INDUSTRY 4.0 Revolution

وزارة الإنتاج الحربي
Ministry of Military Production

ورشة عمل" تطبيقات الثورة الصناعية الرابعة للصناعة"
التابعة للمبادرة القومية لإعداد كوادر الرقمنة الصناعية

التي أطلقتها وزارة الإنتاج الحربي
(التدريب على تقنيات الثورة الصناعية الرابعة – مرحله اولى)

جمهورية مصر العربية

وزارة الإنتاج الحربي

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Ministry of Military Production

INDUSTRY 4.0

Revolution

Presented by:
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جمهورية مصر العربية

وزارة الإنتاج الحربي

Presenter C.V.

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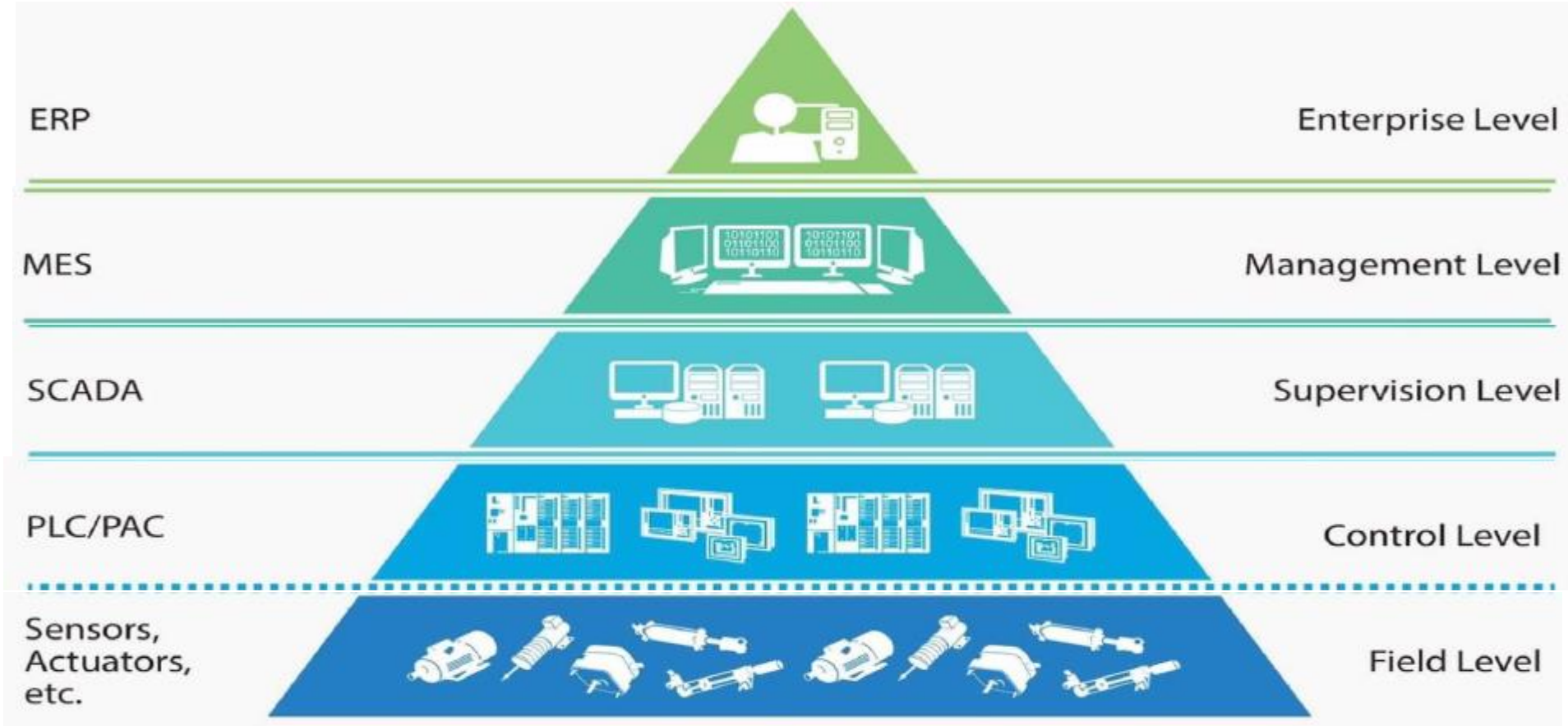
- Gradution year 2014
- I&C Department

Automation Pyramid



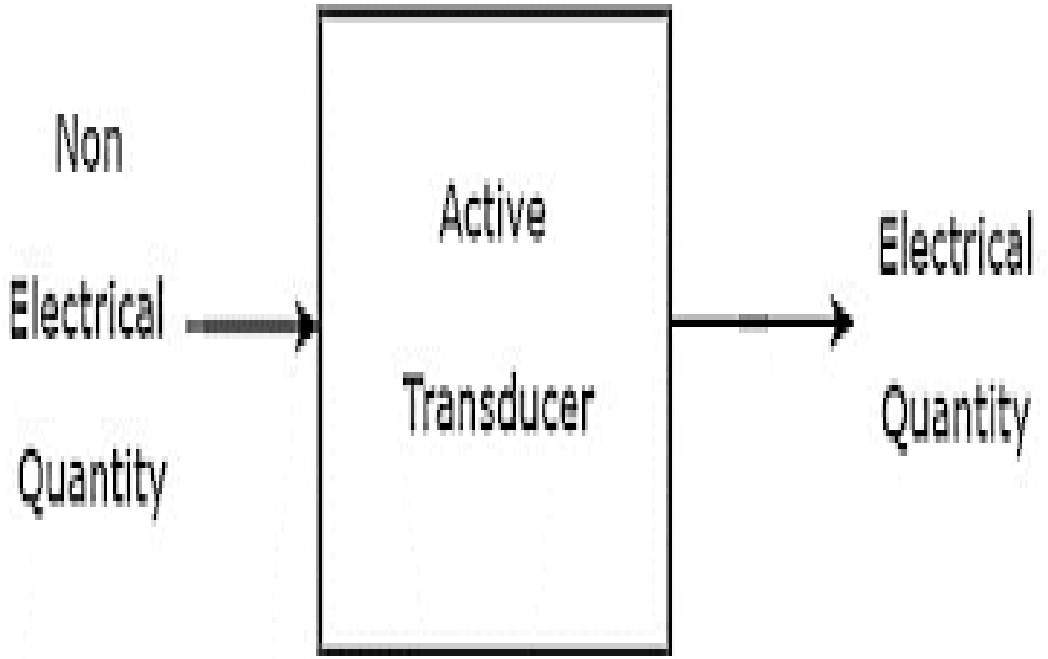
Automation System

- Inputs are the signals or data received by the system
- outputs are the signals or data sent from it.
- The term can also be used as part of an action; to "perform I/O" is to perform an input or output operation.

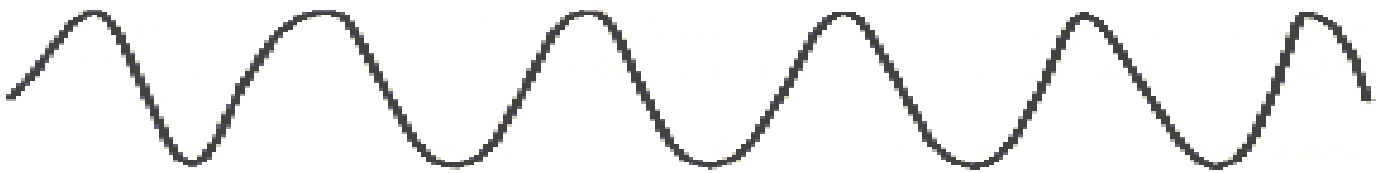
Outputs

- Valves
- Motor Starters
- Solenoids
- Actuators
- Control Relays
- Horns & Alarms
- Stack Lights
- Fans
- Counter/Totalizer
- Pumps
- Printers

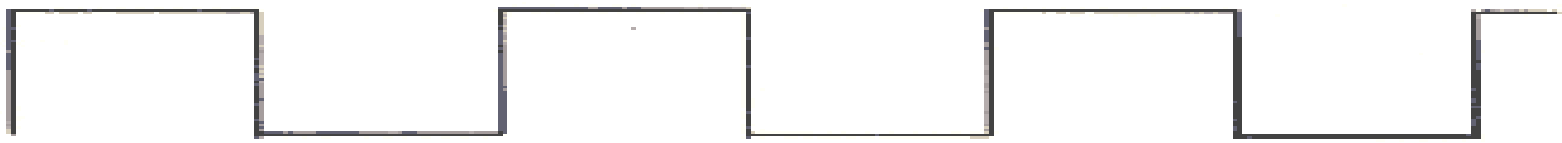
Sensors


Non
Electrical
Quantity
Active
Transducer
Electrical
Quantity

Digital Vs Analogue signals



Analog Signal



Digital Signal

Switches

1-Level Switch

2-Pressure Switch

3-Temperature Switch Thermostat

….. Etc…

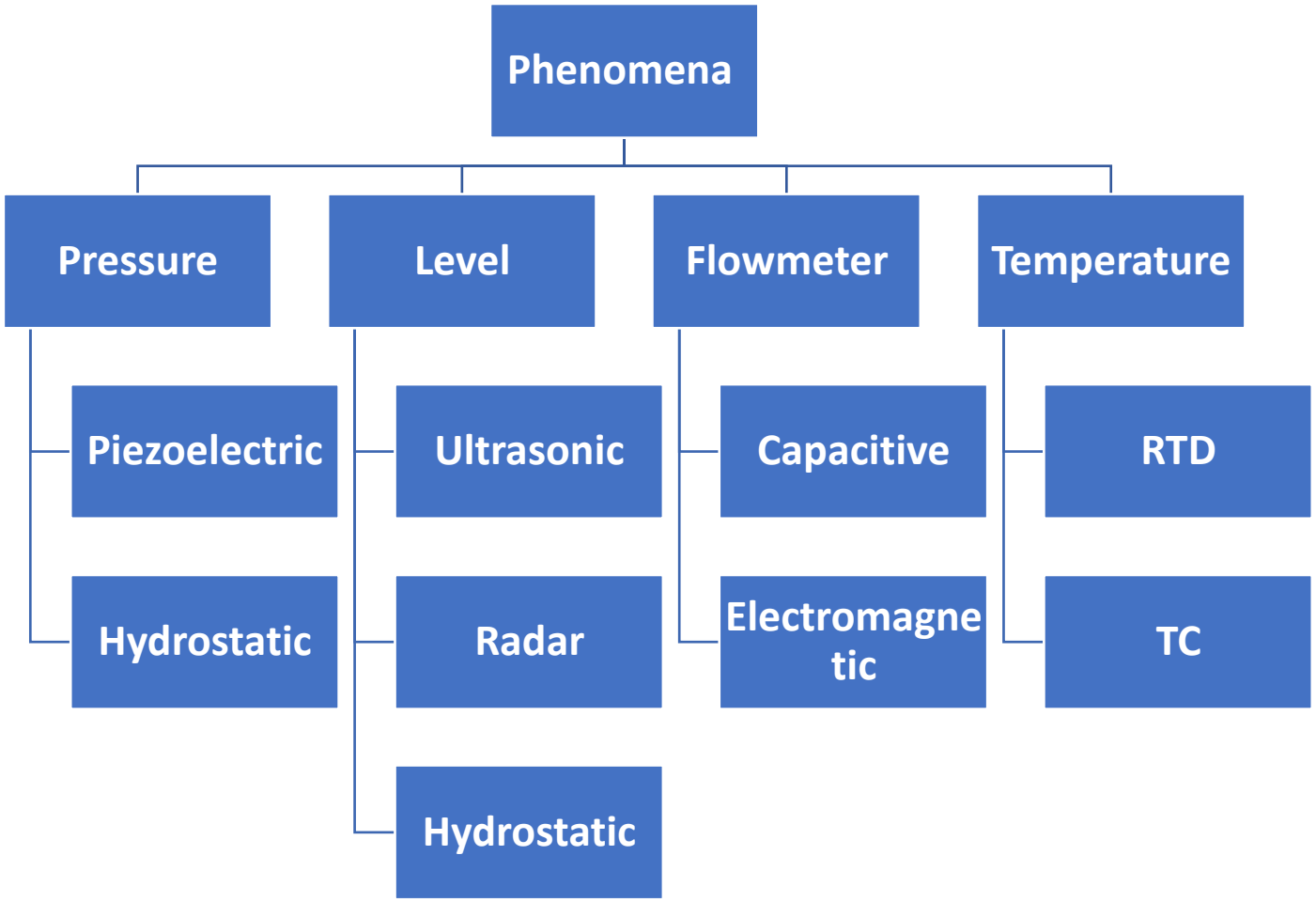
Transmitters

1-Level Transmitters

2-Pressure Transmitters

3-Temperature Transmitters

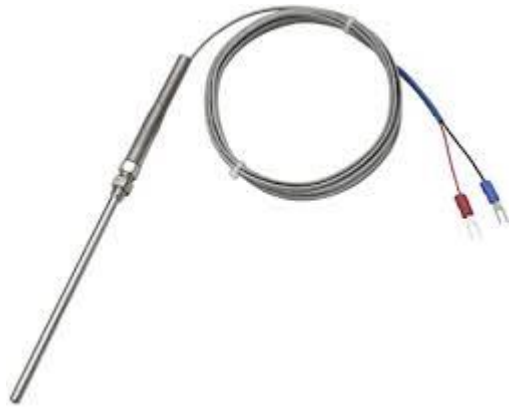
4-Flowmeter.


