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Industrial Controls (1)

By

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Lecture (2)

Detecting sensors
&
actuating elements

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Selecting Criteria for Sensors

- A number of static and dynamic factors must be considered in selecting a suitable sensor to measure the desired physical parameter.
- **Following is a list of typical factors:**

a) Range: Difference between the maximum and minimum value of the sensed parameter.

b) Resolution: The smallest change the sensor can differentiate.

c) Accuracy: Difference between the measured value and the true value.

Selecting Criteria for Sensors

d) Precision: Ability to reproduce repeatedly with a given accuracy.

e) Sensitivity: Ratio of change in output to a unit change of the input.

f) Zero offset: A nonzero value output for no input.

g) Linearity: Percentage of deviation from the best-fit linear calibration curve.

h) Zero Drift: The departure of output from zero value over a period of time for no input.

i) Response time: The time lag between the input and output.

j) Bandwidth: Frequency at which the output magnitude drops by 3 dB.

Selecting Criteria for Sensors

k) Resonance: The frequency at which the output magnitude peak occurs.

l) Operating temperature: The range in which the sensor performs as specified.

m) Dead band: The range of input for which there is no output.

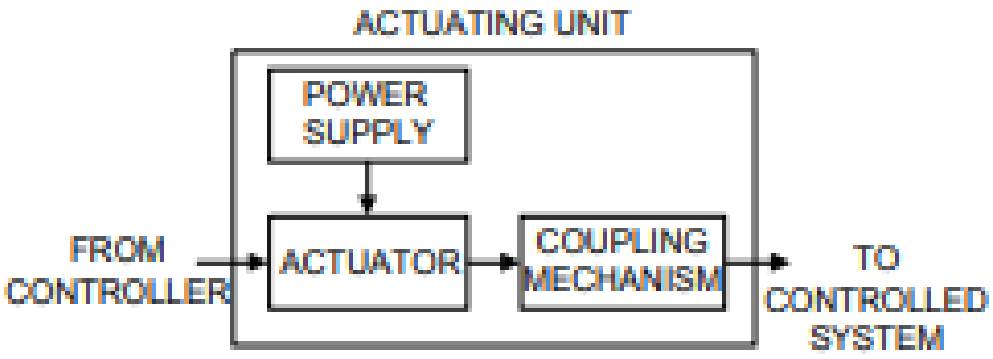
n) Signal-to-noise ratio: Ratio between the magnitudes of the signal and the noise at the output

2. Actuating Elements

- Actuators are basically the muscle behind a mechatronics system that accepts a control command (mostly in the form of an electrical signal) and produces a change in the physical system by generating force, motion, heat, flow, etc.

- Normally, the actuators are used in conjunction with the power supply and a coupling mechanism.

- The power unit provides either AC or DC power at the rated voltage and current.
- The coupling mechanism acts as the interface between the actuator and the physical system. Typical mechanisms include rack and pinion, gear drive, belt drive, lead screw and nut, piston, and linkages.



Basic Concepts of Actuators

- An actuator is something that actuates or moves something.
- More specifically, an actuator is a device that coverts energy into motion or mechanical energy.
- Therefore, an actuator is a specific type of a **transducer**.

Actuators can be classified based on the type of energy:

