UNICOS: UNIFIED INDUSTRIAL COCONTROL SYSTEM

CPC (CONTINUOUS PROCESS CONTROL)

BASIC COURSE

SESSION 3: PLC BASICS

CERN EN/ICE group

Overview

Overview

- Programmable Logic Controller
  - Designed for industrial processes.
  - Works under severe conditions.
  - Real time system.
  - Handles sensors and actuators (I/O).

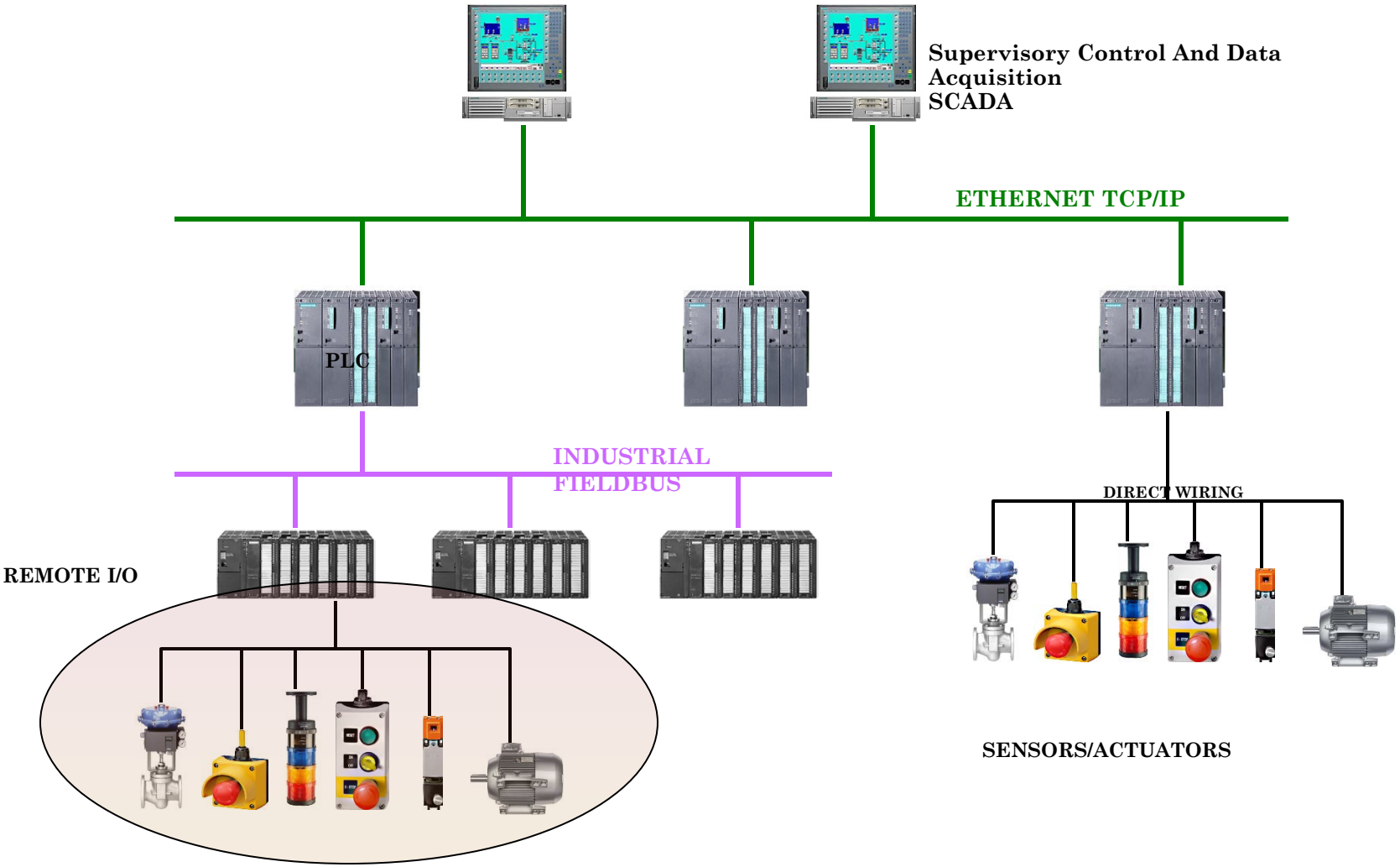
Functions

- Process control
  - Collects inputs (digital, analog)
  - Runs the process control
    - Basic logic functions
    - Complex algorithms (PID…)
    - Safety functions
  - Produces actions (outputs)
  - Provides data to the supervision layer

Features

- Reliable. Used for safety systems.
- Robust. Resistant to electrical noise, vibration, impact, dust, heat.
- Extensive range of inputs/outputs.
- Extensive range of functionalities.
- Long term support.
- Long life, around 30 years.

