EXECUTIVE SUMMARY

As a large international in-kind collaboration, the ITER project promotes standardization of the control infrastructure to ensure a manageable integration of all subsystems.

Together with ITER’s Control System Division (CSD), Cosylab played a valuable role in building the right tools, and providing expert training and support to achieve the high level of harmonization and standardization of the system’s interfaces that ITER is aiming for.

ITER AND THE INTEGRATION CHALLENGE

ITER is an experimental power reactor based on nuclear fusion, the process that powers the Sun, a potential source of abundant safe and clean energy.

With a building cost of over US$14 billion, the ITER project ranks among the world’s largest scientific projects.

The ITER fusion reactor is a large and complex project due to the multitude of large composing parts called plant systems. Seven ITER domestic agencies are tasked with building them as in-kind contributions: they must be delivered as completed systems including their own Instrumentation and Control (I&C).

KEY CHALLENGE

How to integrate the many subsystems into the central control system?

“Standardization is a key factor when attempting to integrate a control system with pieces provided by hundreds of different suppliers. Together with selected hardware components the CODAC Core System is the implementation of this standardization”

Anders Wallander, Head of Control System Division at ITER Organization
THE CODAC CORE SYSTEM: ITER’S CONTROL SYSTEM STANDARD

ITER’s Control System Division (CSD) is in charge of realizing the control system of the ITER machine, named ITER CODAC (Control, Data Access and Communication).

To improve the homogeneity of the plant system’s I&Cs, that will become a part of CODAC, the CSD promotes standardization for the development and testing of those plant system I&Cs.

CSD has prepared a set of rules for the development of plant system I&Cs - the Plant Control Design Handbook (PCDH), which must be followed by all ITER contributors.

CSD also has developed a platform called the CODAC Core System, which is a software distribution with all the necessary tools that enable developers to make the plant system I&Cs PCDH compliant.

Using the platform, ITER contributors are encouraged to use standardized solutions, thus reducing risks during system integration.

For the execution, ITER CSD wanted to have the world’s best experts to collaborate with them.

They contracted Cosylab to deliver these services:

- Develop and build the CODAC Core System including all of its tools, such as EPICS
- Set up a well documented, standardized development environment and packaging system. Its purpose is to mass deliver a software distribution that serves as both a runtime and development environment for 3rd party I&C systems
- Provide high-level training to I&C engineers around the world to use the CODAC Core System, giving them a sufficient level of expertise to develop plant system I&Cs for ITER.
- Provide direct technical support to the CODAC Core System users around the world, ensuring that they will be able to use its tools with ease and following the PCDH standards and guidelines.

The Cosylab company and culture is built around this very concept of delivering such industry-grade services around a core of open source Big Science community software.

CODAC ESSENTIALS

The underlying basis upon which CODAC is built, is the EPICS middleware, widely used in Big Physics particle accelerators and telescopes.

Cosylab got involved in the development of CODAC and the CODAC Core System because it had project references with years of experience with EPICS-based development services and system integration for large projects [2].

“From the very beginning, we have been building an exhaustive suite of tools for enforcing our selected standards. This includes all software layers, from the Linux kernel modules supporting the selected I/O boards up to the tools for building and running operator displays following ITER “style guides”. All these have been built using the EPICS framework and EPICS tools, and completed with some ITER-specific configuration tools. For real-time control, high performance networks are used for precise time stamping (PTP) and for deterministic data exchange over Ethernet. Cosylab expertise in all these domains has been very valuable, from the early phases, starting from the development of new components, their integration into a consistent software distribution, up to quality control before releasing a new version to our world-wide distributed user community.”

Franck Di Maio, CODAC Core System Responsible Officer at ITER

CODAC CORE SYSTEM DISTRIBUTION

At Cosylab, we are aware of the multi-faceted nature of a software distribution infrastructure like the CODAC Core System (CCS). It is both a runtime and a development environment. It cannot be monolithic if it needs to allow contributions from the EPICS community, ITER domestic agencies or others to be easily incorporated. It must be granular and dynamic, yet well-managed. This is essential to achieve uniformity across the various development sites and be developer-friendly.