Phenomena
Pressure
Level
Flowmeter
Temperature
Piezoelectric
Hydrostatic
Ultrasonic
Radar
Hydrostatic
Capacitive
Electromagnetic
RTD
TC

Temperature

RTD

TC



RTD VS TC

Working Principle

RTD (**Resistance Temperature Detector**) is a temperature sensor that works on the **principle** that a material's electrical resistance changes with change in temperature.

Thermocouple is based on Seeback Effect **principle** when two dissimilar metals are joined, a predictable voltage will be generated that relates to the difference in temperature between the Two junctions.

RTD VS TC

Ranges

RTDs sensors are the best suitable for the measurement in low temperature range **200 to 400 °C.**

Thermocouple are designed for the measurement of High Temperature Range **200 to 1750 °C.**

RTD VS TC

Accuracy

RTDs are more accurate than Thermocouple. RTD has accuracy of **0.1 to 1°C.**

RTD is more accurate in Lower temperature range.

Thermocouple has lower accuracy i.e **0.5 to 5°C.**

Thermocouple are more accurate in Upper temperature Range.

RTD VS TC

Sensors types

PT-100(Platinum-100) is most popular type of RTD. PT-100 produces 100 Ohms on zero degree centigrade temperature.

PT-50,Cu-50, PT-1000 are also used in various applications.

K type (0 to 1250 °C) Thermocouple is most commonly used in industries.

R,S,J type Thermocouples are also used in various applications.

RTD VS TC

Response

The Response time of RTD is slow. Generally the Response time of RTD is **1 to 50 seconds.**

The Response time of Thermocouple is fast compared to RTD. Generally the Response time of Thermocouple is **0.1 to 10 seconds.**

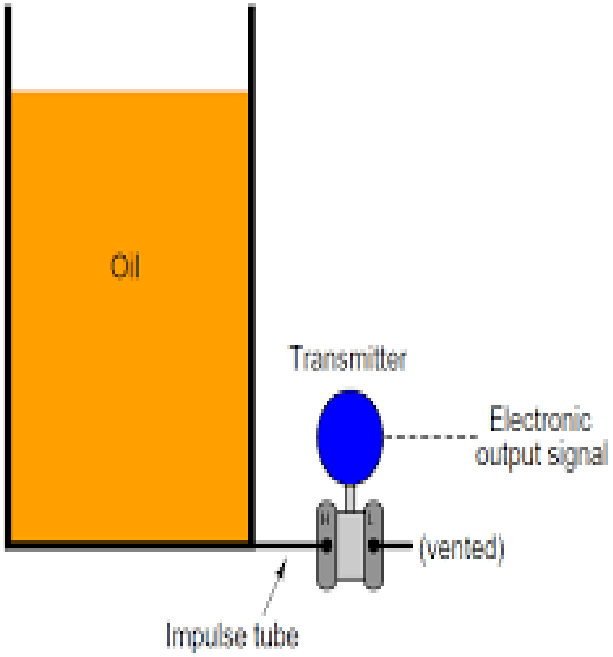
RTD VS TC

Cost

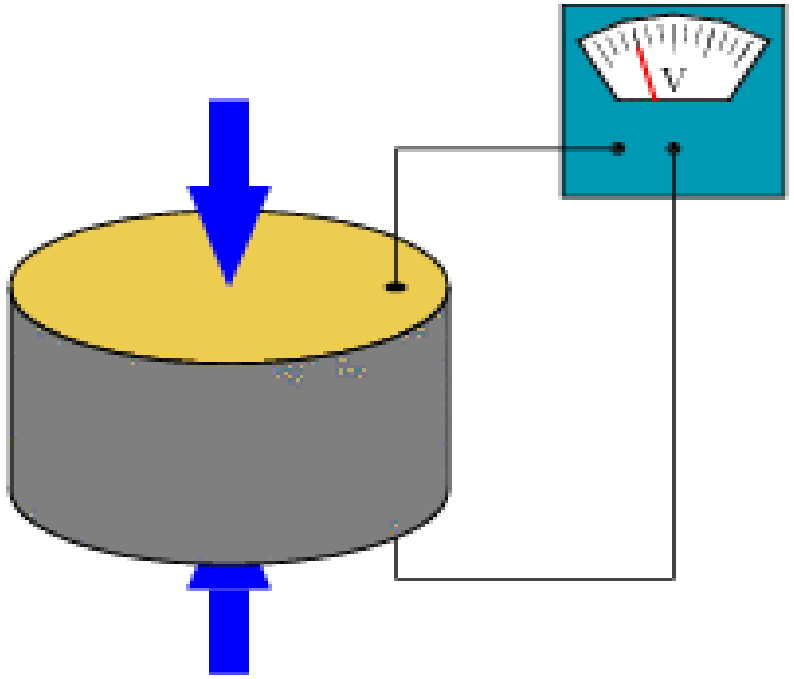
RTD often cost more than the Thermocouple due to its design technique and Material used.

Thermocouples are generally cheaper than RTDs.