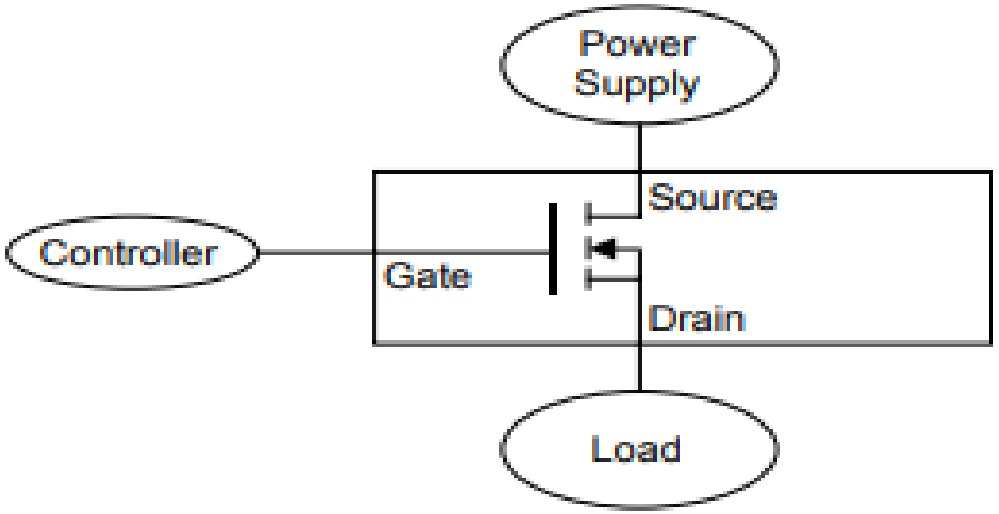
a) Electrical Actuators.
b) Electromagnetic Actuators.
c) Electromagnetic Actuators.
d) Hydraulic and Pneumatic Actuators.

a) Electrical Actuators

- Electrical switches are the choice of actuators for most of the on-off type control action.

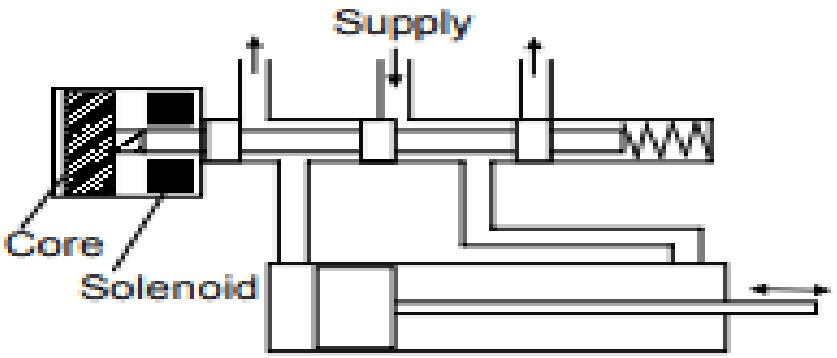
- Switching devices such as diodes, transistors, triacs, MOSFET, and relays accept a low energy level command signal from the controller and switch on or off electrical devices such as motors, valves, and heating elements.

- **Ex**: a MOSFET switch is shown in figure, The gate terminal receives the low energy control signal from the controller that makes or breaks the connection between the power supply and the actuator load.
- When switches are used, the designer must make sure that switch bounce problem is eliminated either by hardware or software.



b) Electromagnetic Actuators

- **The solenoid** is the most common electromagnetic actuator. A DC solenoid actuator consists of a soft iron core enclosed within a current carrying coil.
- When the coil is energized, a magnetic field is established that provides the force to push or pull the iron core.
- AC solenoid devices are also encountered, such as AC excitation relay.



c) Hydraulic and Pneumatic Actuators

- Hydraulic and pneumatic actuators are normally either rotary motors or linear piston/cylinder or control valves.
- They are ideally suited for generating very large forces coupled with large motion.
- **Pneumatic actuators** use air under pressure that is most suitable for low to medium force, short stroke, and highspeed applications.
- **Hydraulic actuators** use pressurized oil that is incompressible.

- They can produce very large forces coupled with large motion in a cost-effective manner. The disadvantage with the hydraulic actuators is that they are more complex and need more maintenance.

Selecting Criteria for Actuators

- **the following performance parameters** must be addressed before choosing an actuator for a specific need:

a) Continuous power output: The maximum force/torque attainable continuously without exceeding the temperature limits.

b) Range of motion: The range of linear/rotary motion.

c) Resolution: The minimum increment of force/torque attainable.

d) Accuracy: Linearity of the relationship between the input and output.

e) Peak force/torque: The force/torque at which the actuator stalls.

f) Heat dissipation: Maximum wattage of heat dissipation in continuous operation.

g) Speed characteristics: Force/torque versus speed relationship.

h) No load speed: Typical operating speed/velocity with no external load.

i) Frequency response: The range of frequency over which the output follows the input faithfully, applicable to linear actuators.

j) Power requirement: Type of power (AC or DC), number of phases, voltage level, and current capacity

ICS (Industrial Control System)

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IACS (Industrial Automation and Control Systems)

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What is Automation?

