UNICOS: UNIFIED INDUSTRIAL CONTROL SYSTEM

CPC (CONTINUOUS PROCESS CONTROL)

BASIC COURSE

SESSION 0: INTRODUCTION

CERN EN/ICE group

Outline

- **Objectives, Instructors, Contents and Material**
- Process Automation at CERN
- Introduction to Process Control
- Automation Architecture and Hardware

OBJECTIVES

The course introduces the UNICOS-CPC framework and gives to the students the means of **building industrial process control applications.**

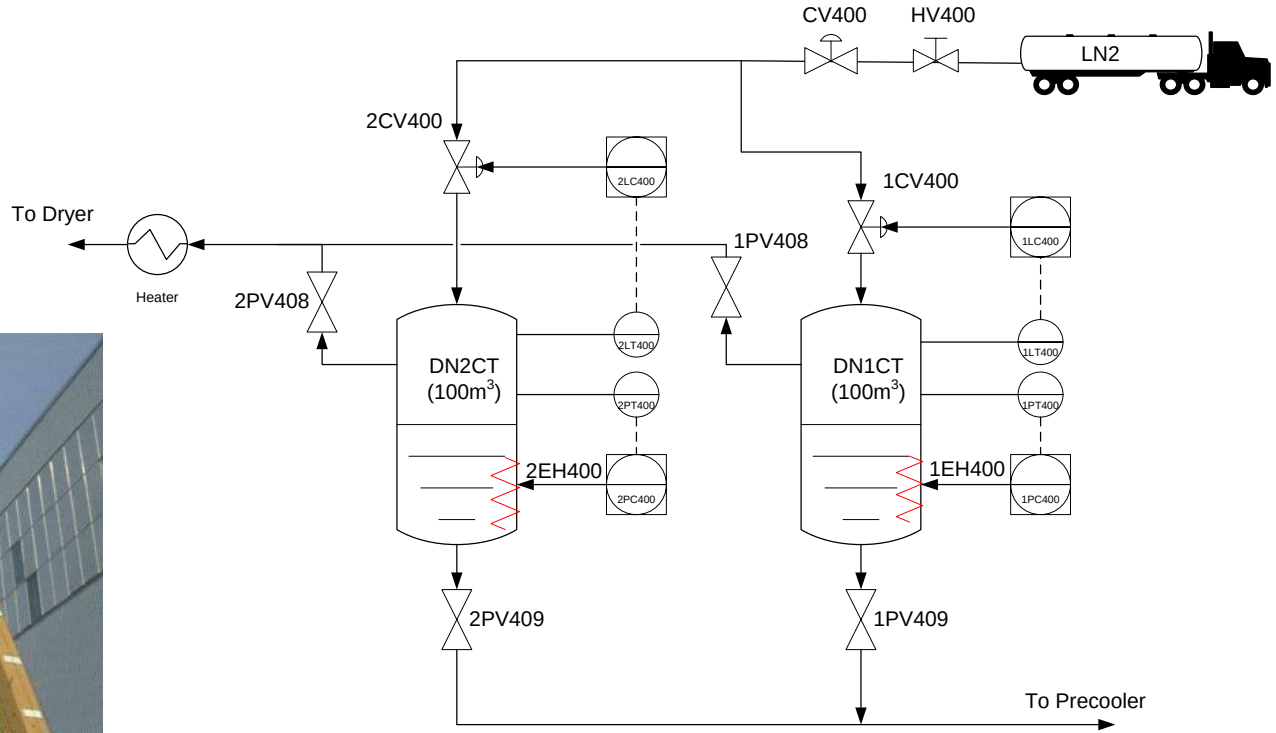
It focuses on further **hands-on examples** of developing process control applications. Students will be better able to optimize the CERN standardization by means of deploying adapted standards and choosing the right best practices. With a ***real project scenario*** as a baseline, students will apply themselves all the introduced concepts during all the phases when developing a project.