Pressure

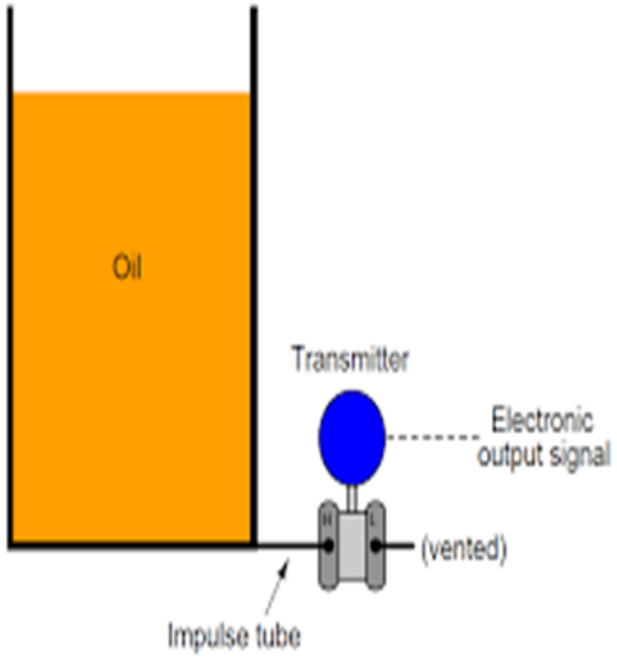


Hydrostatic

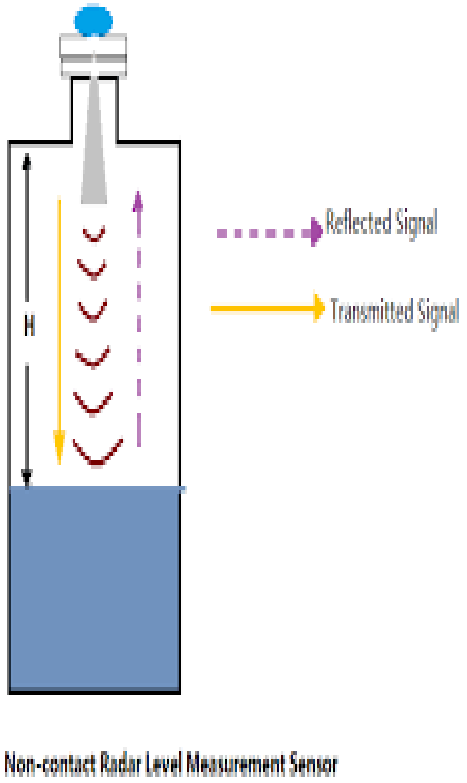


Piezoelectric sensor

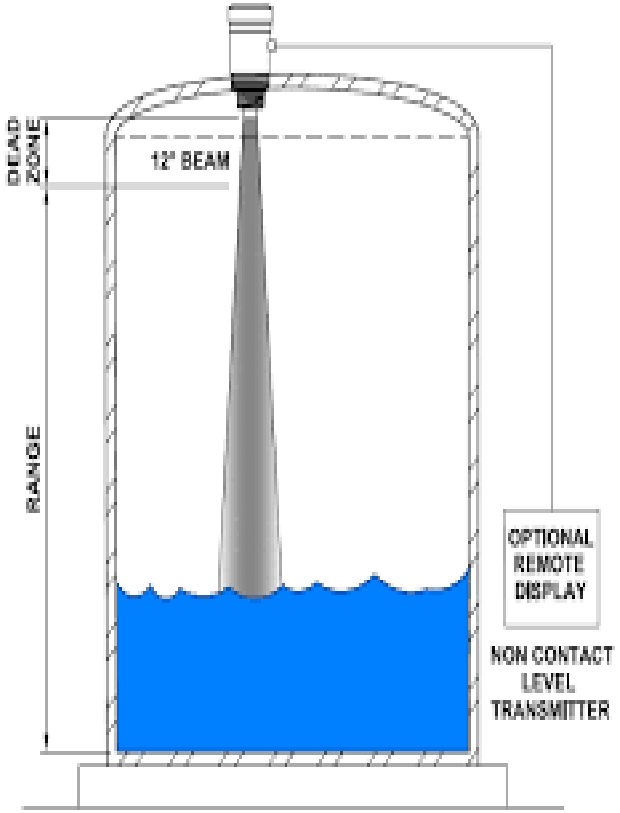
Level



Hydrostatic

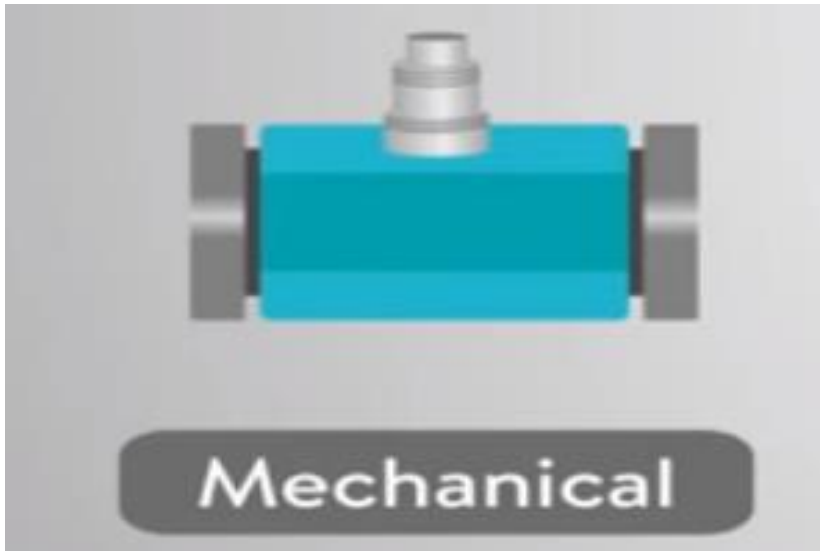


Radar

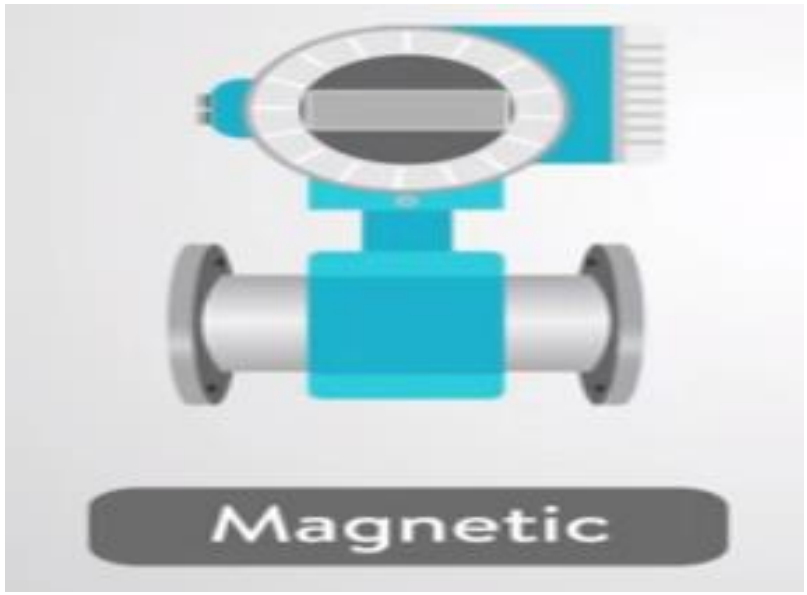


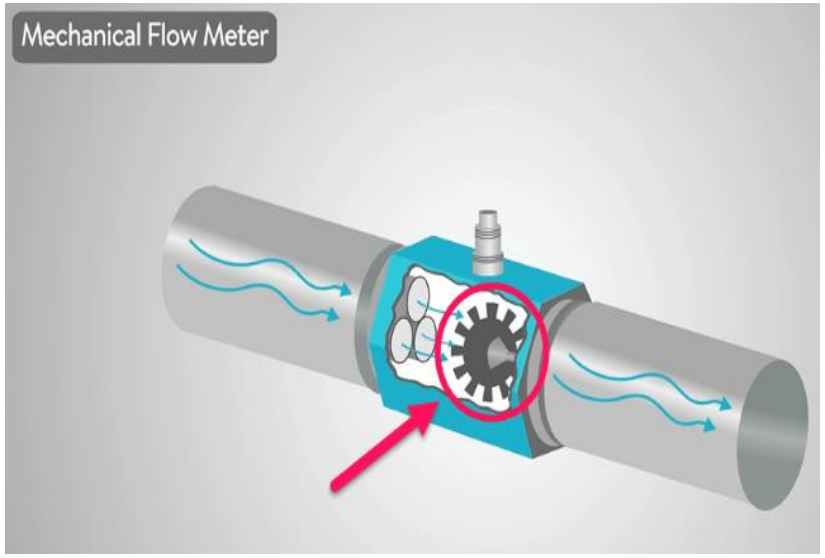
Ultrasonic

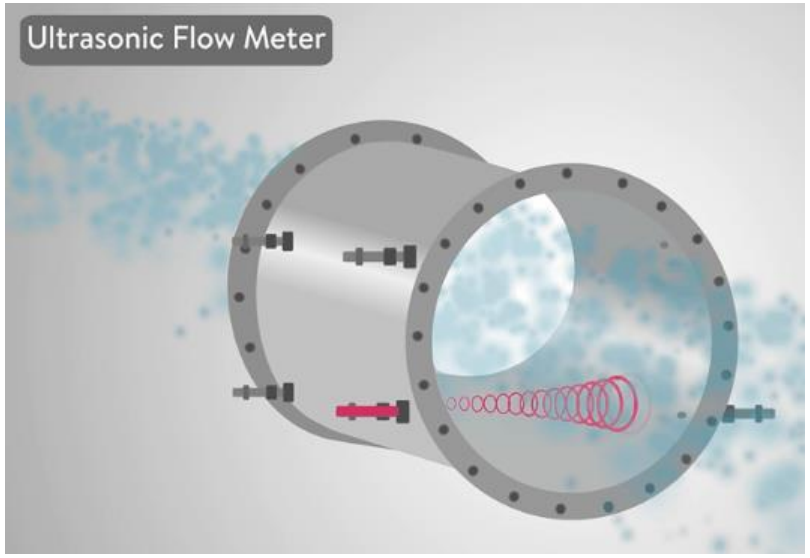
Flow meter

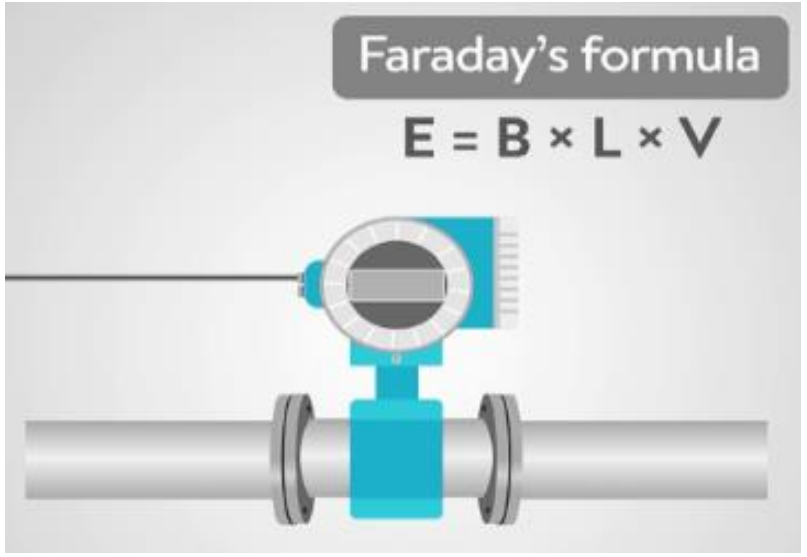

Mechanical


Ultrasonic

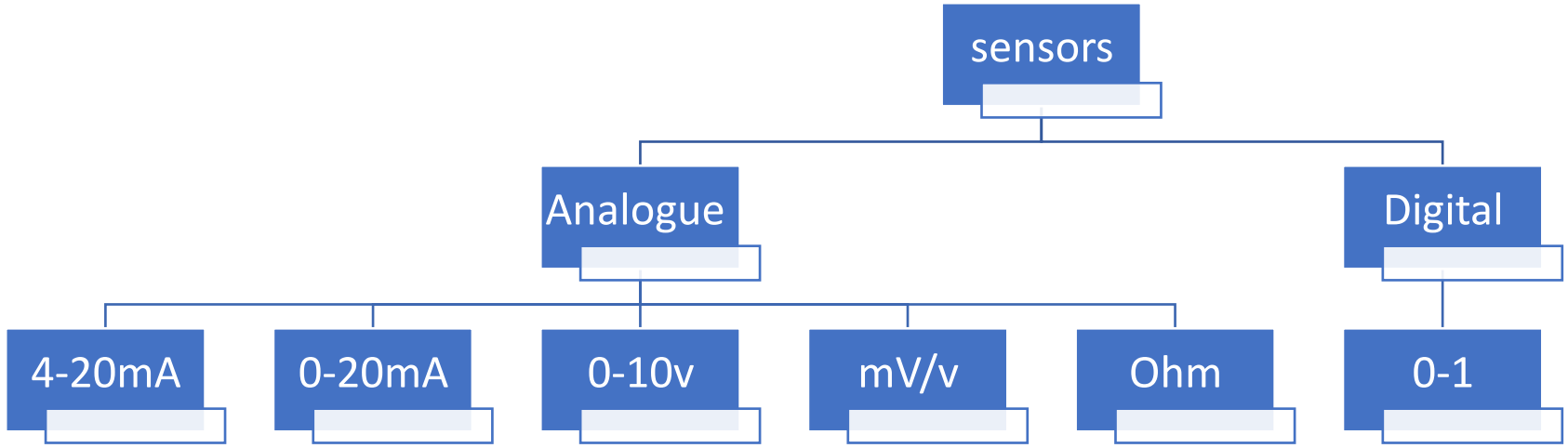

Magnetic


Mechanical Flow Meter


Ultrasonic Flow Meter


Faraday's formula
E = B × L × V

Measuring Standards



Why current signal is better than voltage signal ?

- When voltage signal transmitted over a long distance it cause a voltage drop in the wires , so there might be large voltage difference between the sending end and receiving end this leads to measure errors

- These errors isn’t found when we use current signals

- The transmitter is generally loop powerd with 24 v supply the transmitter with this arrangement is called two wire transmitter

- The process signal can be measured by connecting ampere meter in the series with 24 v supply source

- The response of current signal is more linear than the response of voltage signal is more linear than the response of voltage

- The noise immunity of current signal and voltage signal depends on the impedance of the source
The current signal provides low impedance to sensor / transmitter so it has better immunity to noise

- The accuracy of current signal transmission is far better than voltage transmission signal

Why 4-20 mA is preferred over 0-20 mA ?