- Automation is basically the delegation of human control function to technical equipment for:

Increasing Productivity

Increasing Quality

Reducing Cost

Increasing Safety in working conditions

Types of Automation

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1. Building automation

- **Ex:** lifts, smoke detectors.

2. Office automation

- **Ex:** printers, cctv cameras.

3. Scientific automation

- **Ex:** rocket launching.

4. Light automation

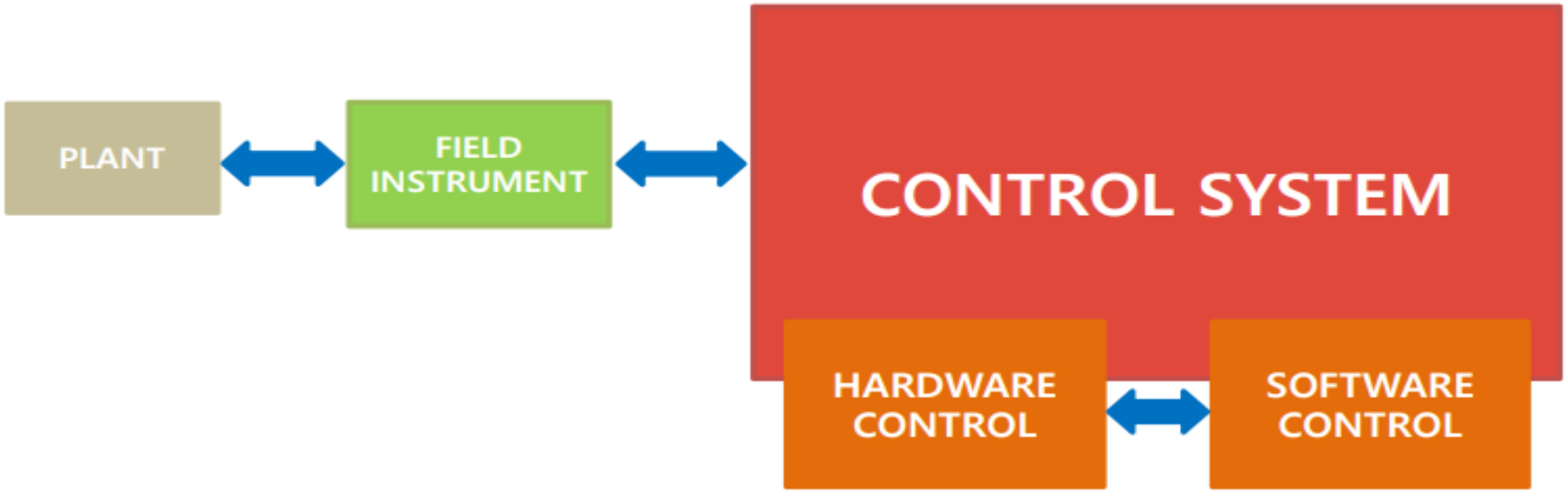
- **Ex:** street solar lighting.