You will be able to:

- **Analyze** an industrial process and **design** the more adapted control system.
- **Develop** and **implement** process control applications based on the CERN UNICOS standard.
- **Help operation** staff during their 24/7 needs by the preventive **diagnostics** of the controls infrastructure.

REAL INSTALLATION: QSDN

Cryogenics Surface Dewar Nitrogen



PREREQUISITES

- Desirable knowledge of P&IDs, E&ICs and automatic control
  - Interpret flows and piping
  - Understand electrical connections
  - Basic regulatory control skills

- Basic knowledge of PLC and SCADA architecture
  - Understand the PLC architecture (Siemens)
  - Create and Configure SCADA projects (WinCC OA)

- Sound knowledge of programming in IEC-61131 languages, specially SFC (sequential function charts) and ST (structured text)
  - Programming PLCs

INSTRUCTORS

The course is divided in sessions each having different experts:

- *Session* 0: **Introduction**
  - Enrique Blanco (EN/ICE PLC)
- *Session* 1: **Project Specifications & Functional analysis**
  - Benjamin Bradu (EN/ICE PLC)
- *Session* 2: **Deployment of the process control application**
  - Marc Quiliquini (EN/ICE PLC)
- *Session* 3: **Development of the process control application**
  - Jeronimo Ortola Vidal (EN/ICE PLC)
- *Session* 4: **SCADA: Configuration, Operation and maintenance**
  - Alexey Merezhin (EN/ICE PLC), Marco Boccioli (EN/ICE/SCD)

CONTENTS

Day 1
From 09:00 to 12:00

***SESSION 0*: General Introduction**

- Introduction
  - course contents
  - Process Control
  - Automation Architecture & Hardware components
- UNICOS – CPC package
  - Devices : TCT
  - Generation tools: UAB
- From Process to Operation using UNICOS-CPC
  - Objects main functionalities
  - UNICOS – CPC Procedure
- Support: UNICOS-CPC web page & CERN team

CONTENTS

Day 1 **From 13:30 to 17:30**	**Day 2** **From 9:00 to 12:00**

***SESSION 1*: Project Specifications & Functional Analysis**

- Project specifications
- Hardware needs
- IO List (E&IC)
- P&ID
- Functional Analysis
- How to deal with the analysis
  - Alarms & Interlocks
  - Object dependencies
- Design phase
  - CPC objects description
  - PCOs functionalities
  - Specs creation

CONTENTS

Day 2
From 13:30 to 17:30

SESSION 2: Deployment of the control application

- UAB Project creation
- Automatic Code Generation
  - Instances generation (PLC, WinCC Flex, WinCC OA)

- Libraries:
  - PLC architecture: baselines
  - WinCC Flexible basics
  - SCADA project structure: packages needed

- UCPC Project architecture: Siemens
  - Create PLC + PVSS projects (also components)
  - Import Instances for each component

- Components deployment
  PLC, SCADA (*and Local panels) deployment

* Depending on schedule

CONTENTS

Day 3
From 09:00 to 17:30

***SESSION 3*: Development of the control application**

- Siemens PLC basics
  - Step7 project: SCL & Graph
  - UCPC in Siemens (architecture)
  - UAB Logic generation
  - Importation of logic
- Advanced programming: full automation
  - Basic PLC code for logic
  - Python scripting language in UNICOS
  - Logic Templates
- Versioning
  - PLC & SCADA versions tags
- SVN best practices

CONTENTS

Day 4
From 13:30 to 16:00

***SESSION* 4: SCADA: Configuration, Operation and maintenance**

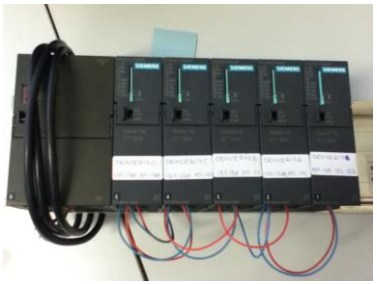
- User interface creation: Panels
- SCADA features
  - UI navigation and components
  - Widgets
  - Diagnostics: alarms, events, diagnostics, filtering
  - Archiving
  - User rights: Usage of Domains
  - Remote UIs (OWS)
- Operation:
  - UNICOS principles of operation
  - OWS
  - Diagnostics (TSPP communication)
- Online modifications
  - Spare channels