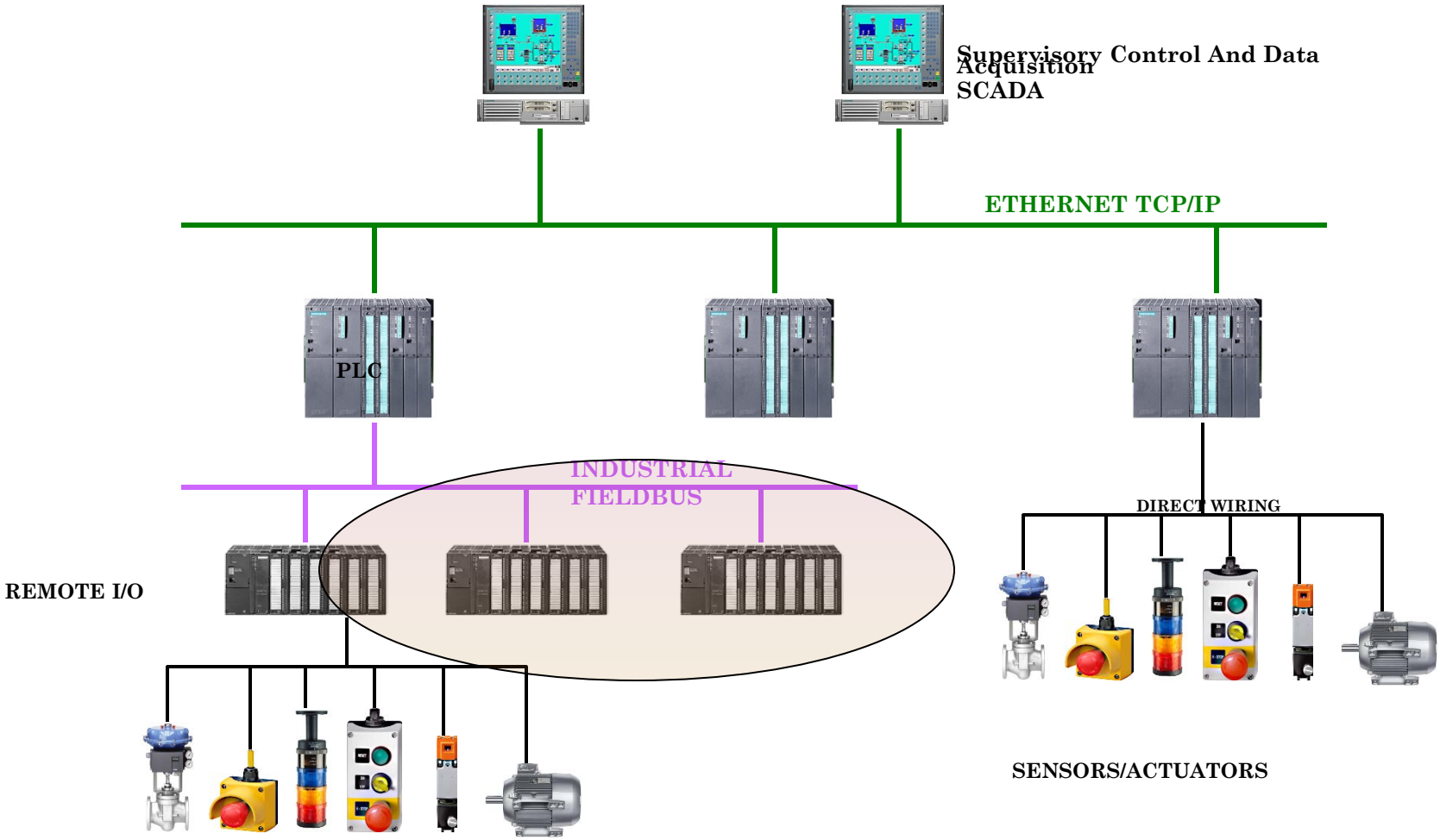
HARDWARE OVERVIEW



Sensors - Actuators

- Device which converts the signal from one form to another.
- Sensors
  - Analog: Temperature, pressure, humidity, level, flow, weight…
  - Digital: Level, pushbutton (emergency stop), position switch, photoelectric sensor…
- Actuators
  - Analog: valve, pump, heater, power supply…
  - Digital: Signaling column, contactor, electro valve, switch, OnOff pump…

HARDWARE OVERVIEW



Periphery Stations

- Communication modules
- I/O Modules.
  - Convert physical value into numeric value and vice versa.
- Function modules.