Because the broken wire can be easily detected with using of 4-20 mA

Types Of Control Systems

1-Openloop

2-Closed loop

Open loop Control System

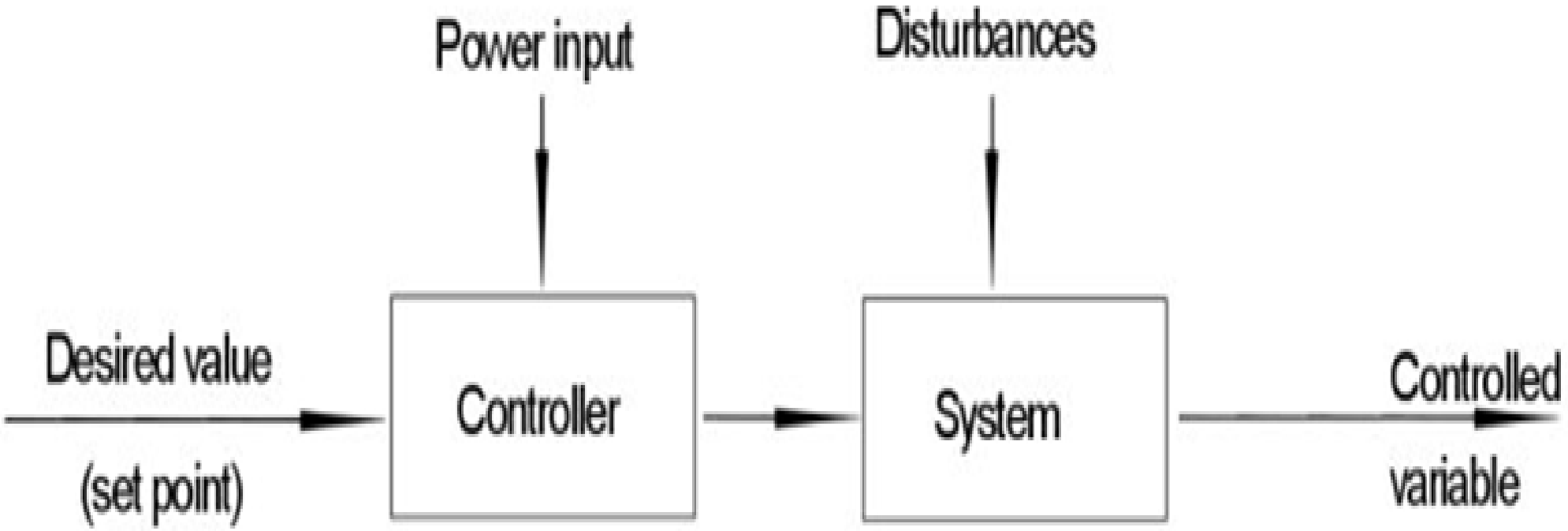
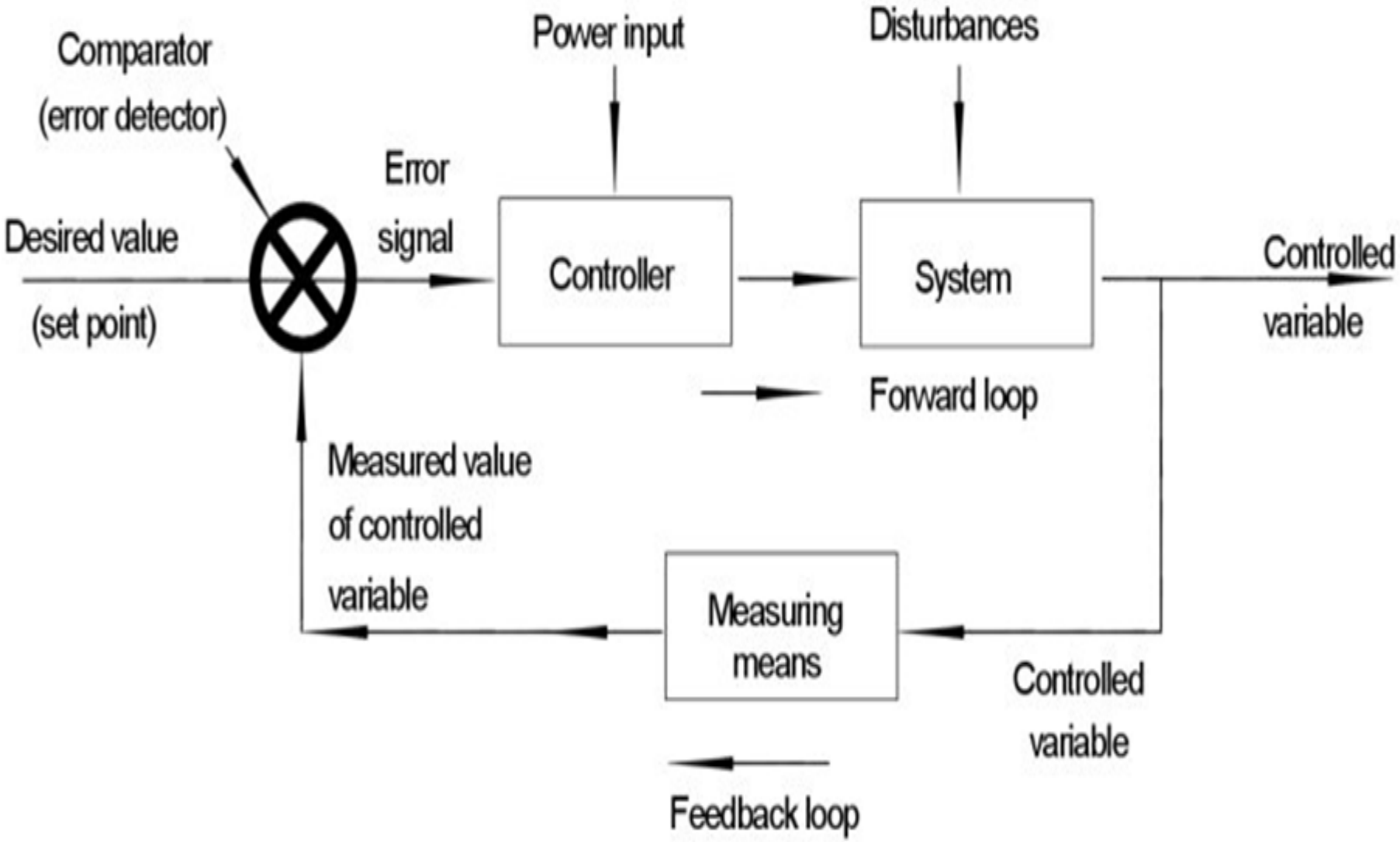
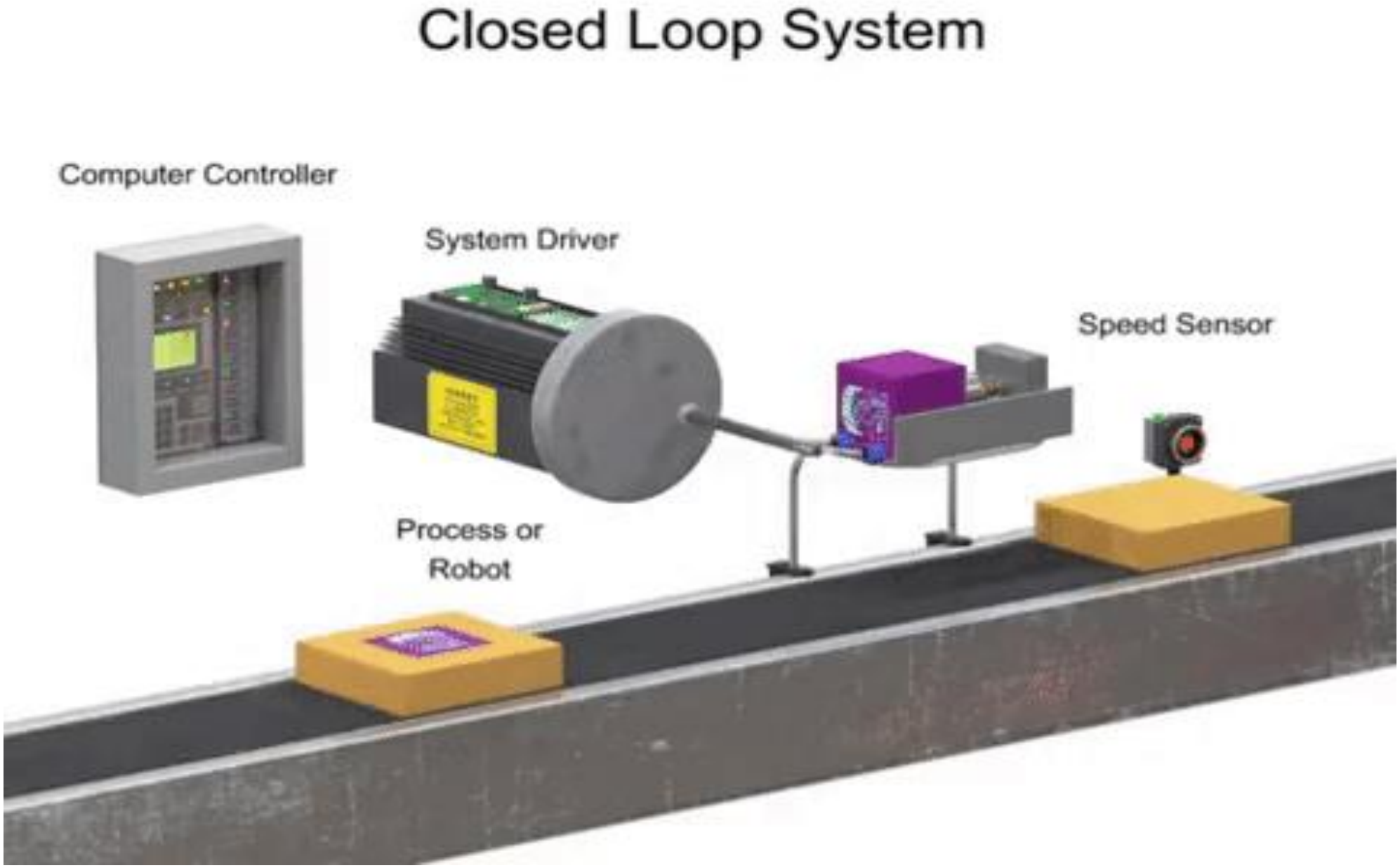


Figure 1A

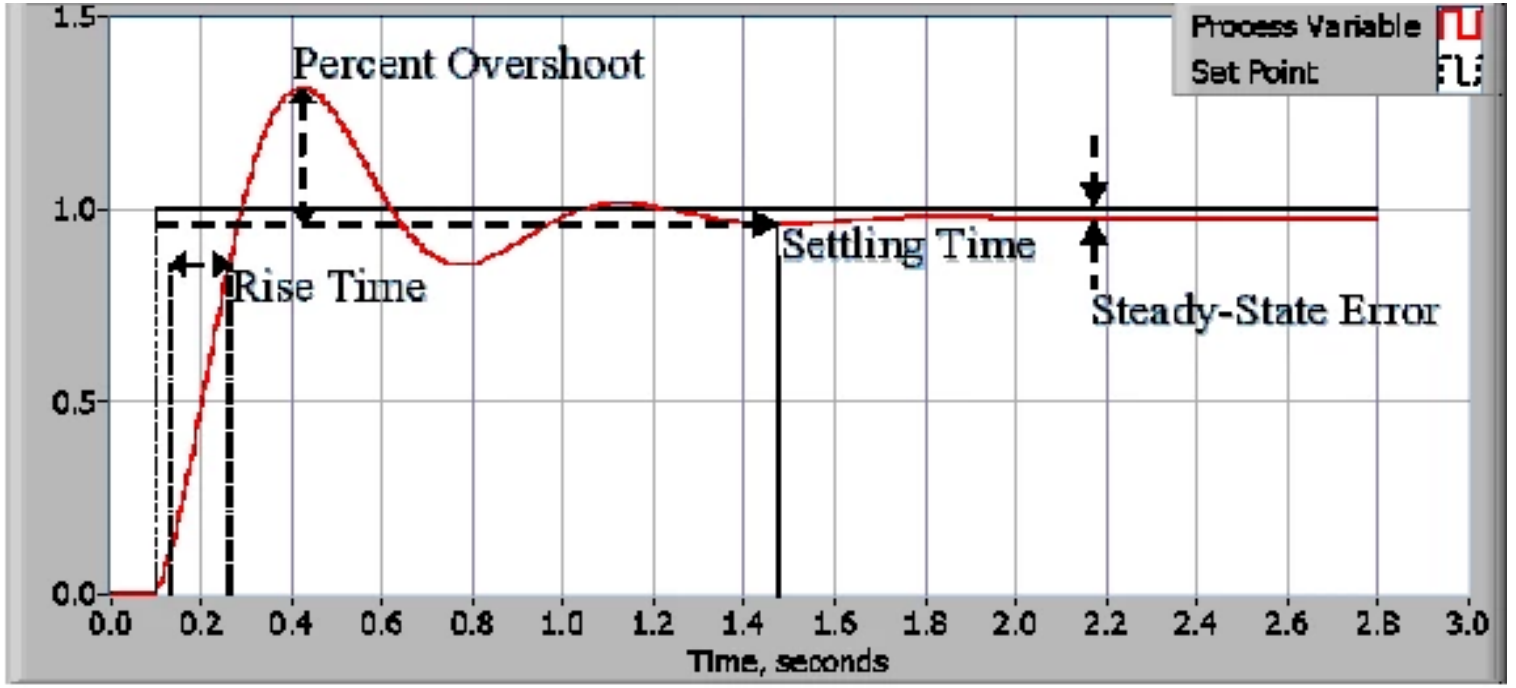
Closed loop Control System



Example


Closed Loop System
Computer Controller
System Driver
Speed Sensor
Process or
Robot

PID Controller



Parameter	Rise-time	Overshoot	Settling time	Steady State Error	Stability
K_p	Decrease	Increase	Small Change	Decrease	Decrease
K_i	Decrease	Increase	Increase	Eliminate	Decrease
K_d	Minor changes	Decrease	Decrease	No effect	Improve if Kd is small


ANY
QUESTIONS?


BREAK
TIME!!!

Control in Manufacturing

1-Classic control

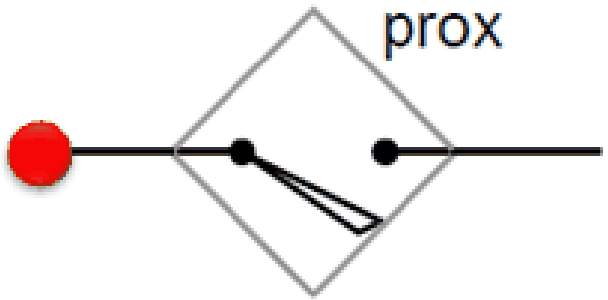
2-Microprocessors

3-Microcontrollers

4-PLC

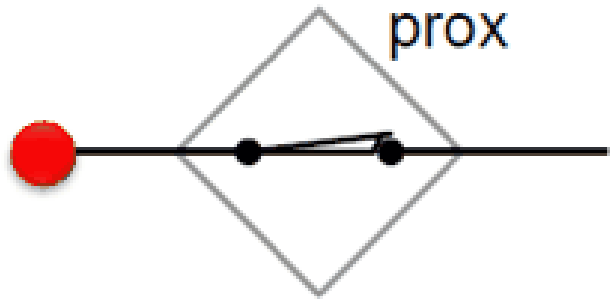
Control Concept

Proximity switch symbols



Normally-open

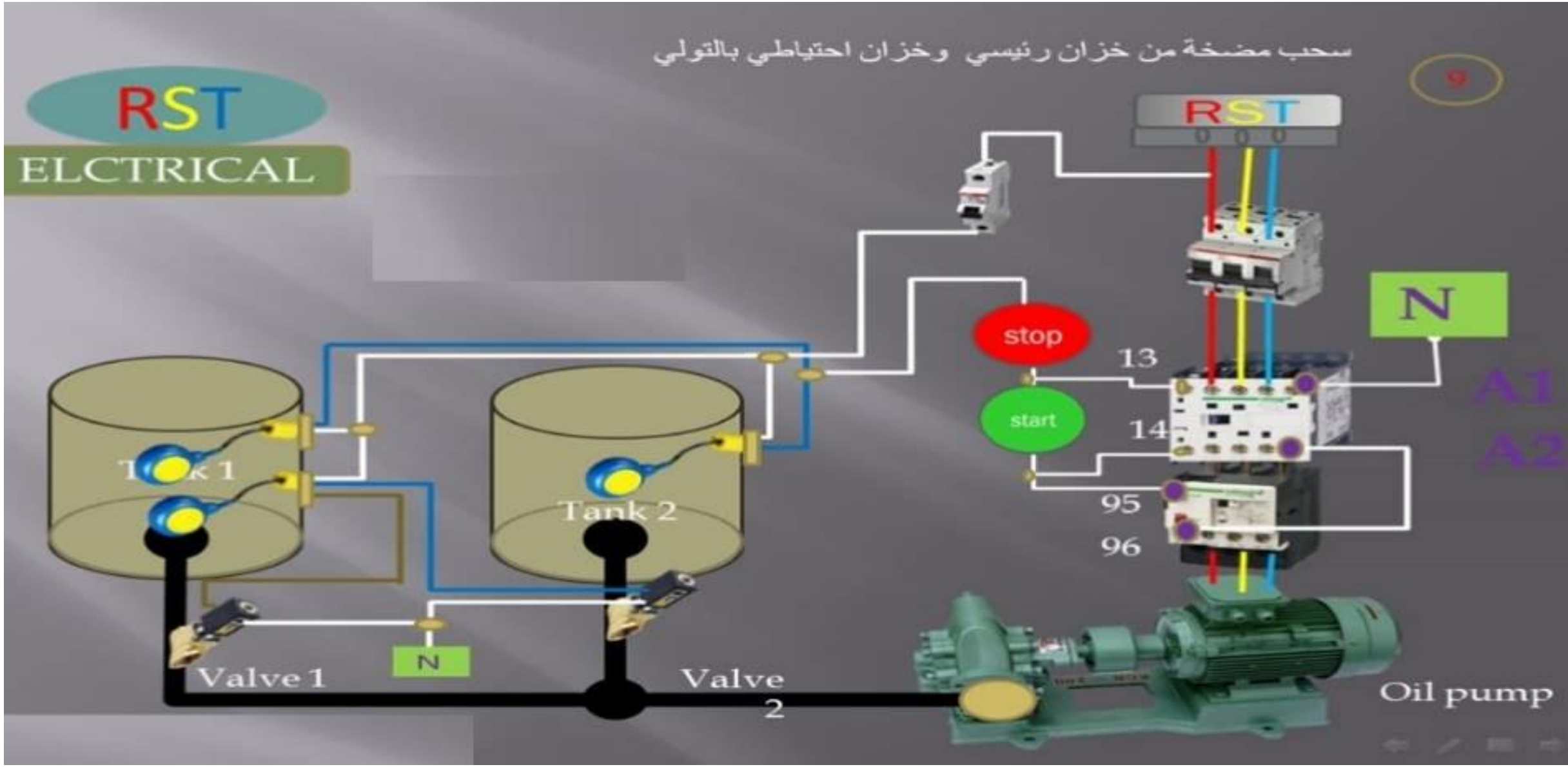
(NO)



