Continuous Delivery for a Real-Time Robotic Test Facility: Modernization of Facility Monitoring and Control System of the European Proximity Operations Simulator*

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Extended abstract

European Proximity Operations Simulator (EPOS) is a robotic testbed integrating two industrial robots. It is used daily for Rendezvous-Guidance, Navigation and Control software tests [6, 8], biweekly for satellite operator training [1] and by external customers [7]. The Operation System (OS) for the Facility Monitoring and Control (FMC) system was no longer supported after more than 10 years of operations. To realize the modernization without longer downtimes and increase future flexibility, a Continuous Delivery (CD) system was desired.

Classical CD combine version control with multi-level, automated testing for software deployment in short cycles [5]. Containerization is used jointly to CD because hardware and software maintenance can then be decoupled. Virtualization allows to keep the server host up to date against security issues. At the same time, it makes possible continuous operations of applications developed for no longer deliverable hardware or OS. Because the FMC software has to control the EPOS hardware with 250Hz in Real-Time (RT) [2], the typically solution using a host agnostic container technology was not a viable option.

Fig. 1 illustrates the concept of Infrastructure as code (IaC) applied at EPOS. Widespread opensource tools (gitlab, vagrant, puppet, docker, cmake) were selected because they can be applied to additional machines without huge licensing costs. All the configurations and setup scripts for the hardware and software components are version controlled. So, setups are reproducible and the only difference between the development and the productive environment are the real-time conditions. The automated setup allows to configure redundant hardware within hours once shipped at EPOS. Doing so, it is allways possible to keep an operational set and test the newest changes using a second set.

Iteratively, the FMC software was migrated to the new host OS and - where necessary - reimplemented inside a virtualized environment. At this stage, we also added unit tests [4] to accelerate the error search [3]. Only the last system test is executed inside the facility with RT hardware.

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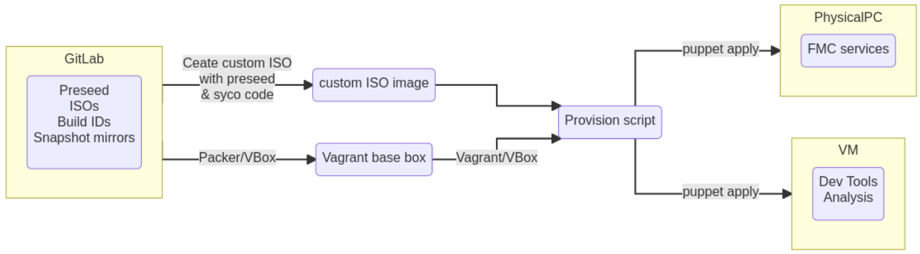

Fig. 1. The Continuous Delivery framework in use at EPOS.

We applied the principles of IaC and CD to modernize an outdated OS, continued to support the regular operations at EPOS with challenging specifications and this without exploding the budget.

Before modernization, maintenance required planning months in advance, and system changes were irreversible. Now spare components are integrated within hours into the new FMC, and it is safely possible to switch between working releases and newest updates.

References

1. Benninghoff, H., Rems, F., Risse, E.A., Irmisch, P., Ernst, I., Brunner, B., Stelzer, M., Lampariello, R., Krenn, R., Reiner, M., Stangl, C., Faller, R., Peinado, O.L.: Ricados - rendezvous, inspection, capturing and detumbling by orbital servicing. In: 7th International Conference on Astrodynamics Tools and Techniques (2018), https://elib.dlr.de/123990/
2. Benninghoff, H., Rems, F., Risse, E.A., Mietner, C.: European proximity operations simulator 2.0 (EPOS) - a robotic-based rendezvous and docking simulator. Journal of large-scale research facilities JLSRF **3** (2017). https://doi.org/10.17815/jlsrf-3-155
3. Gray, J.: Tandem tr 85.7 why do computers stop and what can be done about it? (1985), https://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.110.9127
4. Hamill, P.: Unit test frameworks. O'Reilly, Sebastopol, California, 1st ed. edn. (2005)
5. Humble, J.: Continuous delivery : [reliable software releases through build, test and deployment automation]. The Addison-Wesley signature series, Addison-Wesley, Upper Saddle River, NJ, 3th printing edn. (2011)
6. Klionovska, K., Burri, M., Frei, H.: Robust feature extraction pose estimation during fly-around and straight-line approach in close range. In: 16th Symposium on Advanced Space Technologies in Robotics and Automation (ASTRA 2022) (2022), https://elib.dlr.de/187326/
7. Rems, F., Frei, H., Risse, E.A., Burri, M.: 10-year anniversary of the european proximity operations simulator 2.0—looking back at test campaigns, rendezvous research and facility improvements. Aerospace **8**(9) (2021). https://doi.org/10.3390/aerospace8090235
8. Risse, E., Schwenk, K., Benninghoff, H., Rems, F.: Guidance, navigation and control for autonomous close-range-rendezvous. Deutscher Luft- und Raumfahrtkongress 2020 (2020)