CONTENTS

Day 4
From 16:00 to 17:00

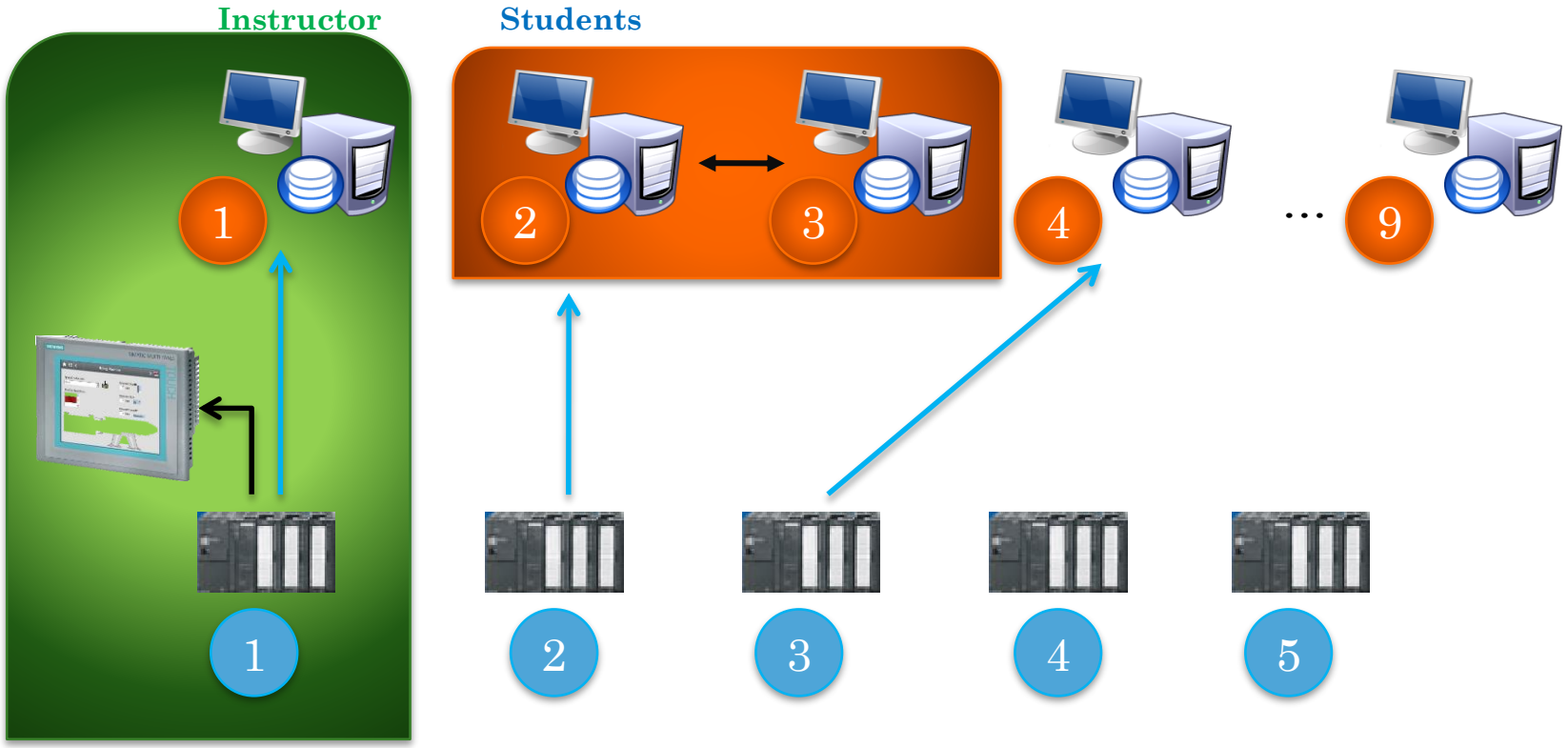
***CLOSING SESSION*: Q & A**

MATERIAL



Classroom/Laboratory Exercises:

The course consists of multiple application exercises of the whole life cycle of a process control application development (e.g. specs, functional analysis, diagnostics…)



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CERN STRUCTURE IN A FEW WORDS…

Administration and general infrastructure - *Sigurd Lettow*

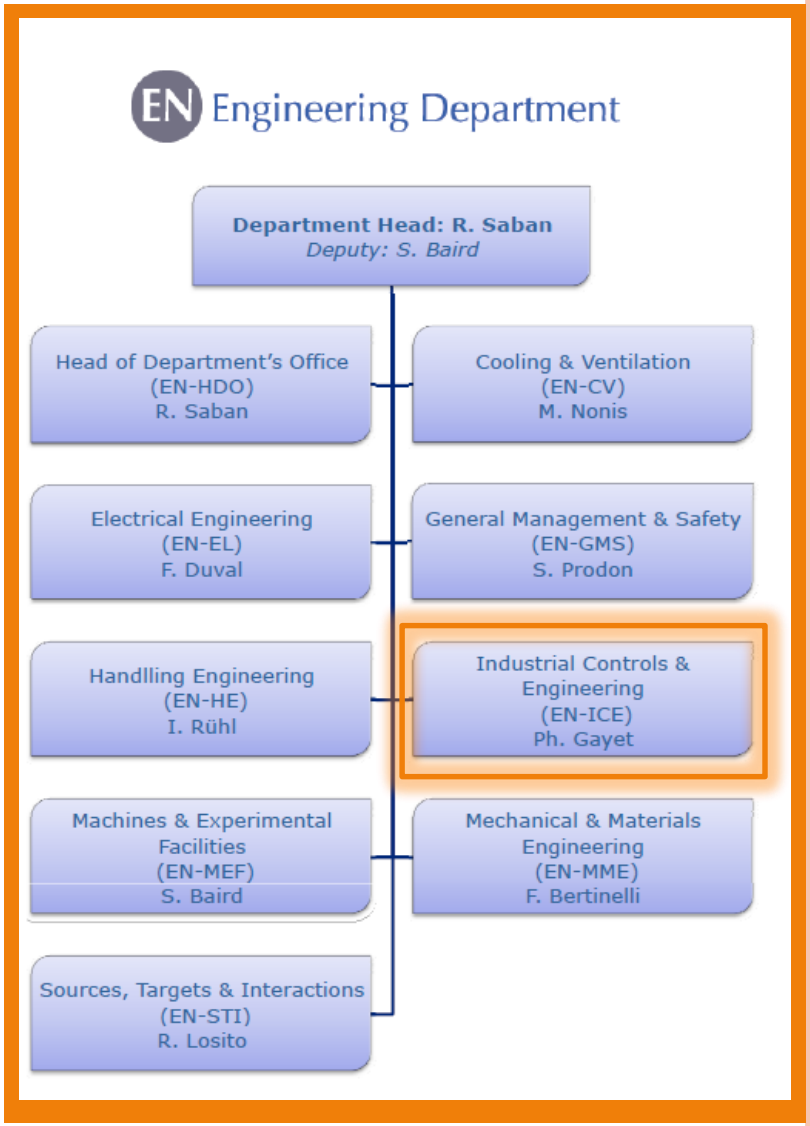
- **FP** FINANCE, PROCUREMENT AND KNOWLEDGE TRANSFER - *T. Lagrange*
- **GS** GENERAL INFRASTRUCTURE SERVICES - *T. Pettersson*
- **HR** HUMAN RESOURCES - *A.-S. Catherin*