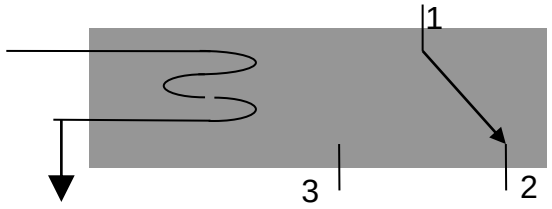
Normally-closed

(NC)

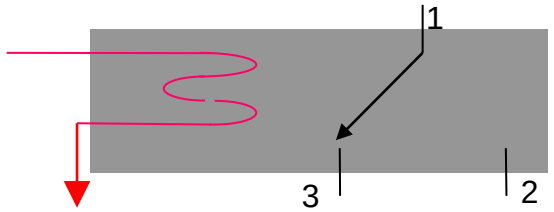
Classic Control



Relays



Coil off: Pin 1 and 2 connected

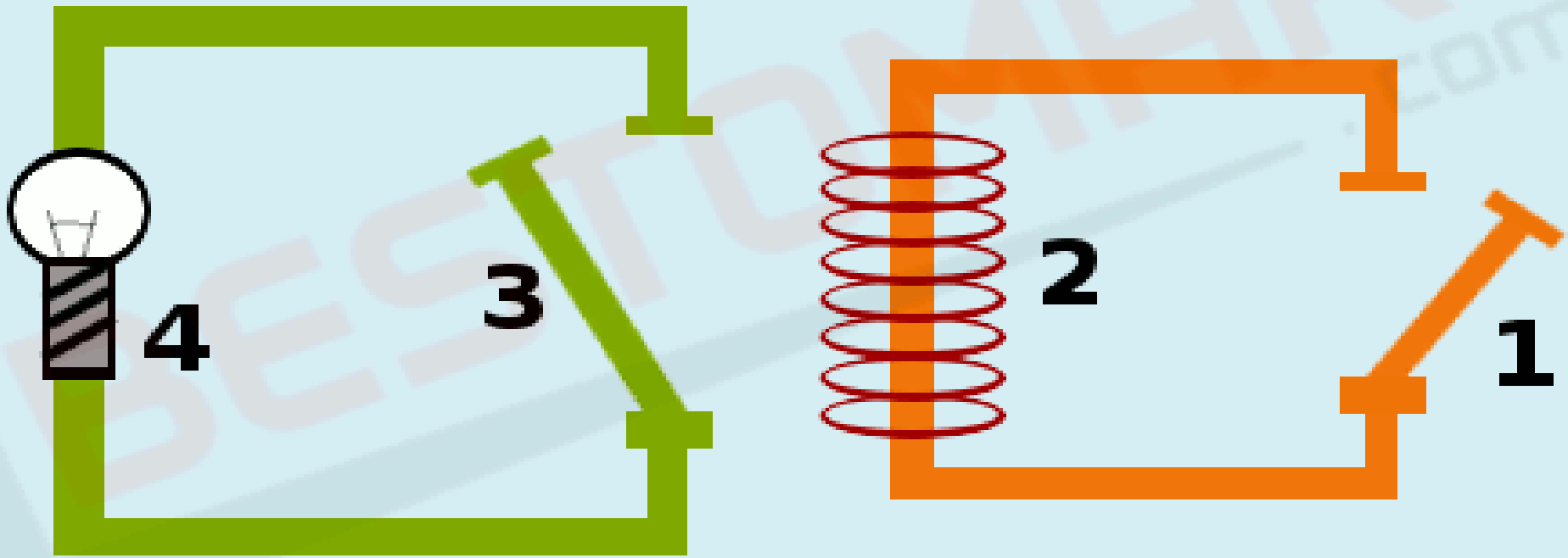


Coil on: Pin 1 and 3 connected

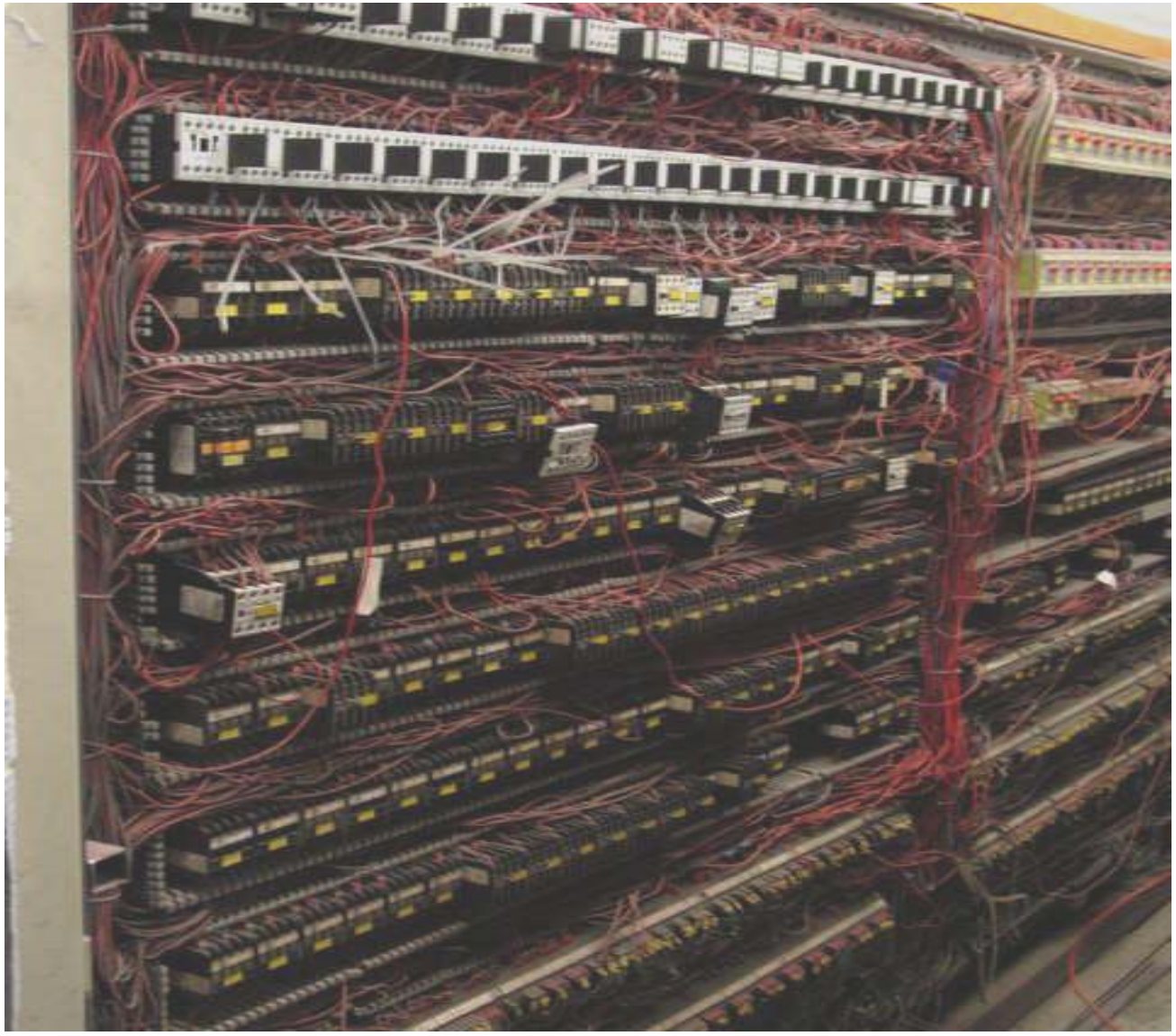
A relay is an electrically operated switch, which consists of coil and switch.

- When no current is passed through the coil, pin 1 and 2 are connected.
- When current is passed through the coil, the contact is pulled by electromagnetic force and pin 1 and 3 are connected.
- Combinations of switches and relays can realize simple to extremely complicated logical operations.
- Control function is defined through wiring switching elements.