I/O Modules

- Analog
  - 16-bit signed from -32768 to 32767.
  - Inputs: Resistance, Current, Voltage, thermocouple…
  - Outputs: Current, voltage.
- Digital
  - 1-bit
  - Inputs: 120v-230v AC, 24v DC
  - Outputs: Relay, 120v-230v AC, 24v-48v-125v DC.

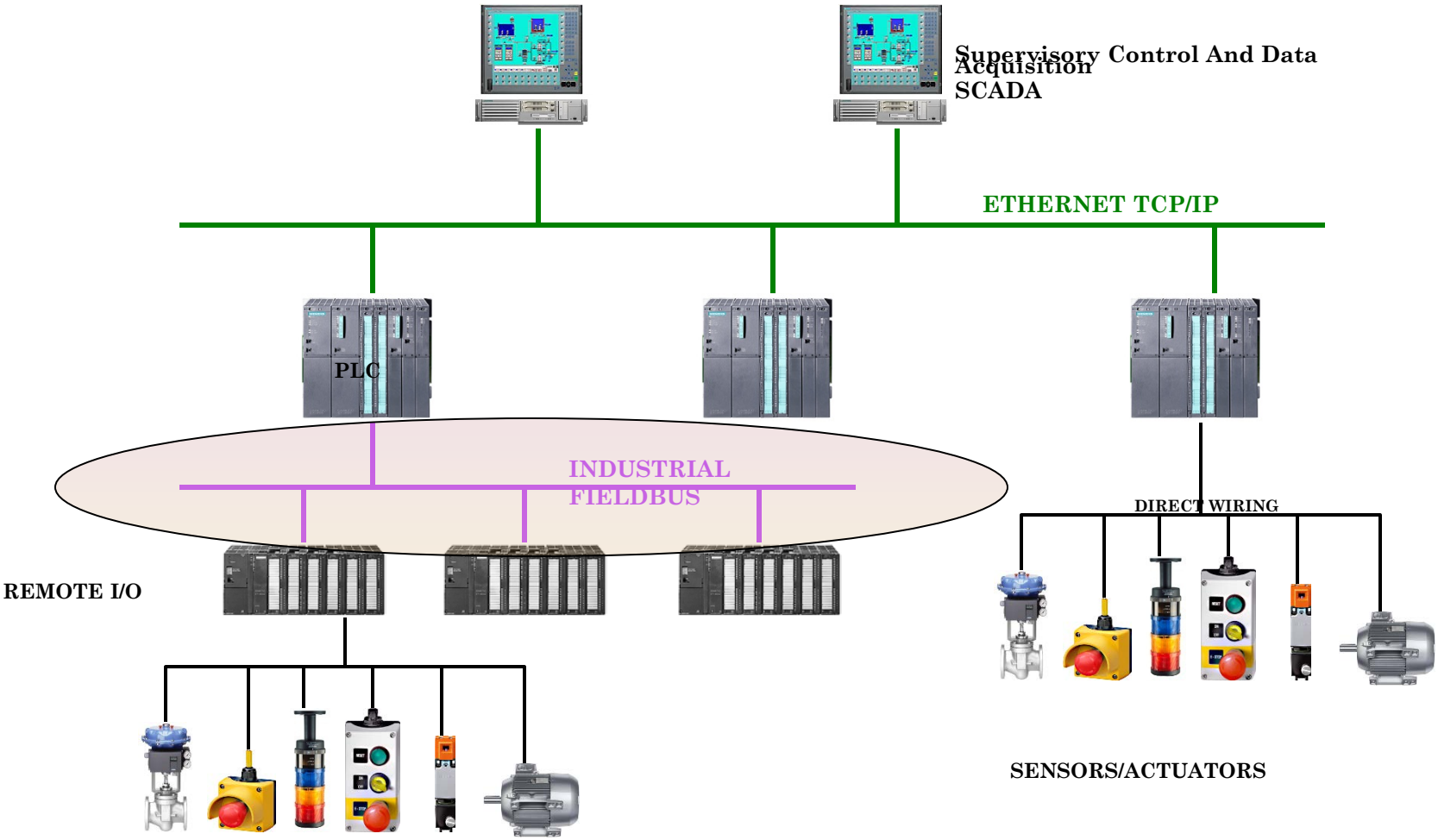
Function Modules

- PID control
- Flow
- Camera controllers
- Numerical controllers
- Counters
- Positioning