5. Industrial automation

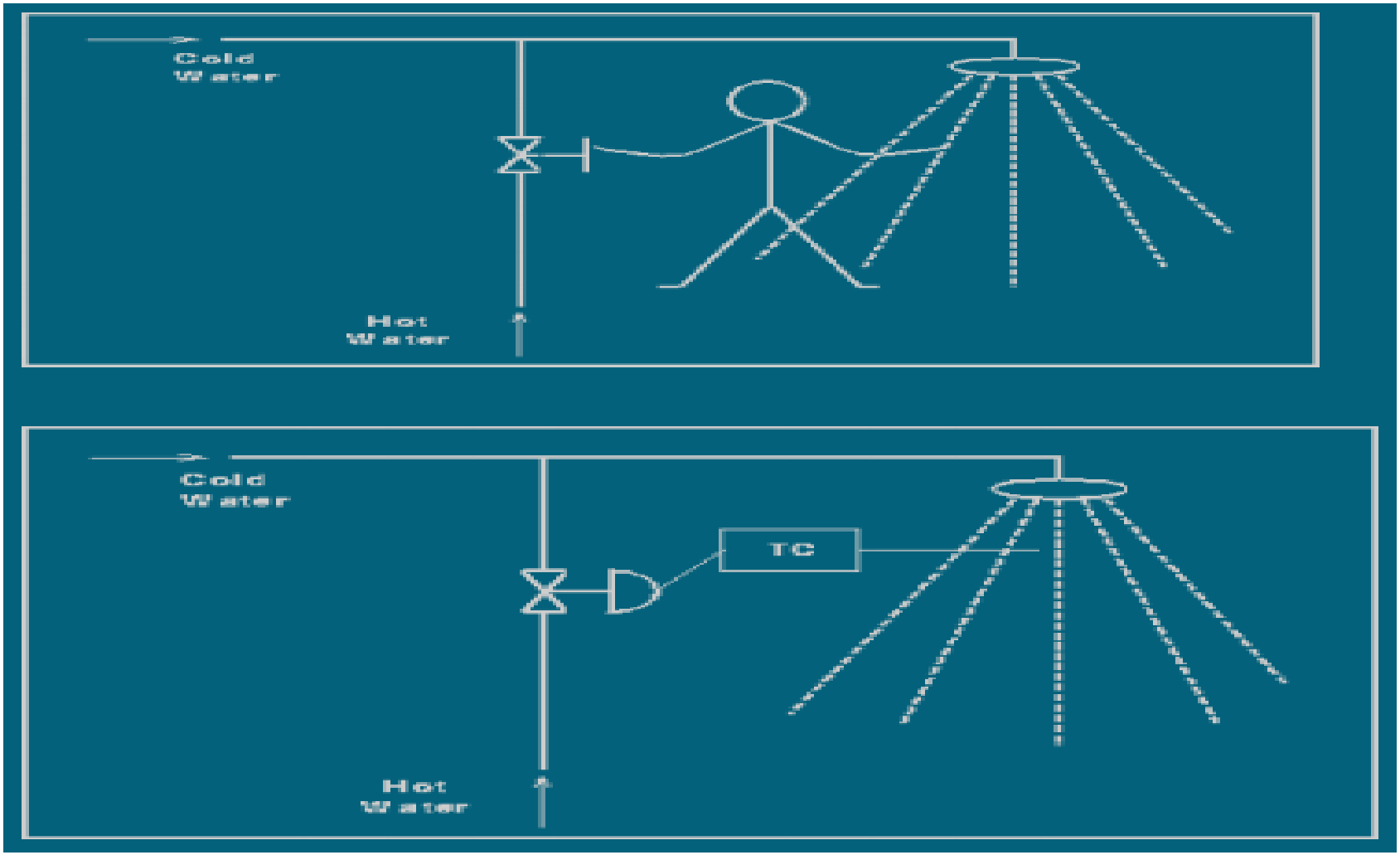
- **Ex:** automated bottle filling stations, steel factories.