The solution Cosylab built is rich in modern software automation technology

- Best-in-class RedHat RPM package manager (YUM) to manage the installation complexity
- Build automation with Apache Maven to manage the many dependencies
- Continuous integration with Jenkins to orchestrate the development process
- Support for installation, uninstallation, updates and upgrades, even allowing different versions to coexist simultaneously
- Resolution of dependencies (adaptation of configuration files, creation of database schemas, population of databases, etc.)
The table with system stats on the right illustrates the size and complexity of the 2018 version 6.0 of the CODAC Core System distribution that has been built and maintained by Cosylab for the ITER CSD.

Anders Wallander, Head of Control System Division at ITER Organization says: “To be successful with the standardization the logistics, such as packaging, distribution, training and support, is essential. Cosylab has been a major contributor in implementing this logistics successfully.”

CODAC CORE SYSTEM SUPPORT TEAM

The CODAC Core System is currently being used intensively in the development of plant system I&Cs. It is a toolkit that is both high-level and I&C oriented. It is used for developments to be specifically ITER PCDH compliant. Using such a toolkit requires extensive technical support. The CODAC group engaged Cosylab to set up and provide this kind of user support, using email as a standard communication channel.

There are currently 64 following organizations registered as CODAC Core System users worldwide. Cosylab has been providing CODAC Core System support directly to all of them. The Cosylab team has been exclusively handling CODAC Core System support directly and continuously since May 2011. CODAC Core System support covers all topics and tools related to ITER plant system I&C development.

Franck Di Maio, CODAC Core System Responsible Officer at ITER, says: “For making sure that our software distribution is well adopted and properly used, we provide the ITER domestic agencies and all ITER suppliers with a wide range of support services.

The main entry point for support is an email address that is handled by a Cosylab team for addressing the user requests and triggering actions whenever required. A good support with a fast response time and appropriate answers is strategic to making sure that the project’s suppliers can follow the recommended path with evidences of efficiency. This has been very successful.

Various forms of training are also offered with trainers from the Cosylab support team: regular on-site hands-on workshops, ad-hoc sessions at ITER Domestic Agencies (more than 20 sessions in total) and on-line training videos. All these have been very efficient for maintaining a low learning curve and having the ITER suite usable by I&C developers of all backgrounds from around the world.”
CODAC TRAINING PROGRAM

Getting up to speed fast with a development platform such as the CODAC Core System is crucial for the plant system I&C development. It allows the Domestic Agencies and their local industrial suppliers to focus on the big picture of their plant system realization and not get bogged down with technical infrastructure issues.

Drawing on their EPICS training experience, Cosylab developed a tailored and highly effective training program to achieve CODAC fluency across and between the development partners.

RESULTS

The CODAC core system guarantees that central control and the plant systems can communicate

Ensuring a consistent way of managing the plant systems is paramount for a successful operation of ITER and therefore the Plant System Handbook and the CODAC Core System software suite have been put in place.

Since 2008, Cosylab has been ITER’s trusted partner for substantial and continued delivery of software services related to the CODAC Core System. As such, Cosylab contributes to achieving the aims of the CODAC Core System, which is standardization and harmonization of systems and interfaces in the ITER control system.

Specific feedback that is given is that users of CODAC have received un-interrupted and consistent high-level support through Cosylab’s team, that they are satisfied and can focus on their productivity and that the plant system I&Cs are better prepared for a faster integration, with risks of re-work being reduced.

THE ROAD AHEAD

Cosylab’s contributions to the ITER project go beyond the CODAC Core system. Next to the development activities, the ITER project also prepares operational aspects of the control system, for when the ITER machine will be generating plasma pulses. Cosylab experts are assigned consultancy work on technical analysis, design of configuration applications, the real-time framework and other software tools in this area.

CONTACT US

We’re here to answer your questions.

For more information on building the right control system infrastructure for your integration project, send an email to tech_questions@cosylab.com

www.cosylab.com

Founded in 2001, Cosylab provides and integrates state-of-the-art software and electronics for the world’s most complex, precise and advanced systems, to enable research organizations to discover scientific breakthroughs, hospitals to deliver better cancer treatment and organizations to improve their performance. The company employs engineers and physicists that understand the physical operational principles of highly complex devices and master the software and hardware engineering of large-scale distributed control systems at the same time. Headquartered in Slovenia, Cosylab has a strong international presence and has worked on hundreds of multi-year and multi-people projects all over the world.

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