacklisting unstable tests);
Intel GFX CI - https://intel-gfx-ci.01.org

**Current state**: provide timely, public, stable and transparent results for:

- **Trees**:
  - pre-merge: DRM-tip, IGT
  - post-merge: DRM-tip, Linus' tree, Linux-next, *-fixes, Dave Airlie's branch
- **Machines (total of 130 systems / 22 different platforms (Gen 3 to upcoming Gens))**:
  - GDG (Gen3, 2004) -> ICL (not released yet)
  - sharded machines: 6 SNB, 7 HSW, 10 SKL, 7 KBL, 8 APL, 9 GLK, 4 ICL
  - GVT-d BDW and SKL (Virtualization)
- **Displays interfaces**: HDMI, DVI, DP, eDP, DP-MST, DSI, TB, LVDS
- **Test suites**:
  - IGT:
    - BAT: fast-feedback: ~290 tests, ran on all machines
    - Full: KMS + some GEM tests: ~2700 tests, ran on sharded machines
  - Piglit: Run on 5 different systems during the Full test cycle
- **Throughput**
  - from 22k tests/day (Aug 2016) to ~3M tests/day (now)
  - bug filing: usually under half a day during working hours (700+ in 2018)
Intel-GFX CI: Let’s collaborate!

- **Infrastructure:**
  - New community started at XDC:
    - Aims at creating an open source CI toolbox, with well defined interfaces
    - Targets having distributing testing with multiple HW-specific farms like kernel-ci
    - URL: [https://gitlab.freedesktop.org/gfx-ci/documentation](https://gitlab.freedesktop.org/gfx-ci/documentation)
  - i915 infra: [https://gitlab.freedesktop.org/gfx-ci/i915-infra](https://gitlab.freedesktop.org/gfx-ci/i915-infra)

- **IGT:**
  - Write new / improve the driver-agnostic tests
  - Write driver-specific tests for your device

- **Hardware:**
  - Create/modify testing-oriented hardware
  - Example: Google’s chamelium which allows testing hot-plugging
Conclusion
Conclusion

CI makes upstream development easier, faster, and less buggy!
Questions / discussion
Contacts

Tomi Sarvela
  ● Infrastructure and most of the automation software

Arkadiusz Hiler
  ● IGT and FDO’s Patchwork maintainer, back up for Tomi

Martin Peres
  ● Ezbench and CI bug log maintainer, Bug filing

Lakshmi Vudum
  ● Bug filer, main bug scrubber

Petri Latvala
  ● IGT maintainer, Ezbench