Electromechanical Relay

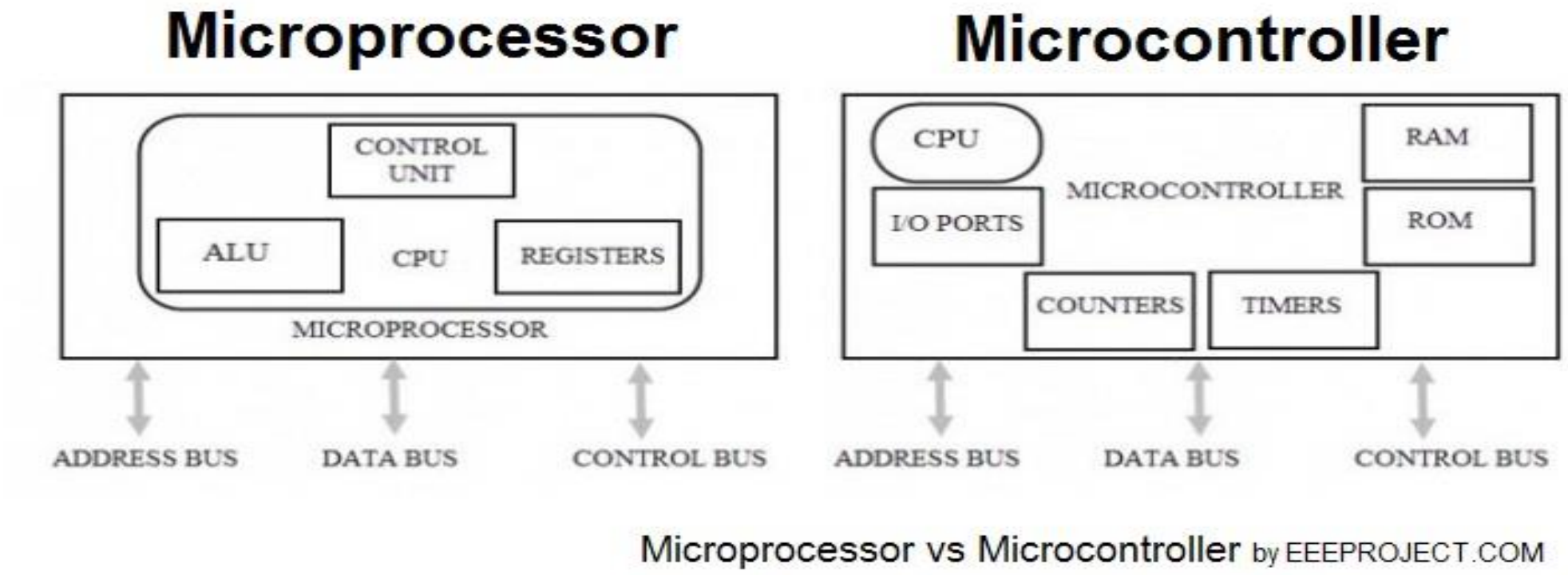


Classic Control Panels



2-Microcontroller Vs Microprocessor

Not reprogrammable



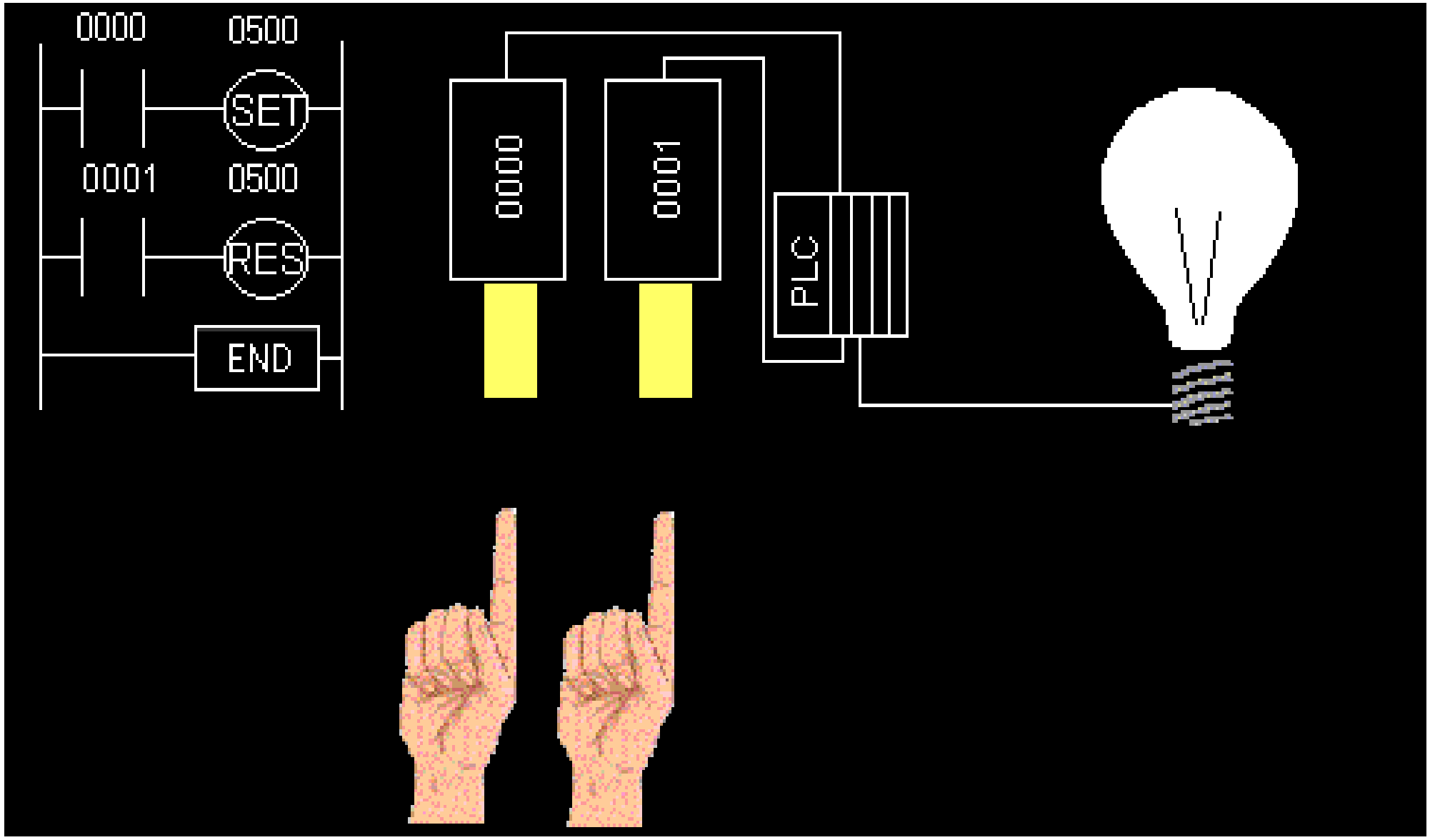
Microprocessor vs Microcontroller by EEEPROJECT.COM

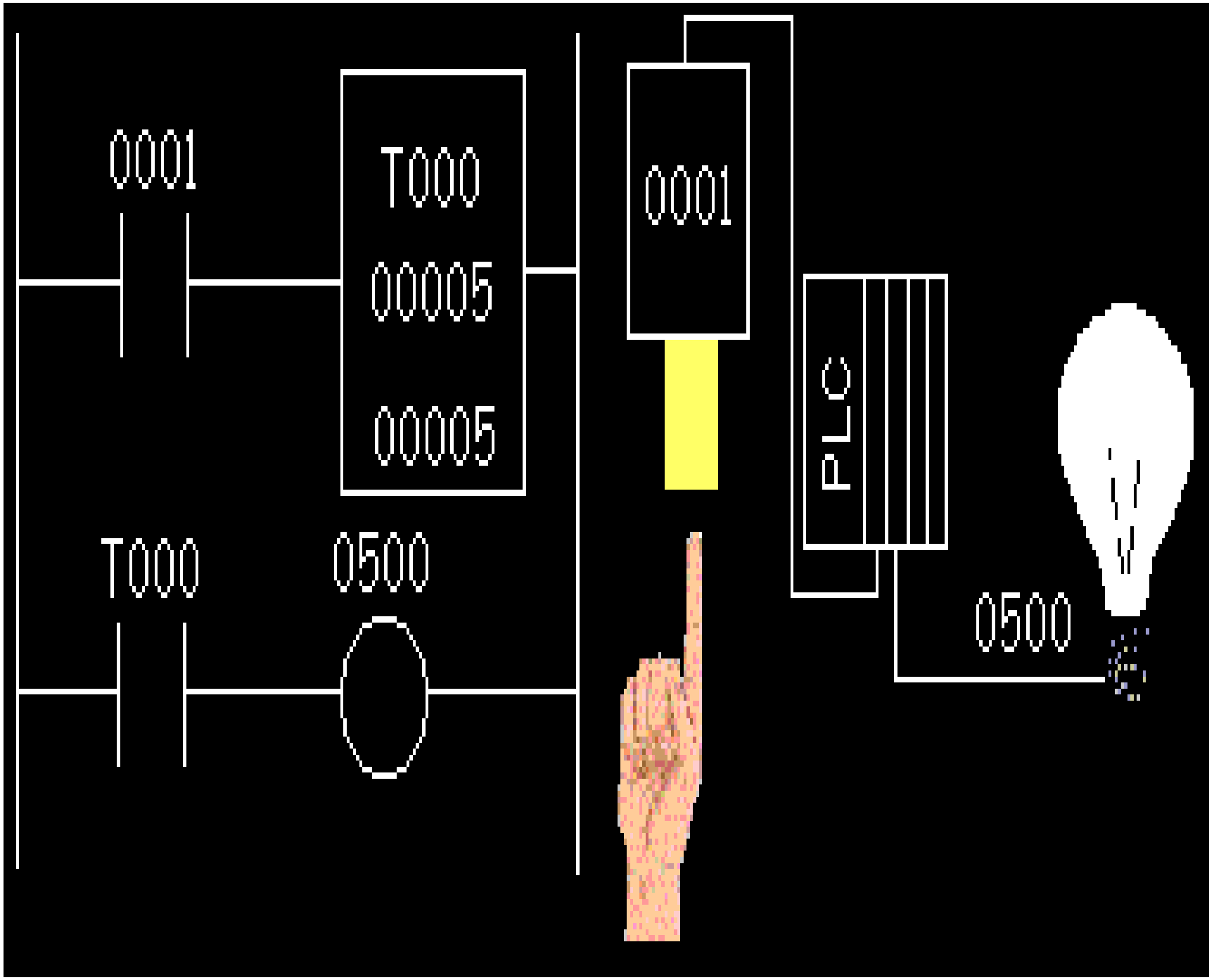
4-PLC

A PLC is an industrial microprocessor-based controller with programmable memory used to store program instructions and various functions

