A MODULAR APPROACH TO DEVELOP STANDARDIZED HVAC CONTROL SYSTEMS WITH UNICOS CPC FRAMEWORK

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ABSTRACT

At CERN there are currently 200 ventilation air handling units in production, used in many different applications, including building ventilation, pressurization of safe rooms, smoke extraction, pulsion/extraction of experimental areas (tunnel, cavern, etc.), and the ventilation of the computing centre. The PLC applications which operate these installations are currently being revamped to a new framework (UNICOS CPC). This work began 3 years ago, and we are now in a position to standardize the development of these HVAC applications, in order to reduce the cost of initial development (including specification and coding), testing, and long-term maintenance of the code. In this paper we will discuss the various improvements to the process, and show examples, which can thus help the community develop HVAC applications. Improvements include templates for the “Functional Analysis” specification document, standardized HVAC devices and templates for the PLC control logic, and automatically generated test documentation, to help during the Factory Acceptance Test (FAT) and Site Acceptance Test (SAT) processes.

DATA GATHERING

- Collect information regarding sensors and actuators.
- Based on 2 documents:
  1. Process & Instrumentation Diagram (P&ID)
  2. Electrical Wiring Diagram
- Produce the I/O list based on template, standardizing naming convention

UNICOS CPC SPECIFICATION

- Following the Functional Analysis (FA), UNICOS CPC Specification defines all:
  - Sensors
  - Actuators and Control objects
  - Calculations
  - Interlocks
  - Parameters
  - Regulation loops
- Completed in 2 steps
  1. Initial version, automatically created from Ventilation Spec Tool + I/O list
  2. Manual coding of the automatic logic of the actuators and units

SCADA SYNOPTICS

- Using Siemens WinCC OA
- Based on P&ID and internal standards
- Additional input from operator
- Also usually require a local Touch Panel (using Siemens WinCC TIA Portal)

REQUIREMENTS SPECIFICATION

Critical phase: Functional decomposition (IEC 61512-1 or ANSI/ISA S88)

Two key features per level:
1. the Stepper (i.e. the state diagram) governing the operation of the individual unit, see Table 1
2. the type of temperature regulation, see Table 2

To simplify and save time identified 4 common types.

Standard requirements captured as a template specification including:
- Stepper
- Table of actuator behaviour
- Standard interlocks

Testing

Implementation and Testing take approximately same time!

- Better quality control
- Repeatability, from 1 version to the next
- Coherence between applications

Developed:
- Test catalog:
  - Automatically generate 90% of cases

Test Environments
- Factory Acceptance Testing (FAT), in the lab
- Simulator: facilitates testing
- Debugging
- Verification of implementation of the AF
- Early changes with operator
- Site Acceptance Testing (SAT)
  - Parameter adjustment for plant dynamics
  - Functional validation

CONCLUSION

A noticeable improvement of the process of developing HVAC control systems with the UNICOS CPC framework has been done. This comprises improved templates for creating the requirements (Functional Analysis), implementing the PLC code (using user templates), and testing (using the commissioning file). However, there is still room for improvement such as enhancing the process to automatically generate more code, directly from the requirements if possible, and generate the SCADA synoptics directly from the P&IDs. Also the I/O list could be generated automatically from the wiring diagram itself, thus simplifying the design process yet further. With these additional improvements, coding errors would be drastically reduced, and the effort required to develop the control system minimized.