COMMUNICATION MODULES

- Ethernet
- Profibus
- CAN
- Point to Point
- Serial RS 232, RS 485
- AS-Interface
- Modbus…

HARDWARE OVERVIEW



Fieldbus- Overview

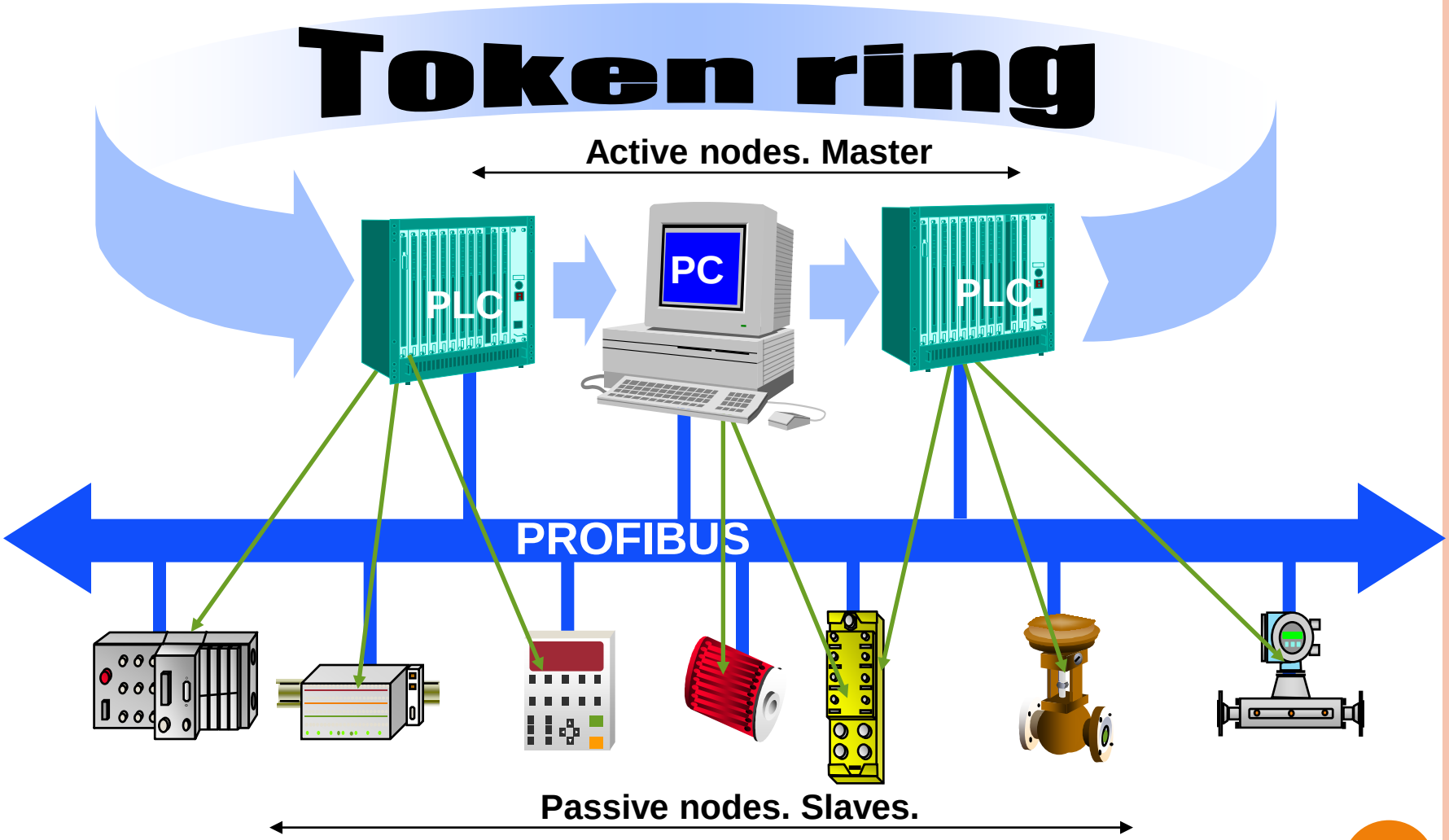
- Industrial Network System
- Provides the PLC with I/Os
- Time deterministic.
- Saves cabling costs

- Sensitive to electromagnetic noise.
- Specific installation rules.
- Several different (incompatible) fieldbus standards.

