Engineering workflow for Cryo at TE-CRG-IC

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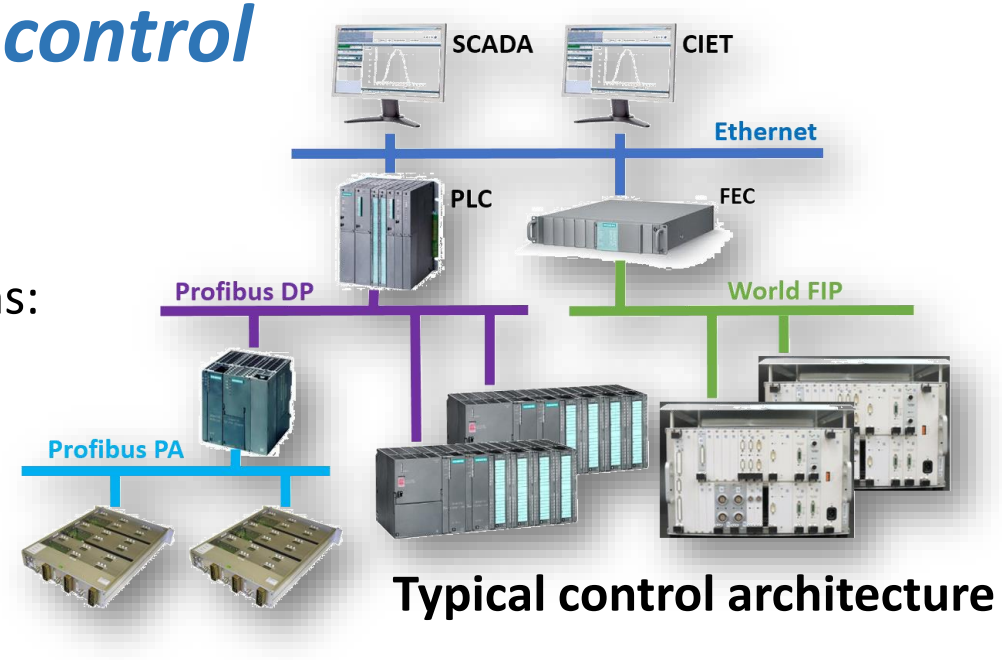
on behalf of the TE-CRG-IC
section control team

Introduction to CRYO control

Scope of activities:

The TE-CRG-IC controls team is responsible for the PLC software maintenance & development for the following cryogenic installations:

- LHC tunnel [18 app. / ~110'000 objects],
- Atlas & CMS LHC detectors [14 app. / ~25'000 objects],
- non-LHC experiments & test facilities [69 app. / ~90'000 objects]



Typical control architecture

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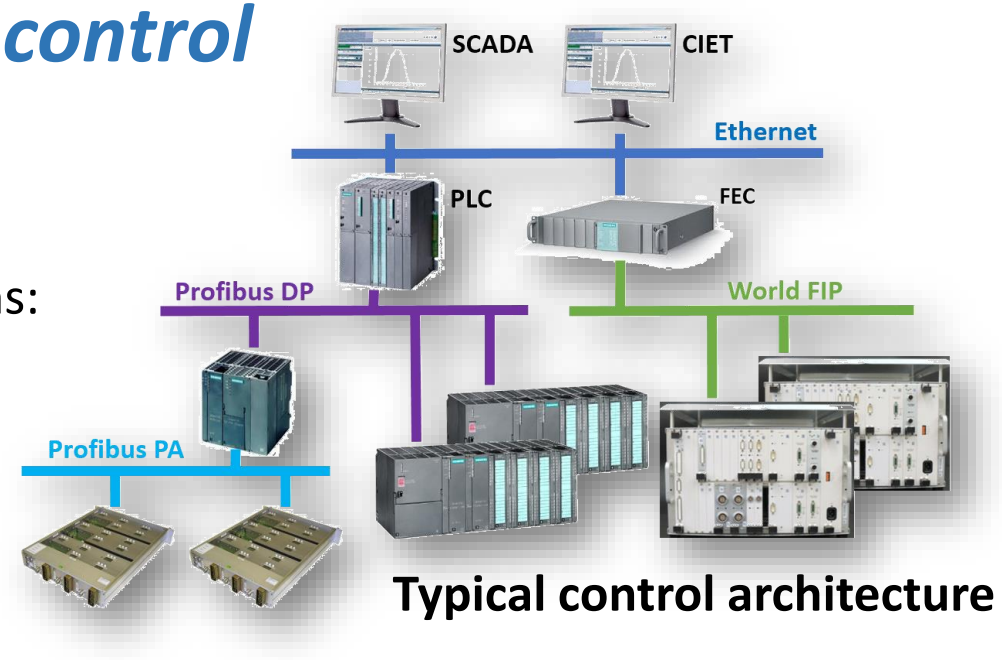