Research and scientific computing - *Sergio Bertolucci*

- **IT** INFORMATION TECHNOLOGY - *F. Hemmer*
- **PH** PHYSICS - *P. Bloch*

Accelerators and technology - *Steve Myers*

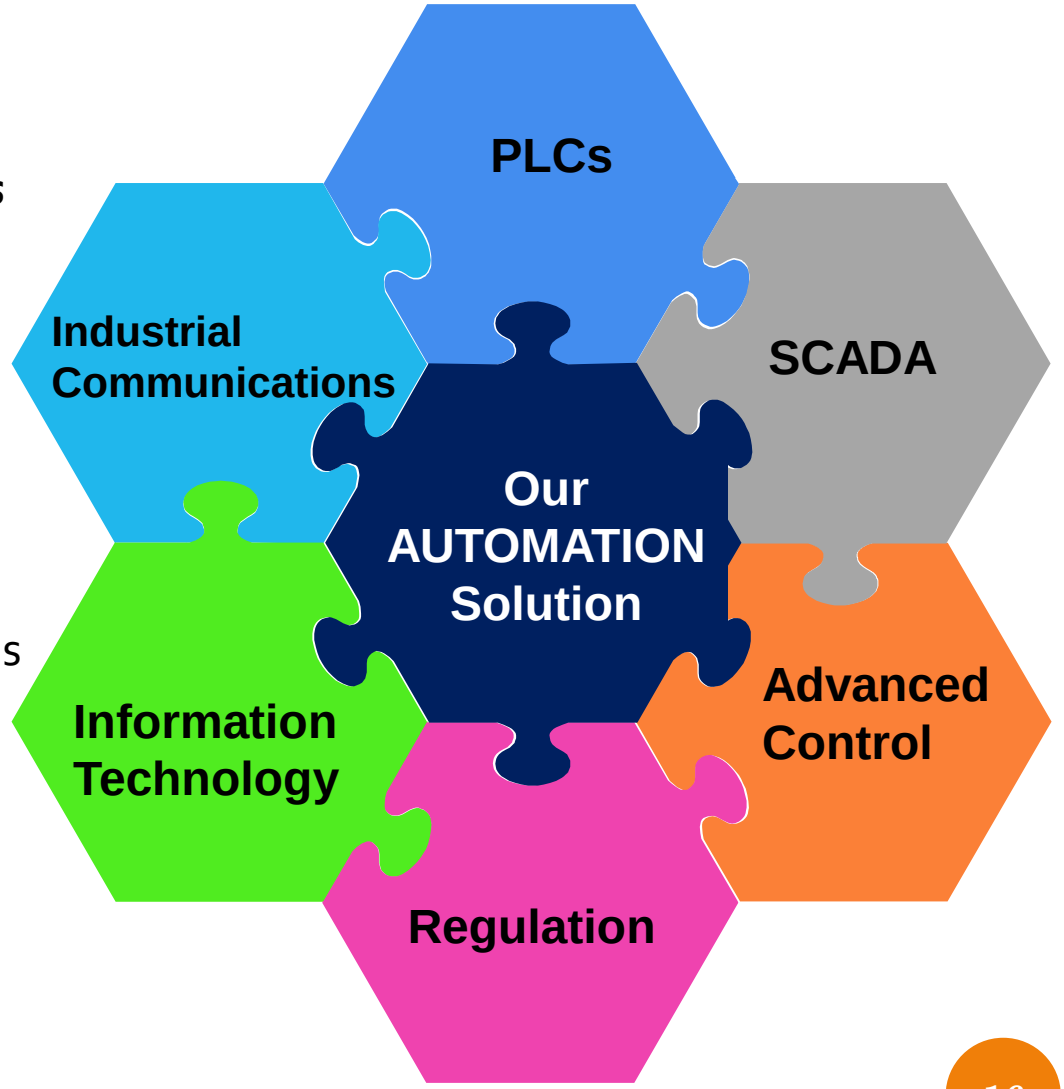
- **BE** BEAMS - *P. Collier*
- **EN** ENGINEERING - *R. Saban*
- **TE** TECHNOLOGY - *F. Bordry*