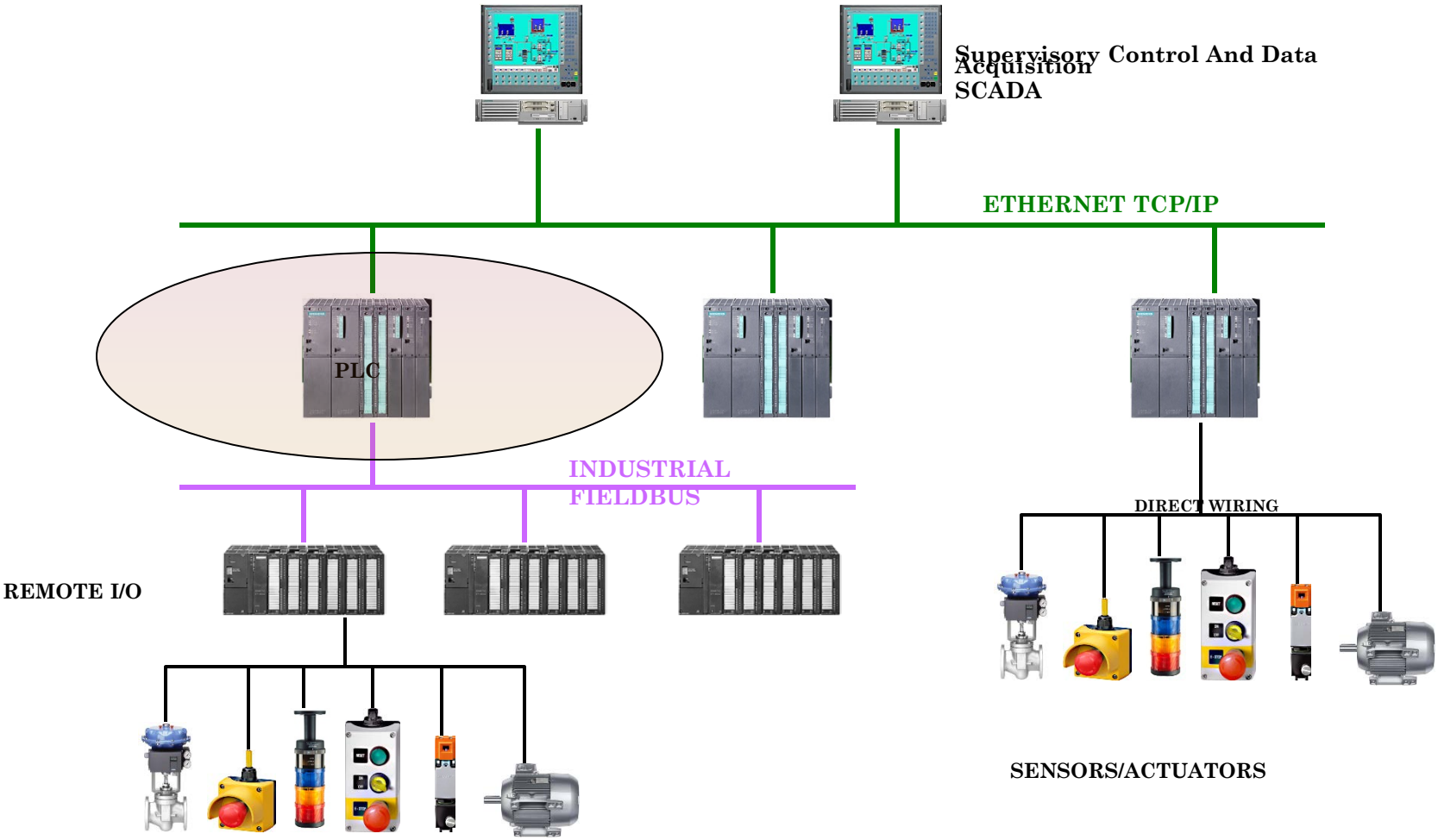
Fielbus Standards

- Profibus
  - Industry leader. 14 million nodes.
- WorldFip
  - Robust (radiation resistant)
- CAN. CANOpen. CANBus
  - Low cost
  - Easy to implement
  - Used for ELMB at CERN
- ProfinetIO
  - Interbus integrated (Phoenix Contact).
  - Ethernet based fieldbus

PROFIBUS


Token ring
Active nodes. Master
PLC
PC
PLC
PROFIBUS
Passive nodes. Slaves.