Typical control architecture

Technology overview:

- All software change requests are tracked in JIRA projects (classified by cryo domains).
- All applications are built on the basis of the UNICOS CPC framework and continuous integration practices. Application with hardware exposed to radiation environment uses the FESA framework, with support provided by BE/ICS.
- In total 100 PLC applications implemented in one of the following technologies: Schneider M580, Siemens S7-400/300 and S7-1500 (TIA Portal).
- The support for SCADA/CIET Data Servers is provided by BE/ICS.

Sources of engineering request

- **New project:** typical for non-LHC experiments & test facilities domains.
- **Software correction / hardware failure:** typically urgent/critical modification **implemented on-the-fly**, requested by operation or control-instrumentation support teams.
- **Control process improvements:** an improvement in the process requested by cryo engineers in charge of installations, supported by an engineering change request (ECR) or new process logic specification.
- **Control frameworks upgrade:** executed once per few years (like for UNICOS), to ensure homogeneity between cryogenic installations as well as support and maintainability of their control systems.
- **Control hardware upgrade:** planned hardware replacement due to reached end-of-life or reliability issues.

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Non urgent/critical engineering requests are usually combined together
and scheduled as a package to be deployed during installation technical stop / shutdown.

When we can update our control systems ?

Classification by operation cycles:

1. **In nominal RUN since their start-up**: critical installations like NA62 Krypton or ATLAS Argon calorimeters

- small modification can be implemented after an agreement with client, when there is no physics run
- PLCs reload once per ~12 years, with justification, complex preparatory work and compensatory measures