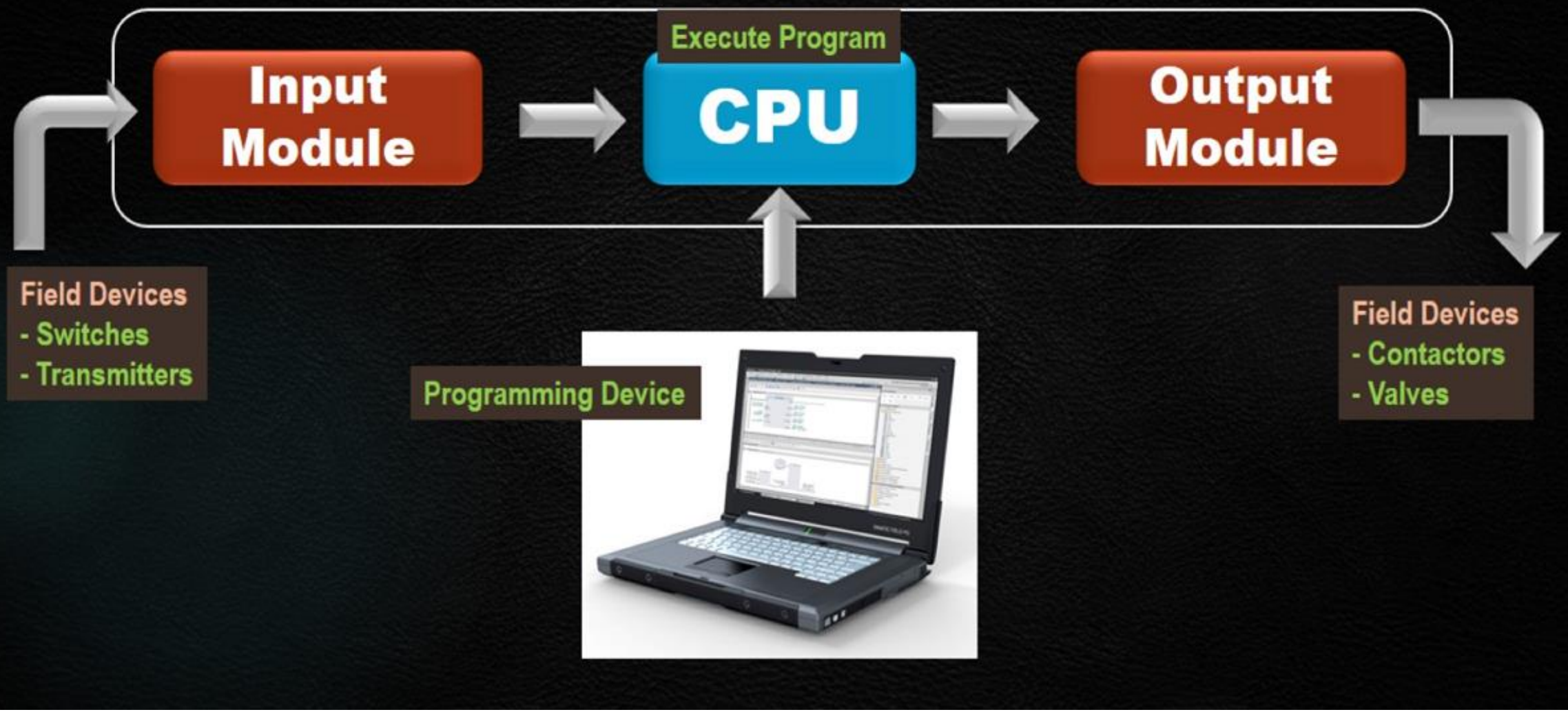
Advantage of PLC

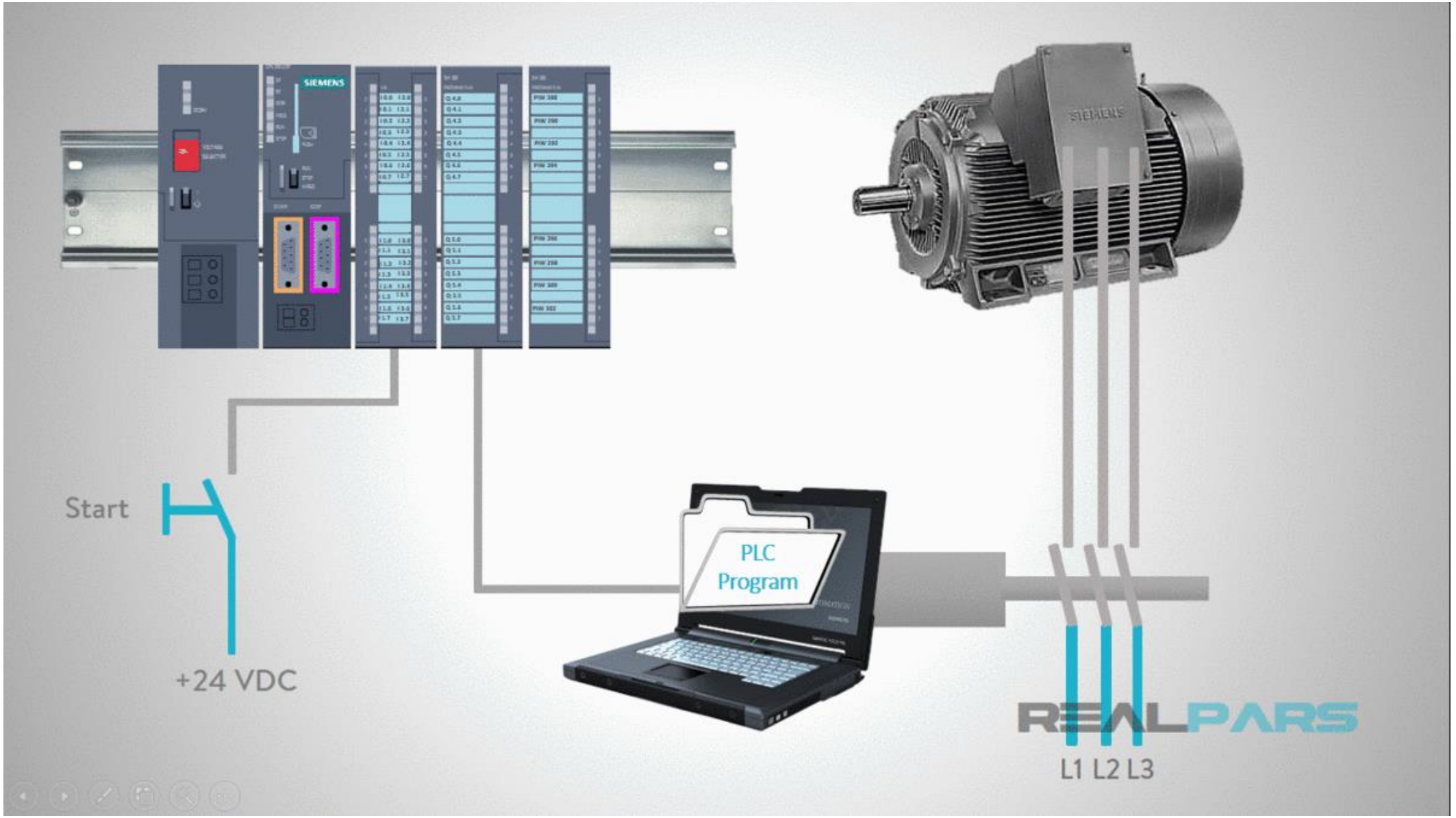
No	Advantage	Description
1	Flexibility	▪ Universal Controller ▪ Can replace various independent/ standalone controller.
2	Implementing Changes and Correcting Errors	▪ Do not have to rewiring relay panel. ▪ Change program using keyboard.
3	Large Quantity of Contact	▪ Large number of' Soft Contact' available
4	Lower Cost	▪ Advancement in technology and open architecture of PLC will reduce the market price.
5	Pilot Running (Simulation Capability)	▪ A program can be simulated or run without actual input connection.
6	Visual Observation.	▪ Can observe the opening and closing of contact switch on CRT. ▪ Operator message can be programmed for each possible malfunction.
7	Speed of Operation	▪ Depends on scan time -millisecond. ▪ Asynchronous operation.


0000
0500
SET
0001
0500
RES
END
0000
0001
PLC


0001
T000
00005
00005
0001
PLC
T000
0500
0500

PLC / Main Components

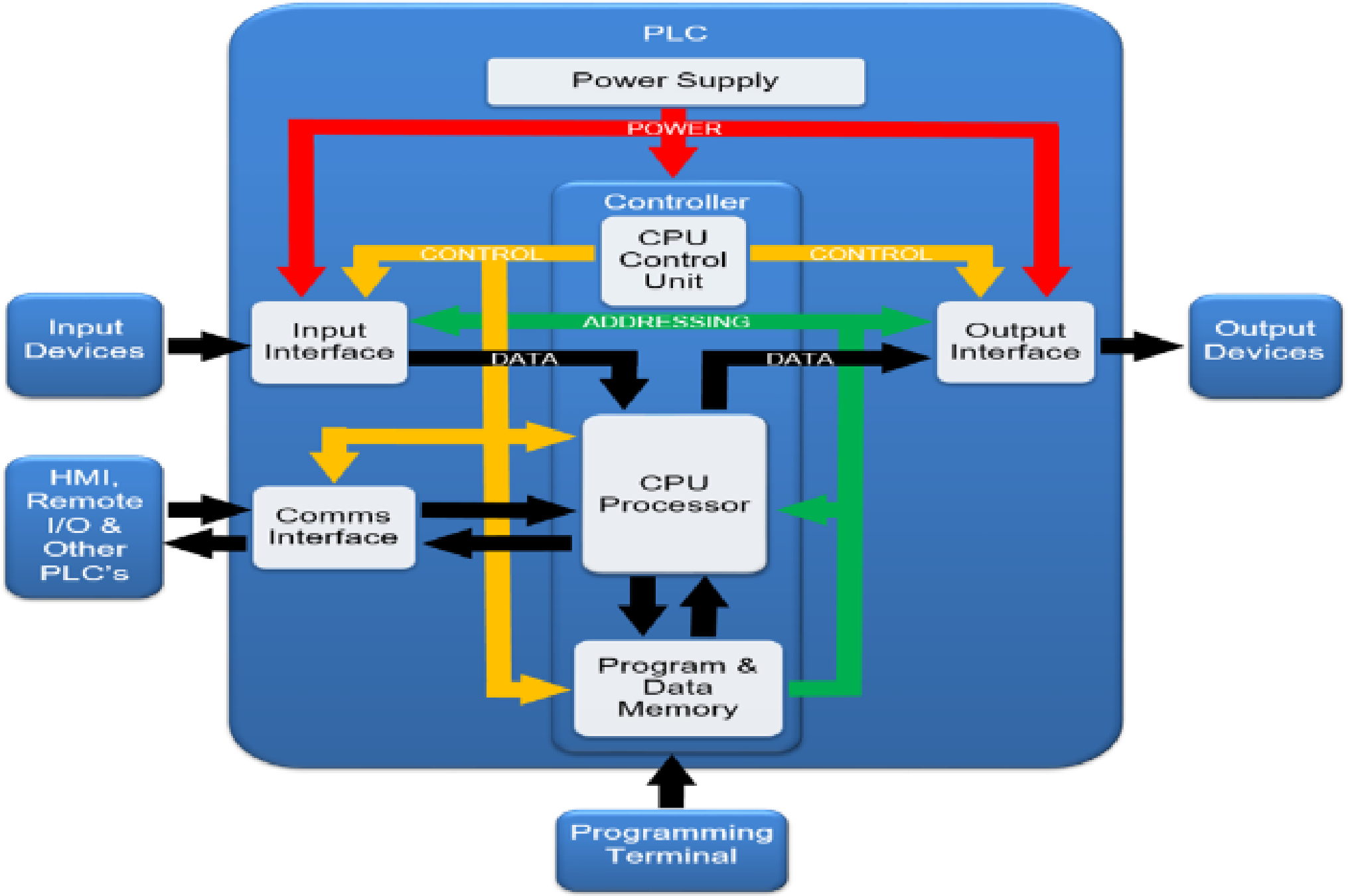



SIEMENS
Start
+24 VDC
PLC
Program
L1 L2 L3
REALPARS

PLC / PLC Manufacturers

Market Share Ranking	PLC Manufacturers	PLC Brand Name/s
1	Siemens	Simatic
2	Rockwell Automation	Allen Bradley
3	Mitsubishi Electric	Melsec
4	Schneider Electric	Modicon
5	Omron	Sysmac
6	Emerson Electric (GE)	RX3i & VersaMax (GE Fanuc)
7	Keyence	KV & V-8000
8	ABB (B&R Automation)	AC500 X20 & X90
9	Bosch	Rexroth ICL
10	Hitachi	EH & H

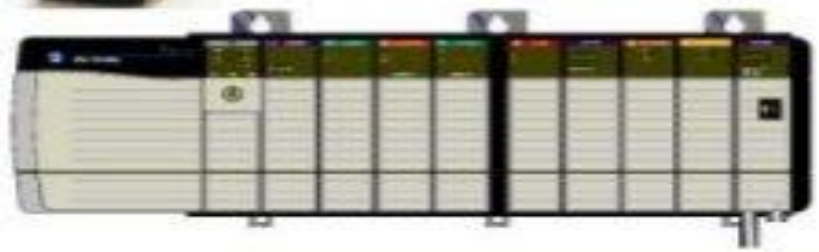
Market Share Ranking	PLC Manufacturers	PLC Brand Name/s
10	Hitachi	EH & H
11	B&R Automation (part of ABB)	X20 & X90
12	Phoenix Contact	AXC
13	Panasonic	FP
14	LS Electric (LSIS)	XG, Master-K & GM
15	Eaton	XC & EasyE4 (Cutler-Hammer)
16	Delta Electronic	DVP, AS & AH
17	Fuji Electric	Micrex


PLC
Power Supply
POWER
Controller
CPU Control Unit
CONTROL
CONTROL
Input Devices
Input Interface
ADDRESSING
Output Interface
Output Devices
DATA
DATA
HMI, Remote I/O & Other PLC's
Comms Interface
CPU Processor
Program & Data Memory
Programming Terminal

Types Of PLC

- There are three types of PLC.
  1. Unitary PLC

2. Modular PLC



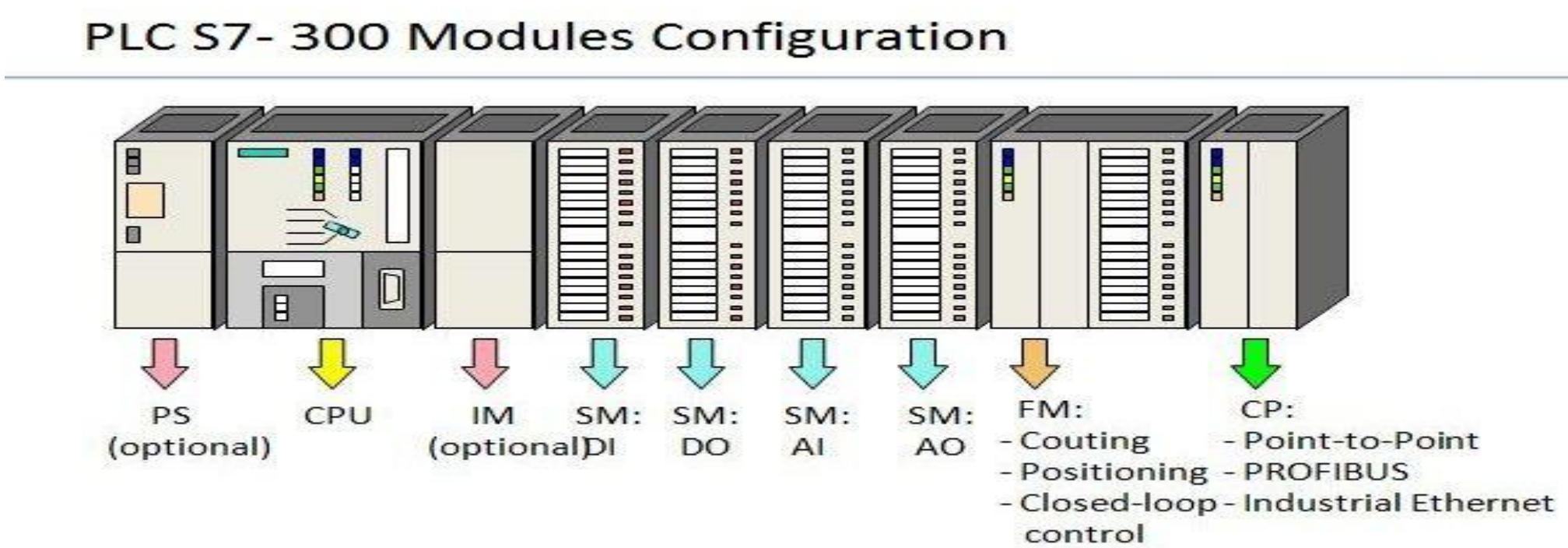
3. Rack Mounted PLC :

PLC Types Comparison Table

PLC TYPES	FIXED PLC 	MODULAR PLC 	DISTRIBUTED PLC 
CPU Performance	Low	Medium to High	High
Program & Data Memory Size	Small	Medium to Large	Large
Power Supply	Embedded	Module	Module
Input Interface	Embedded	Modules	Modules
Output Interface	Embedded	Modules	Modules
Communication Interface	Embedded	Modules	Modules
Mounting System	Single Unit	Rack, Back plane, Rail or Chassis.	Rack, Back plane, Rail or Chassis.
Physical Size	Small	Medium to Large	Medium to Large
Flexibility	No	Yes	Yes
Customizable	No	Yes	Yes
Applications	Basic applications with small number of inputs and outputs.	Medium to high end applications with large number of inputs and outputs.	High end applications and plant wide control with a very large number of inputs and outputs.