HARDWARE OVERVIEW



SIEMENS S7-200

- S7 200 (low range)
  - Compact
  - Low cost
  - Small systems

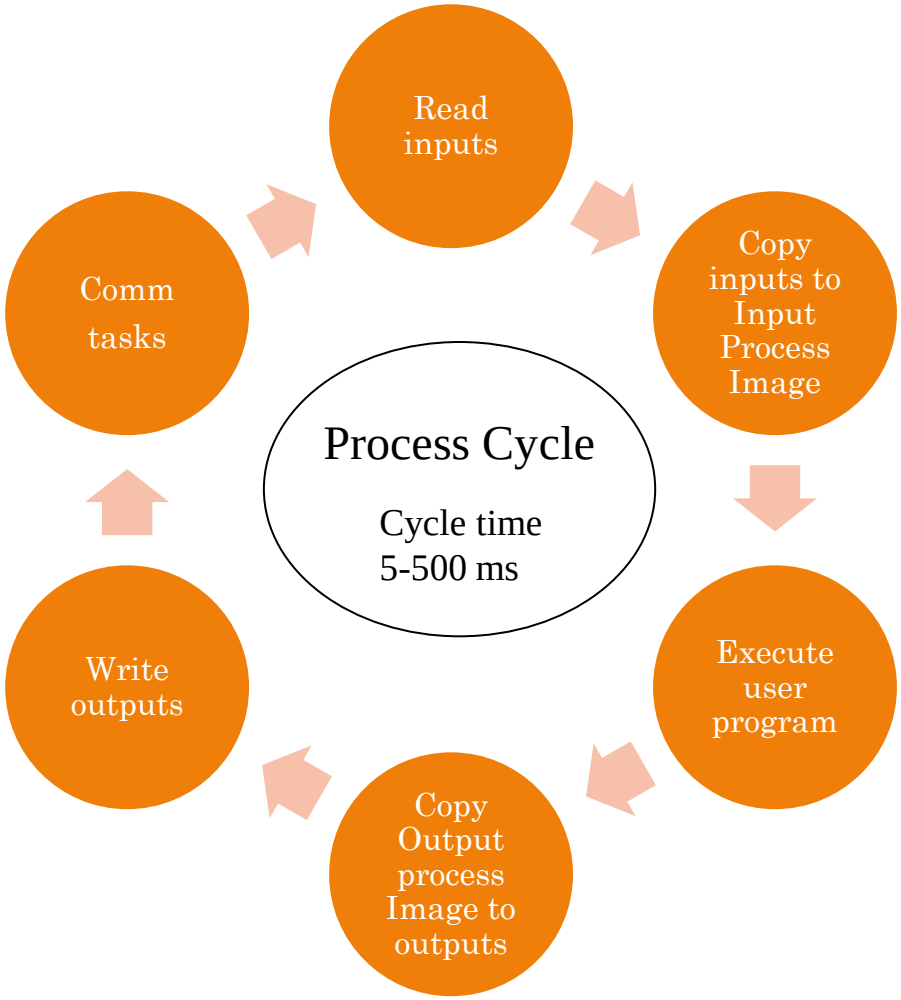
SIEMENS S7-300

- S7 300 (medium range)
  - Modular
  - Wide range of IOs
  - Widely used
  - Limited memory
  - Limited range of fieldbuses

SIEMENS S7-400

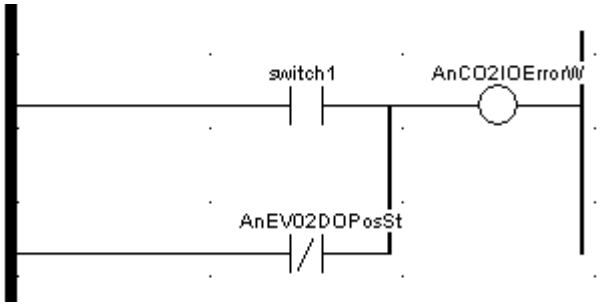
- S7 400 (high range)
  - Redundant architecture
  - Large memory
  - High performance

PROCESS CYCLE



Programming Languages

- Traditional *ladder logic* is an easy-to-use graphical programming language that implements relay-equivalent symbol. Intuitive. Limited functionalities.