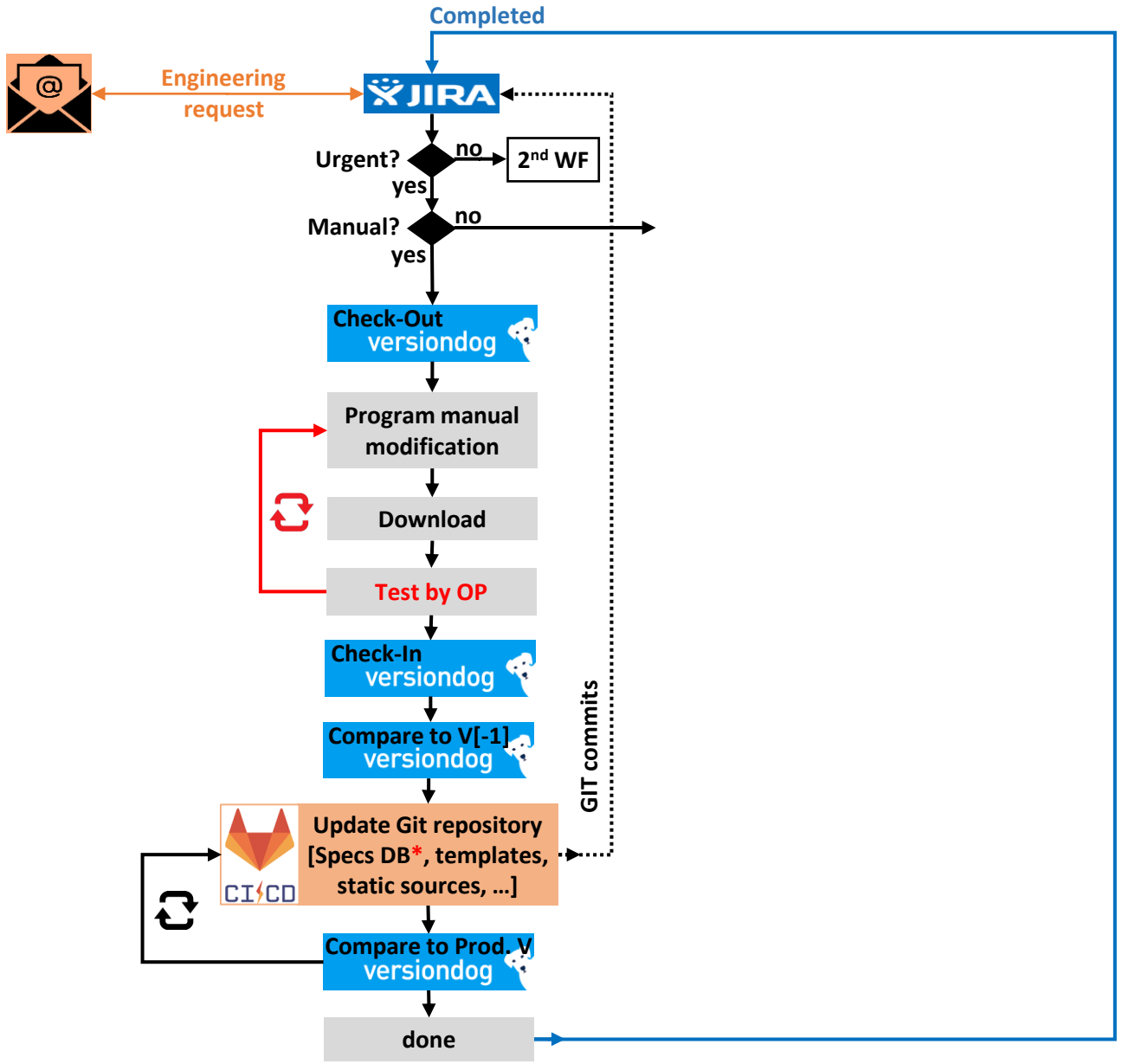
2. **Following LHC schedule**: LHC Tunnel or LHC Detectors

- small modification usually are implemented during YETS (TS if more urgent);
- PLCs reload done during LS1 & LS2

3. **Following an individual schedule:** non-LHC experiments & test facilities (SM18, Cryolab, NA, ISOLDE, …)

- many small modifications are implemented everyday (frequent evolution)
- PLCs reload done during installations shutdowns.

Workflow for urgent/small modifications implemented “on-the-fly”



The workflow is common for all cryogenic domains (LHC & non LHC) and PLC software type (Schneider Control Expert, Siemens Step-7 and Siemens TIA Portal).

The urgent/small modification don’t require a PLC STOP and new UNICOS objects.

The PLCs source code modifications, build and downloads are done using 10 dedicated virtual machines (in TN) and 20 GIT runners (in GPN), both type configured on the CERN Open Stack.

The SCADA objects and process synoptic modifications are done simultaneously with PLC download.

*The LHC tunnel Specs DB modification are done directly in the Tunnel UNICOS Control DB (attached to the LHC Layout DB).