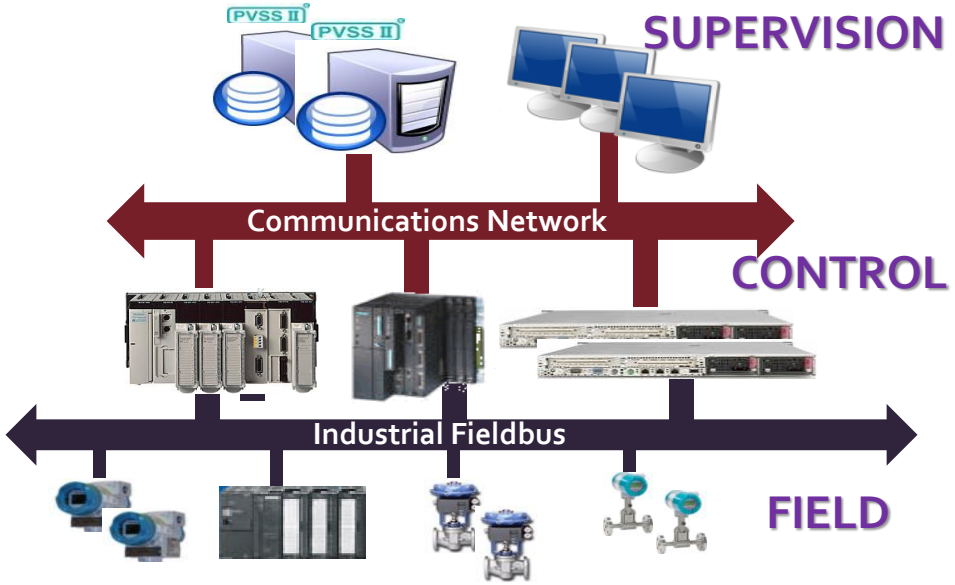
AUTOMATION @ CERN: ENGINEERING DEPARTMENT

The Industrial Control Engineering Group in the Engineering Department **develops solutions** and **provides support** in the domain of large and medium scale industrial control systems as well as laboratory control systems and promotes their use.

Mandate key points:
- Identifying commercial solutions
- Adopted solutions support
- Design & Develop in-house frameworks and components
-Design, implement and support control systems.



AUTOMATION GENERAL ARCHITECTURE



1. process control strategy: P&ID.
2. electrical and cabling of instrument and control systems
3. Instrumentation
4. Control logic (PLCs)
5. Supervisory systems (SCADA)
6. commissioning, start-up, operation and support
7. plant optimization

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Process

- ***Process***, as used in the terms process control and process industry, refers to the methods of changing or refining raw materials to create end products.

- **Process industries** include the chemical industry, the oil and gas industry, the food and beverage industry, the pharmaceutical industry, the water treatment industry, and the power industry.

PROCESS CONTROL

- Process control refers to the methods that are used to control process variables when manufacturing a product.

- Manufacturers control the production process for several reasons:
  - Reduce variability: increase quality
  - Increase efficiency: increase profits
  - Ensure safety: optimize conditions

Process classification

- **Discrete process**

Handles distinct, separate products. In a discrete industrial process, both inputs and outputs must be discrete data flows and/or discrete data stores. Discrete processes can be found in many manufacturing, motion and packaging applications.

- **Continuous process**

Characterized by smooth and uninterrupted variables in time, and are defined as continuous processes.

