Continuous Integration of FPGA firmware and software

A CASE STUDY
# LHCb Run3 Upgrade

## Test beams:
- May 9th - May 22nd
- June 27th - July 18th
- Oct 10th - Oct 23th

## LHCb Commissioning
- LHC RUN2: From March
- LHC LS2: From March
- LHC RUN3: From March

## Subdetectors

<table>
<thead>
<tr>
<th>Year</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCIe40</td>
<td>20v1+1</td>
<td>+24</td>
<td>+50</td>
<td>+280</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Commissioning racks:</th>
<th>Datacenter: I/O modules</th>
<th>TFC+ECS for commissioning:</th>
<th>Eventbuilder commissioning:</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 SX + 1 UX</td>
<td>From April</td>
<td>From August</td>
<td></td>
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</tbody>
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<table>
<thead>
<tr>
<th>Vertical slice:</th>
<th>UX fibers:</th>
<th>“dense” DAQ for commissioning:</th>
<th>HLT farm commissioning:</th>
</tr>
</thead>
<tbody>
<tr>
<td>From October</td>
<td>From July</td>
<td>From September</td>
<td></td>
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</tbody>
</table>
Firmware example (TELL40)
Firmware combinatorics
Software integration

DAQ40 → AMC40 → CCPC40

No deps → ECS (WinCC OA)

GGC7 → RPM/DKMS

PCIe40 → PCIe40v1 → PCIe40v2.x

Program FPGA → Subscribe → Reload → Read information → Configure

Check RxReady → Check RxCounters

TAP report → Stop Run → Check Triggers → Start Run → Check PRBS
Execution model

CERN GitLab-runner cluster (kubernetes)

Docker runners

Quartus bare metal runners

CERN OpenStack (VMs)

Quartus native runners

KeepAlive

LAPP - Annecy

Questa bare metal runner

GitLab CI scheduler

scripts

artifacts
Pipeline layout

**Firmware pipeline (30m ~ 20h)**

- **Prepare**
  - clean_mr
  - mentor:amc40/...
  - mentor:amc40/...
  - quartus:amc40/...

- **Simulate**
  - mentor:amc40/...
  - quartus:amc40/...

- **Compile**
  - quartus:amc40/...
  - quartus:amc40/...
  - quartus:amc40/...

- **Package**
  - document
  - rpm_amc40_nig...

- **Publish**
  - publish_docs
  - publish_unstable

- **Tag**
  - create_tag

**Software pipeline (~10m)**

- **Build**
  - make-cc7-dim
  - make-cc7-disa...
  - make-cc7-mon

- **Package**
  - dkms-cc7
  - dkms-sl6
  - rpm-cc7-daq40

- **Install**
  - install-cc7
  - install-sl6
  - install-daq40

- **Publish**
  - publish-unstable
Pipeline history

Firmware pipelines [success vs. total]

Software pipelines [success vs. total]
Issues and lessons (1/2)

- GitLab assumes short jobs and many runners available
  - Implement CI queue monitor on top of GitLab APIs

- EDA licensing limitations
  - Schedule runners according to license capacity

- Firmware partitioning
  - Use submodules (or subtrees) with custom tooling to manage them

- Reproducibility
  - Review flow scripts for race conditions

- Compilation times
  - Cache artifacts and write tooling to examine change history
Issues and lessons (2/2)

- Traceability
  - Custom tools for firmware identification, firmware database

- WinCC OA integration
  - Custom scripts to initialize new projects and drive JCOP installer

- Reliance on 3rd party infrastructure
  - Anticipate failures

- The “Ops” part of DevOps
  - Team requires operations skills in addition to development skills

- Adoption
  - Clear documentation, clear benefit proposition
GitLab@CERN Day

https://indico.cern.ch/event/749059/

**GitLab@CERN Day**

- **Wednesday 3 Oct 2018, 10:00 → 15:30** Europe/Zurich
- **31-3-004 - IT Amphitheatre (CERN)**

**10:30 → 12:10** Morning session

- **10:30**
  - CERN opening talk
    - Welcome talk, introductions
    - **Speaker:** Alexandre Lossent (CERN)

- **10:45**
  - CERN presentation of GitLab deployment at CERN
    - History of the GitLab project at CERN
    - Some numbers about CERN’s GitLab Instance
    - How CERN deploys and operates GitLab
    - High-level use cases
    - **Speaker:** Alexandre Lossent (CERN)
"I spend a lot of time on this task. I should write a program automating it!"

**THEORY:**

- Work on original task
- Automation takes over
- Writing code
- Free time

**REALITY:**

- Writing code
- Debugging
- Ongoing development
- Rethinking
- No time for original task anymore

Thank you for your attention