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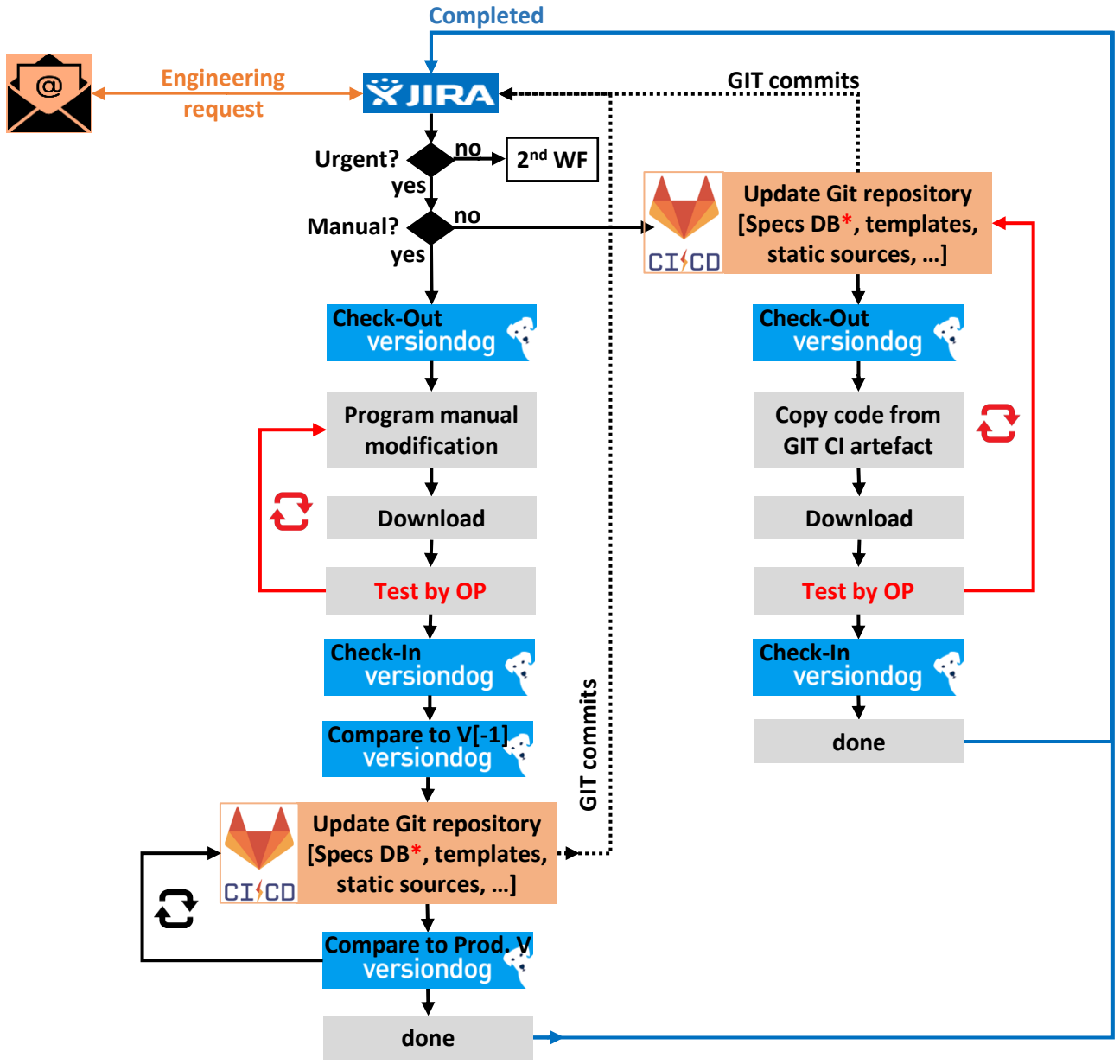