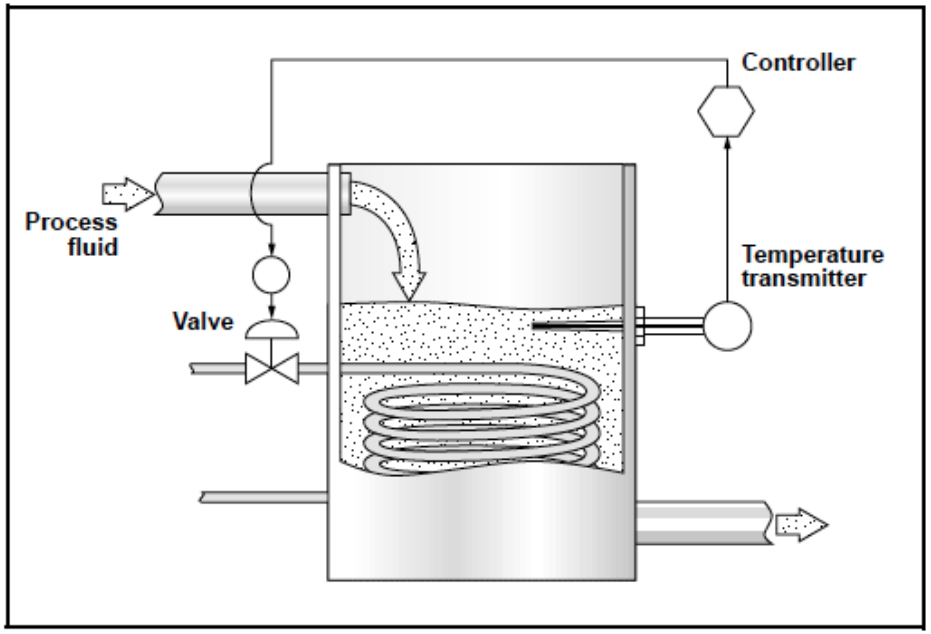
In a continuous process control system, the variables associated with any process are monitored and subsequent control actions are implemented to maintain variables within predetermined process constraints.

- **Batch process**

Characterized by a prescribed processing of materials for a finite duration

INSTRUMENTATION

- Three tasks are needed: Measurement, Comparison, Adjustment
- Measurements
  - Flow
  - Level
  - Pressure
  - Temperature
- Comparison
  - Open loop
  - Close loop
- Actuation
  - Valves
  - Heaters
  - Motors,...



Designing Process Control systems

- Understand the process
- Identify the operating parameters
- Identify the measurable(s)
- Identify the points of measurements and actuation
- Select measurement methods
- Select control method
- Select control system (redundancy, fail safe,…)
- Define the control logic
- Integrate and test

- All this tasks may be shared with Process engineers.