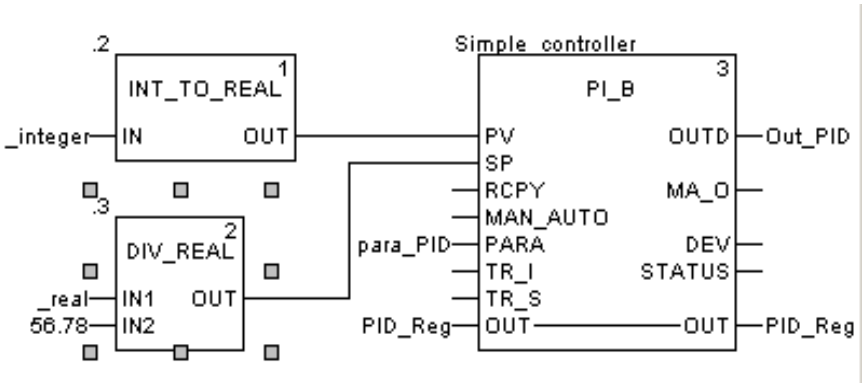
Programming Languages

- STL: Statement List / Instruction List - Fastest possible logic execution. Low level language (similar to assembly language)

```
>>>>>>>>>>>>>>>>>>> Instruction List Start <<<<<<<<<<<<<<<<<<<
(* example  D = A - (B - C) *)
LD A
SUB ( LD B SUB C )
ST D
>>>>>>>>>>>>>>>>>>>> Instruction List End <<<<<<<<<<<<<<<<<<<<
```

Programming Languages

- FBD : Function Block Diagram



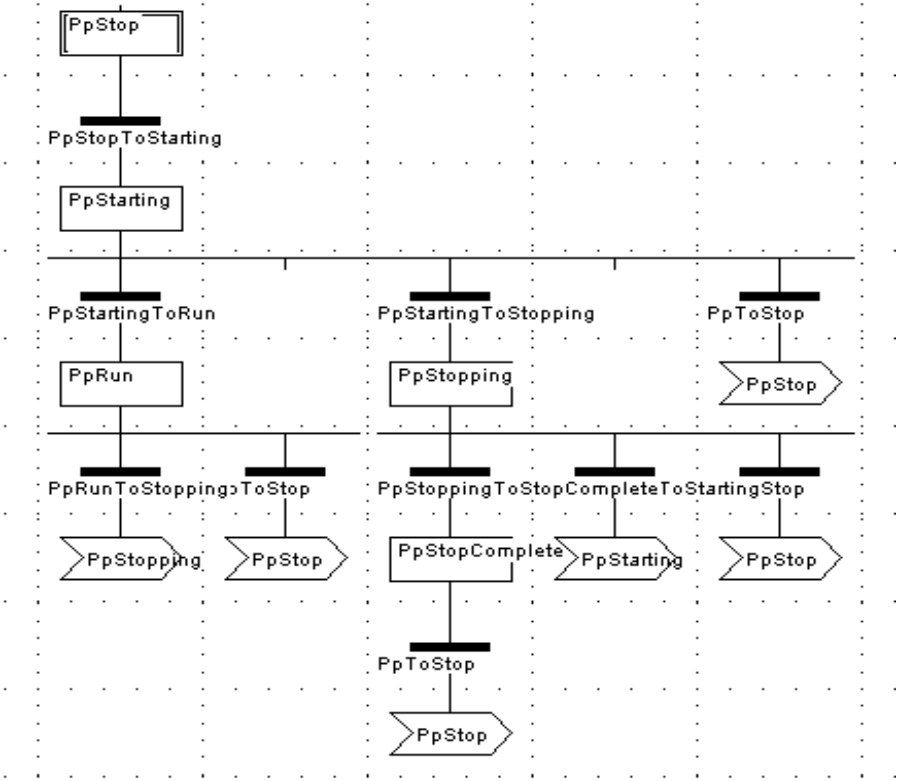
Programming Languages

- ST: Structured Text - Equations, table manipulation, complex algorithms (If/Then)