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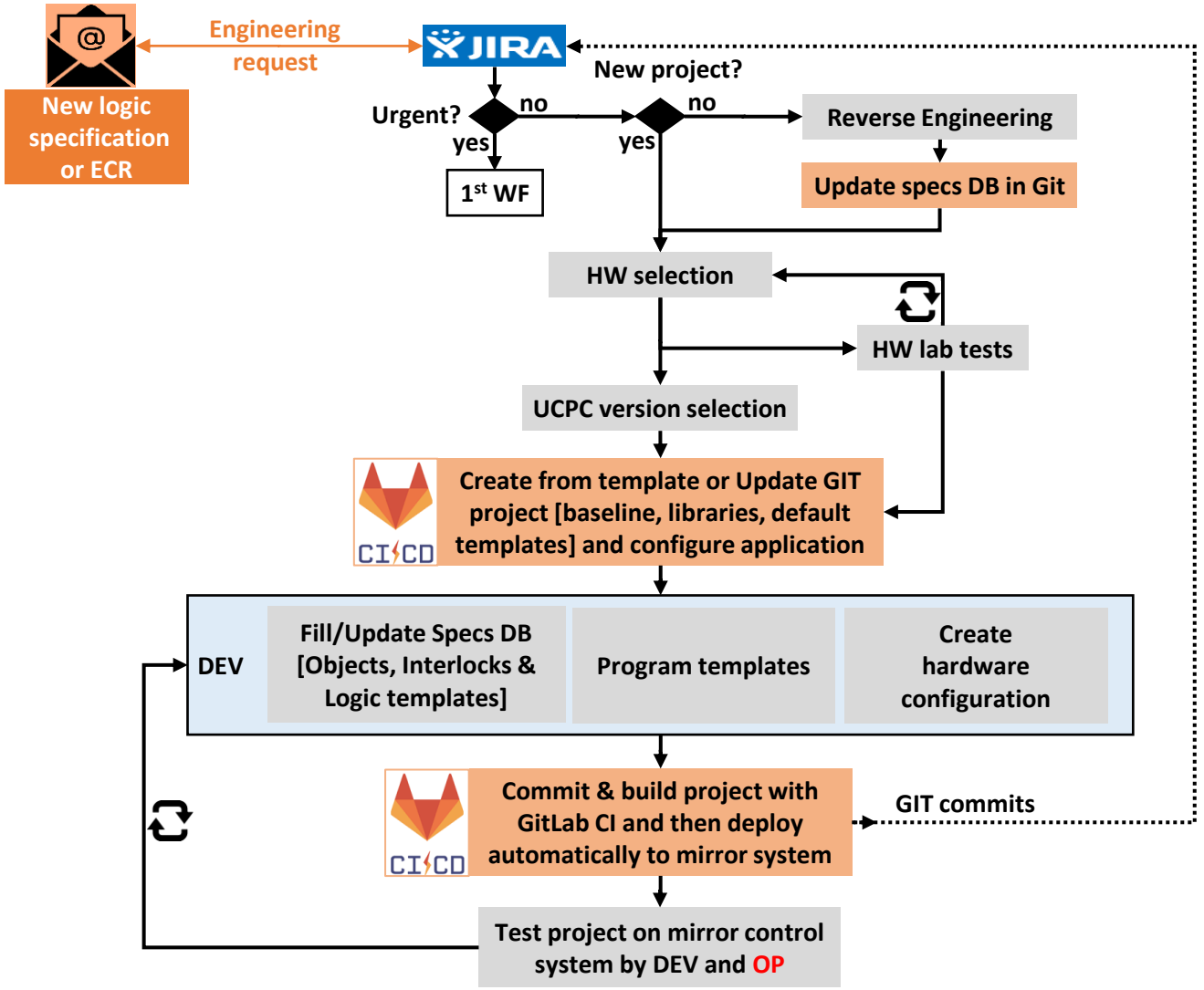