Some process Examples

- Cooling
- Cryogenics
- VAC

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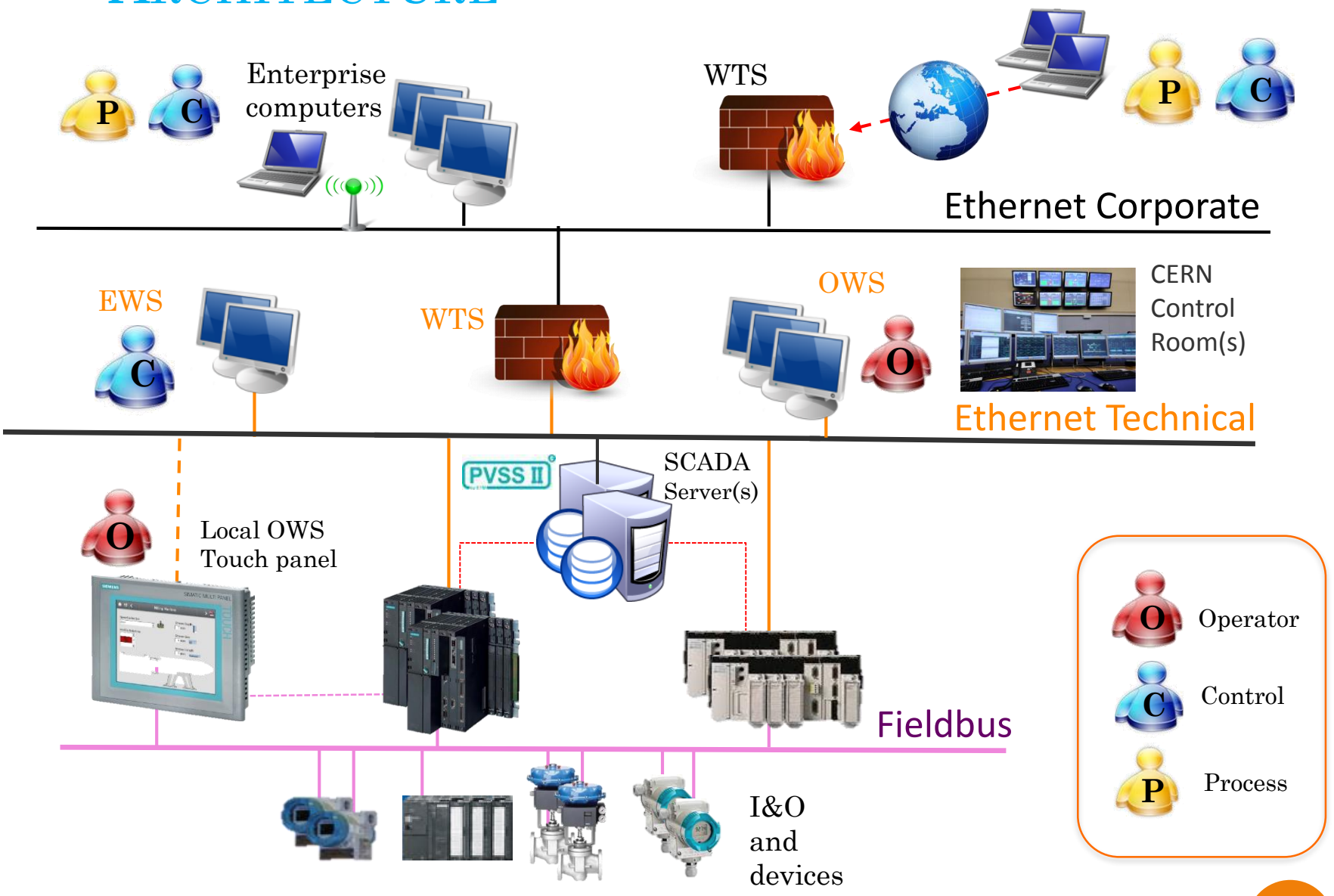
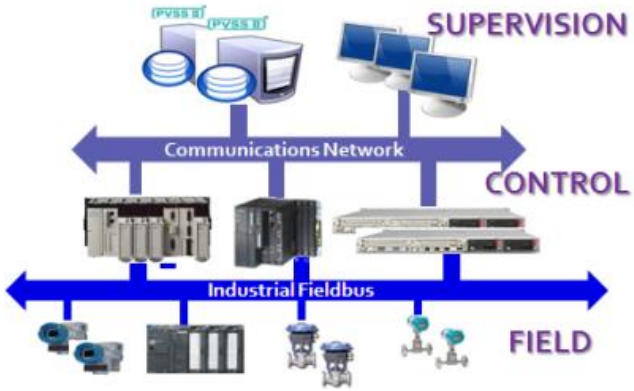
ARCHITECTURE



Hardware Components

- Supervision Layer
  - WinCC OA SCADA
  - **Labview (for labo-sized projects)*
- Control Layer
  - Siemens S7-300, S7-400
  - Schnedier Premium, Quantum
  - Codesys (Somachine, TwinCat3)
- Local operation
  - Simatic HMI (WinCC flex, TIA portal)
  - Magelis (Schneider)
- Industrial communications
  - Profibus, Profinet, Ethernet/IP
  - Modbus TCP



* *In preparation*