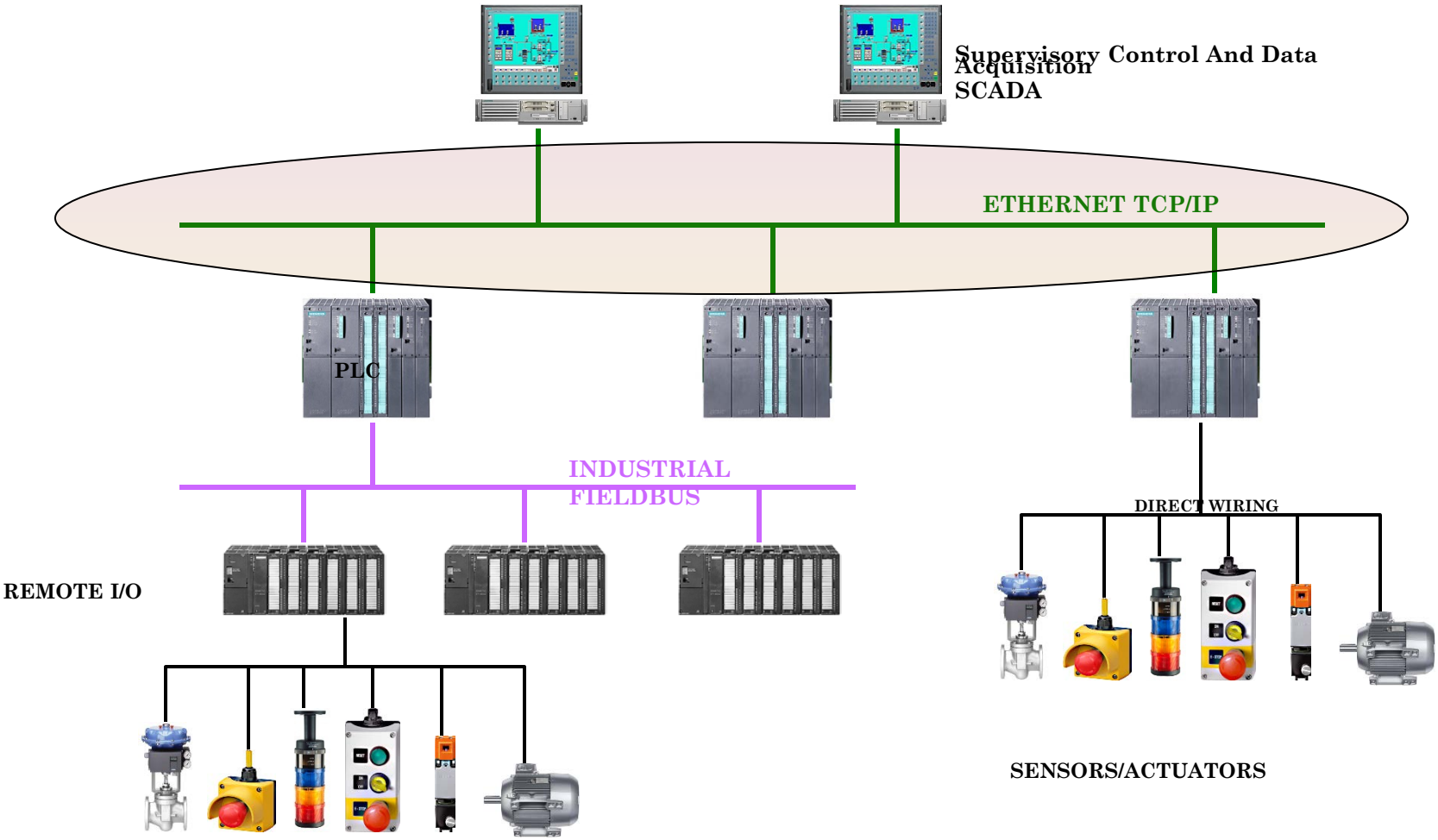
```
(* conditionnal if *)
IF (var1 = 12.45) THEN boolean1 := TRUE;
   else var2 := 56.78; boolean2 := 0;
   END_IF;

(* simple PID controller *)
SIMPLE_CONTROLLER (PV := int_to_real(_integer) , SP := _real/56.78,
                   PARA := para_PID,OUT := PID_Reg,
                   OUTD => Out_PID);
```

Programming Languages

- SFC : Sequential Function Chart -A graphical method of representing a sequential control system (stepper).



HARDWARE OVERVIEW



SCADA COMMUNICATION

- Ehternet TCP IP.
- Big amount of data transfer.
- Non deterministic.
- Big data transfer rates.
- S7 Driver on TCP IP. Siemens.
- OPC.