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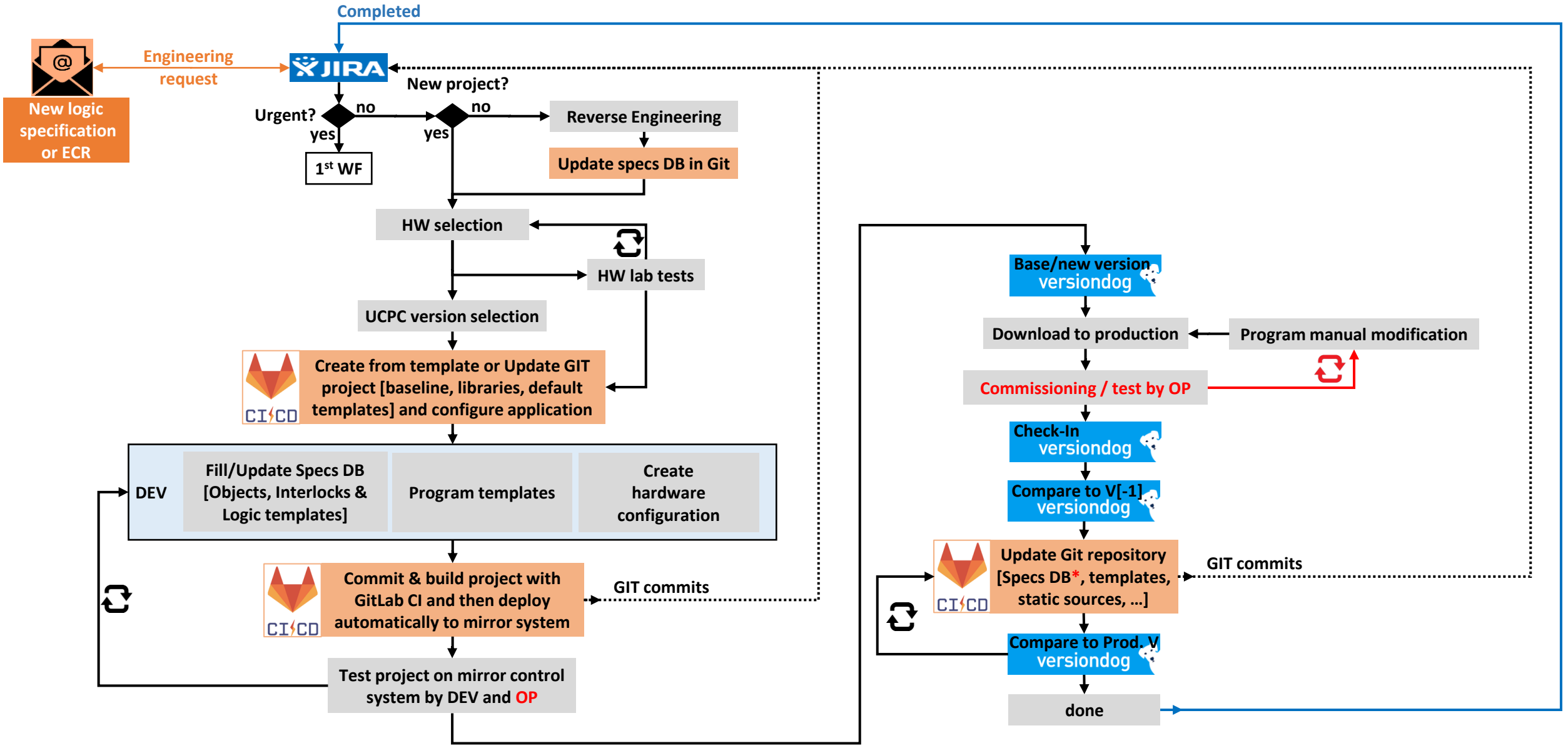

Conclusion

Presented workflows allow us to successfully maintain operational more than 100 PLC applications in unified way, independently from installation type and technology used.

Our workflows combined with an automatic software production allows us significantly reduce the time needed for development and testing as well as improve software quality. (For instance, the time need to review/update of ISOLDE control system was reduced from six months to three weeks.)

The workflows will be used for engineering of the HL-LHC tunnel control system.