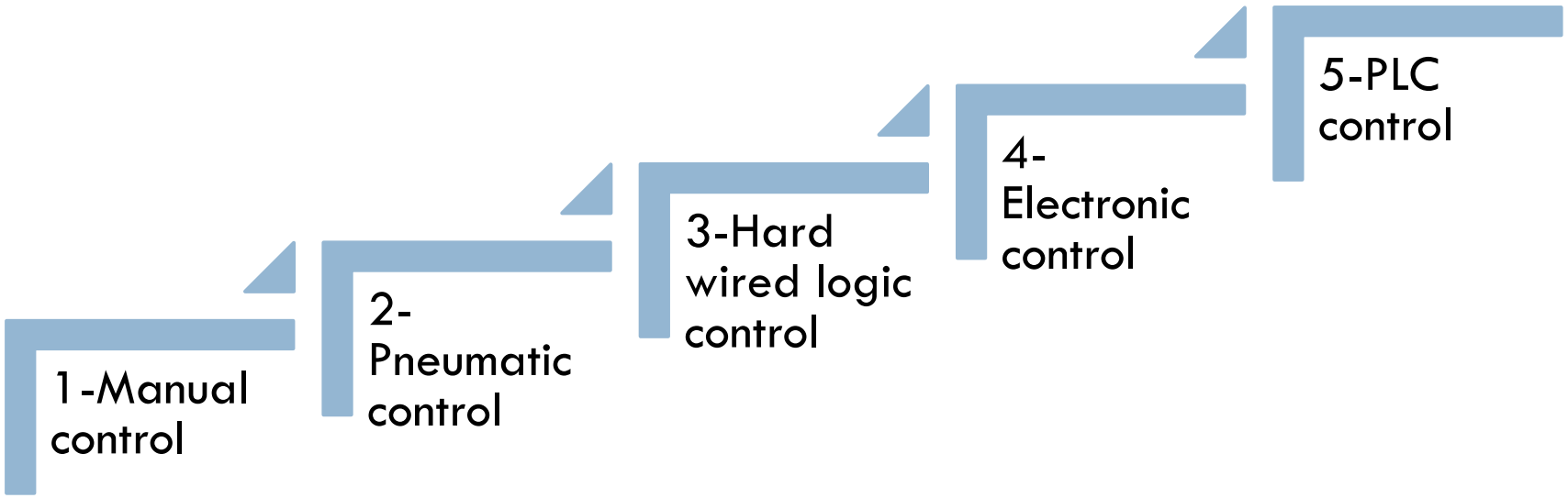
Industrial Automation

- Use of control systems, such as computers or robots, and information technologies for handling different processes and machineries.



History of Control System





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1. Manual control

- All the actions related to process control are taken by the operators.
- **Drawbacks:**

1. Likely human errors and consequently its effect on quality of final product.
2. The production, safety, energy consumption and usage of raw material are all subject to the correctness and accuracy of human action.

2. Pneumatic Control

- Industrial automation, with its machine and process control, had its origin in the 1920s with the advent of "Pneumatic Controllers".
- Actions were controlled by a simple manipulation of pneumatic valves, which in turn were controlled by relays and switches.
- **Drawbacks**

1. Bulky and Complex System.
2. Involves lot of rework to implement control logic.
3. Longer project time.

3. Hard wired logic control

- The contactor and Relays together with hardware timers and counters were used in achieving the desired level of automation.
- **Drawbacks**

1. Bulky panels.
2. Complex wiring.
3. Longer project time.
4. Difficult maintenance and troubleshooting.

4. Electronic Control using Logic Gates

- In 1960s with the advent of electronics, the logic gates started replacing the relays and auxiliary contactors in the control circuits.
- The hardware timers & counters were replaced by electronic timers.
- **Advantages:**

