Industrial Control at CERN

Enrique Blanco

Industrial Controls and Safety Systems Group

Beams Department, CERN
CERN
(Conseil Européen pour la Recherche Nucléaire, 1954)

Yearly Budget
~1100 MCHF (~ 1000 MEUR)

Experiments financed externally.

22 Member states
Austria, Belgium, Bulgaria, Check Republic, Denmark, Finland, France, Germany, Greece, Italia, Hungary, Holland, Israel, Norway, Poland, Portugal, Romania, Slovakia, Spain, Sweden, Switzerland, UK.

Personnel

<table>
<thead>
<tr>
<th>Staff</th>
<th>Fellows &amp; Ass, Students</th>
<th>Users</th>
<th>External companies</th>
</tr>
</thead>
<tbody>
<tr>
<td>2500</td>
<td></td>
<td>1800</td>
<td>13000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2000</td>
</tr>
</tbody>
</table>

5 Observers states
EC, USA, Russian Federation, Japan, UNESCO

3 Candidate states
Serbia, Cyprus and Slovenia (pre-stage of membership)

3 Associate states
Turkey, Pakistan, Ukraine and India
CERN instruments

Accelerators
Detectors

ALICE

LHC
27km length
100m underground
> 1600 Superconducting
magnets (1.8 x 10^9 km of
superconducting filaments
Ultrahigh vacuum: 10^-13 atm
10x moon vacuum
Coldest place in Universe:
-271°C

ATLAS Detector
7000 tonnes, ~100 million
read-out channels, 3000
km of cables
Contains 11 sub-detectors
of different technologies in
layer structure
Built and operated by
collaboration of >3000
physicists
Industrial Control challenges

One of the CERN goals: maximize uptime of the instruments (accelerators, detectors,…) in order to optimize physics data availability.

This objective implies the maximum availability and optimal operation of all the auxiliary/utilities systems (e.g. cryogenics, cooling, HVAC, gas, motion, interlocks,…) -> the correspondent control systems must ensure this.

What is uncommon at the CERN accelerators control systems?

- Environment (radiation areas)
- Large systems (highly distributed and/or interconnected)
- Complexity (control logic)
- Precision (measurements)
- Performance (regulation)
- Data (number and frequency)
BE-ICS (Industrial Control & Safety Systems)

A central group for industrial controls serving the whole CERN community
- Development of frameworks
- Development of control systems
- Support basic technologies
BE-CO (Accelerator Control)

The Controls Group is responsible for the specification, design, procurement, integration, installation, commissioning and operation of the controls infrastructure for all CERN Accelerators, their transfer lines and the Experimental Areas. Support is also provided to the technical infrastructure services that rely on standard controls facilities provided by the group.
Industrial Control Systems at CERN
Industrial Controls Architecture

Frameworks:
- UNICOS
- JCOP
- FESA (BE-CO)

TN or EN (Technical network)

- EWS: Operator Workstation
- OWS: Engineering Workstation
- FEC: Front-End Computer: IPC

- Fieldbus: e.g. Profinet
- Fieldbus: i.e. WFip
- Fieldbus: i.e. CAN
- CAN
- WFip

- PLCs
- IO & devices
- Local panels
- SCADA Servers
- OWS

- DCS
- OPC Servers
- CAEN/Wiener/ISEG
- ELMB

- 600 SCADA Applications
- 400 Industrial PCs
- 10 RAC Oracle Servers
- 200 TB stored per year

- 600 PLCs
- 200 OPC UA Servers
- 90 FECs

- Hundreds of PS
- Hundreds of Fieldbuses
- Thousands of intelligent instruments
- 10 M Hardware I/O

HEPTech - High Tatras, Slovakia. March 18
Enrique Blanco - CERN
Industrial Controls Technologies

SUPERVISION, Visualization and programming
- WinCC OA (PVSS) SCADA (standard)
- Legacy systems: PCVue32, FactoryLink, WinCC

CONTROL
- SIEMENS, Schneider (standards)
- Industrial PCs: SIEMENS IPC, Kontron

FIELD LAYER
- Industrial instrumentation: Sensors, actuators
- Industrial customized actuators: Profibus PA positioners
- Home made electronics: ELMB, Signal Conditioners (CRYO), Power supplies

COMMUNICATIONS
- Fieldbuses: Profibus, WorldFIP, CAN, Profinet, Ethernet/IP
- In house developments: White rabbit
- OPC
Industrial Controls: Standards & Frameworks

- Off-the-shelf components (COTS) whenever possible
- Standardization (ISA, IEC)
- Frameworks
  - **JCOP**: A homogeneous way to build the detector control systems
  - **UNICOS**: A unified way to build process control systems
- **Homogenization**
  Cryogenics, Vacuum, HVAC, Electricity…
Industrial Partners & Collaborations
(some examples…)

Integrators
• **GTD Systems**: LHC cryogenics project (initial budget ~ 6 MCHF)
• **Assystem**: Industrial controls support contract

Suppliers
• Siemens, Schneider,: PLCs; ARC *Informatique*, ETM (Siemens): SCADA; *Empresarios Agrupados*: Industrial modeling and simulation.

Academia
• **UVA** (University of Valladolid, Spain): modelling & simulation, PLC embedded controllers (MBPC)
• **BME** (Budapest University of Technology and Economics), **EPFL** (Lausanne): Formal methods applied to PLC code verification

HEP Institutes
• GSI, ITER, ESO, SOLEIL, MPI…
Enrique Blanco Viñuela
contact: Enrique.Blanco@cern.ch
Head of the Control Systems Engineering (AP) section
Industrial controls & safety group in the beams department at CERN