1. Reduced space requirements.
2. Energy saving.
3. Less maintenance & greater reliability

- **Drawbacks:**

1. Changes in control logic not possible.
2. More project time

5. Programmable Logic Controllers (PLC)

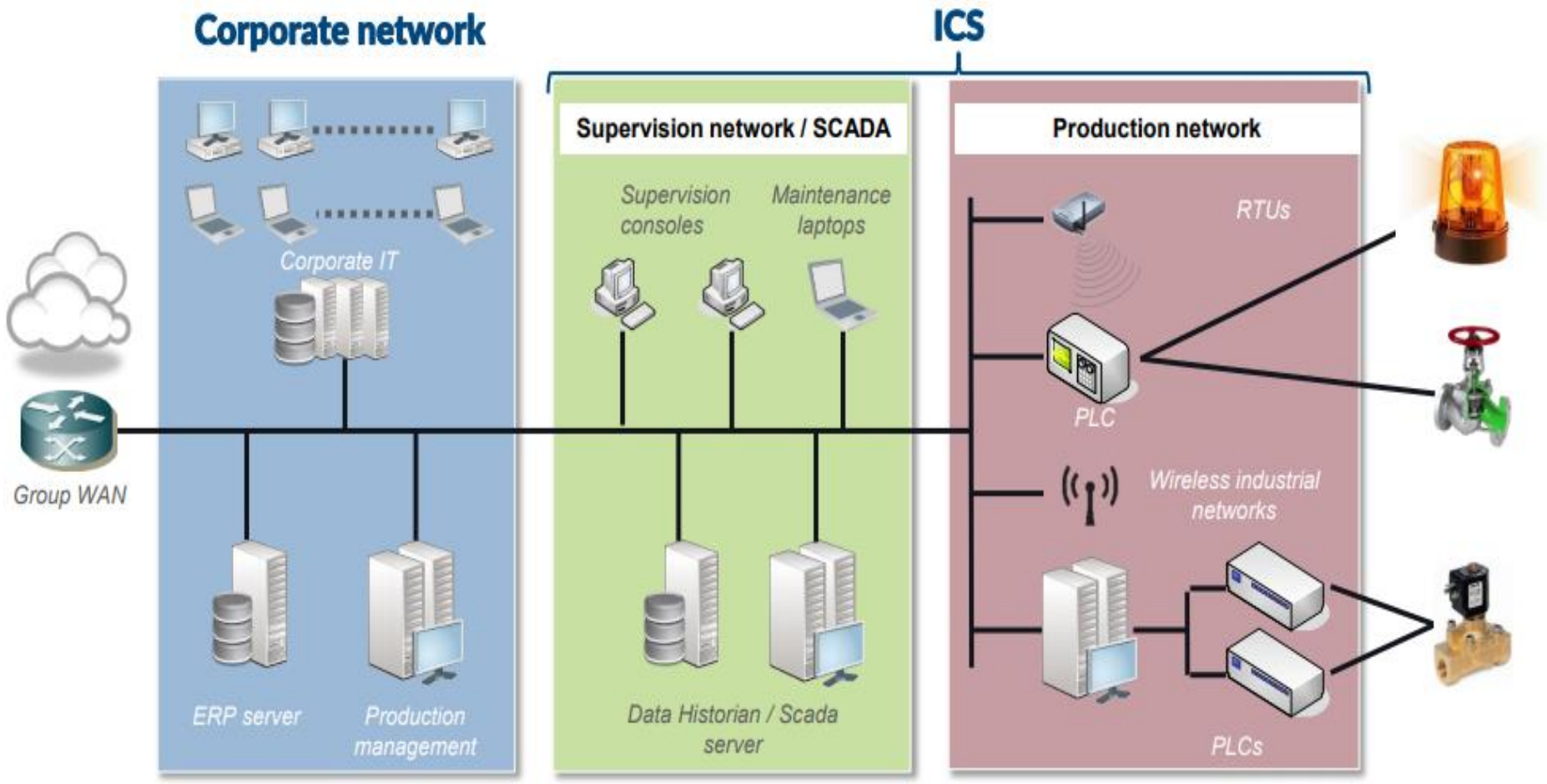
- In 1970s with the coming of microprocessors and associated peripheral chips, the whole process of control and automation underwent a radical change.

- Instead of achieving the desired control or automation through physical wiring of control devices, in PLC it is achieved through a program or say software.

- The programmable controllers have in recent years experienced an unprecedented growth as universal element in Industrial Automation.
- It can be effectively used in applications ranging from simple control like replacing small number of relays to complex automation problems.
- **Advantages:**

1. Reduced space, Energy saving, and Ease of maintenance.
2. Economical.
3. Greater life, reliability, and Tremendous flexibility.
4. Shorter project time.
5. Easier storage, archiving and documentation

What is an Industrial Control System (ICS)?



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ICS Components

1. Sensors and actuators:

- allow interaction with the physical world (pressure sensor, valves, motors, …).

2. Local HMI:

- Human-Machine Interface, permits the supervision and control of a sub process.

3. PLC:

- Programmable Logic Controller : manages the sensors and actuators

4. Supervision screen:

- remote supervision of the industrial process.

5. Data historian:

- Records all the data from the production and Scada networks and allows exporting to the corporate IS

What is Wrong with current ICS Security?

ORGANIZATION & AWARENESS

NETWORK SEGMENTATION

VULNERABILITY MANAGEMENT

SECURITY IN PROTOCOLS

THIRD PARTY MANAGEMENT

SECURITY SUPERVISION

Thank You For Your Attention

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