S7-1200

S7-300

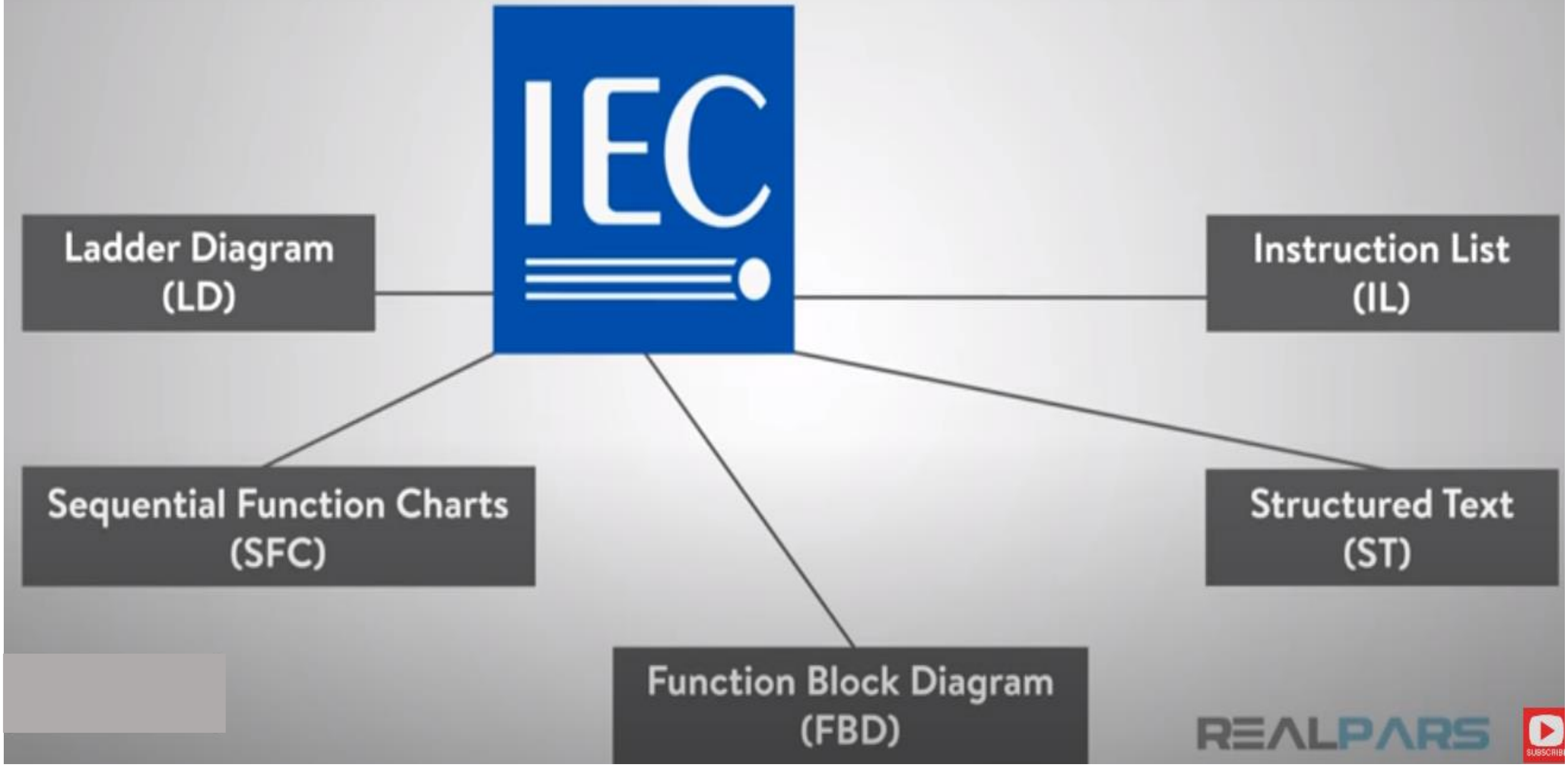

PLC S7- 300 Modules Configuration
PS
(optional)
CPU
IM
(optional)
SM:
DI
SM:
DO
SM:
AI
SM:
AO
FM:
- Couting
- Positioning
- Closed-loop control
CP:
- Point-to-Point
- PROFIBUS
- Industrial Ethernet

S7-300

S7-400

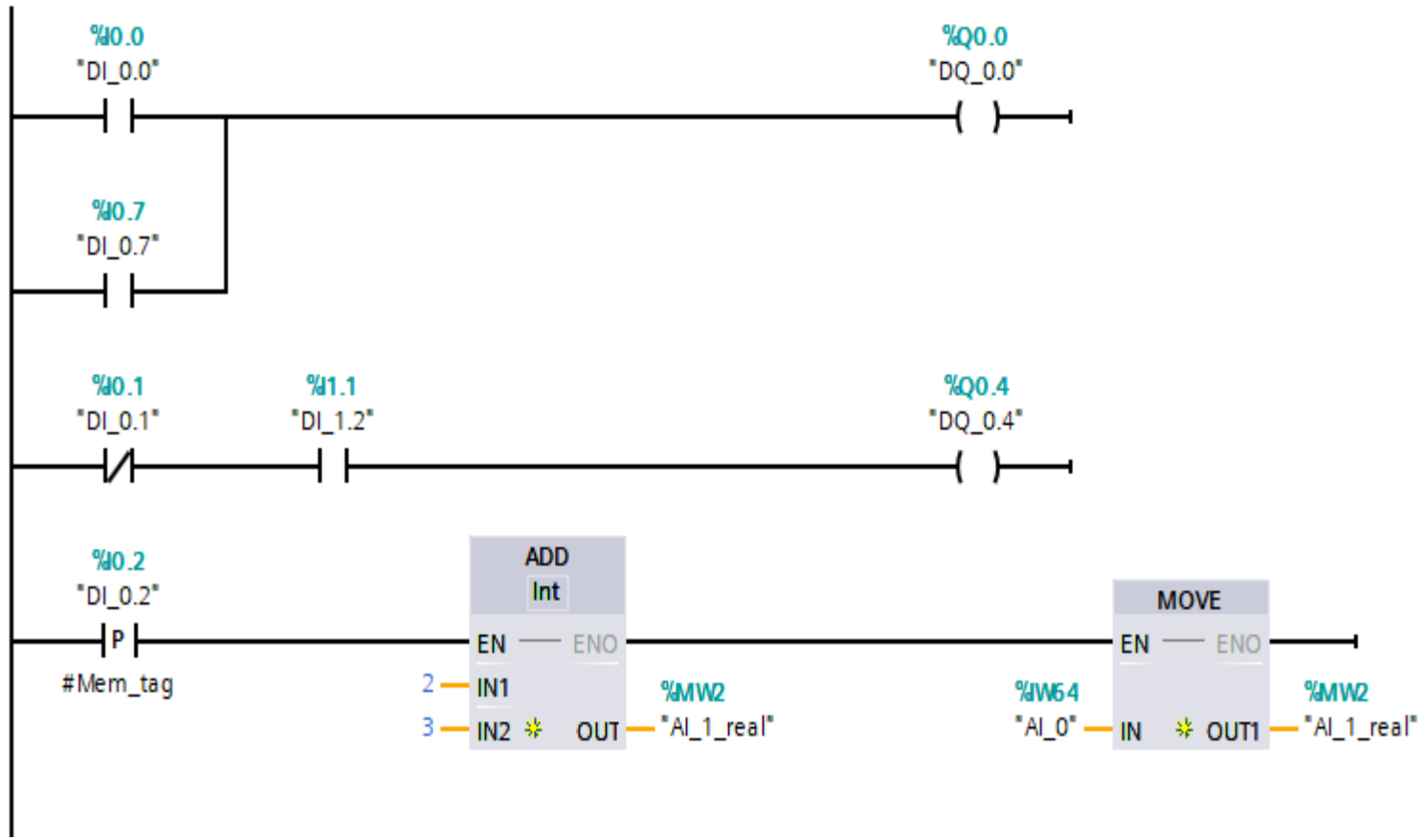

MITSUBISHI
POWER
RUN
ERROR

International Electrotechnical Commission



Network 4:

Comment



DATA Type

- Bit Strings – groups of on/off values BOOL
- bit (0,1)
- BYTE – 8 bit (1 byte)
- WORD – 16 bit (2 byte)
- DWORD – 32 bit (4 byte)

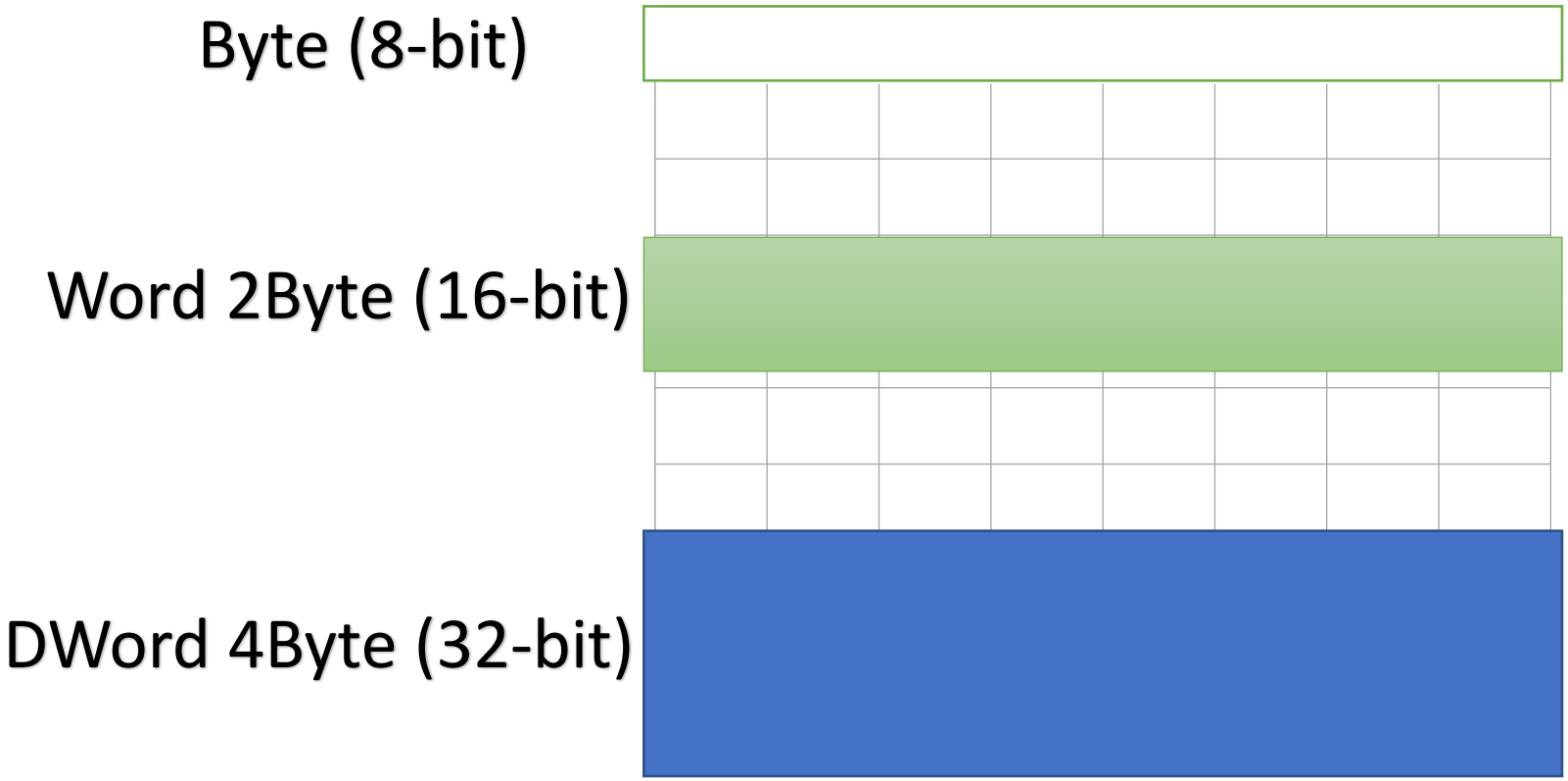
- INTEGER – whole numbers (Considering byte size 8 bits)
  - SINT – signed short integer (1 byte)
  - INT – signed integer (2 byte)
  - DINT – signed double integer (4 byte)
  - LINT – signed long integer (8 byte)
  - USINT – Unsigned short integer (1 byte)
  - UINT – Unsigned integer (2 byte)
  - UDINT – Unsigned double integer (4 byte)
  - ULINT – Unsigned long integer (8 byte)

Basic PLC Data Types

Data Type	Description	Size	Range
Bool	Single bit	Bit	1 = ON 0 = OFF
Sint	8 bits	Byte	-128 to +127
Int	16 bits	Word	-32,768 to +32,767
Dint	32 bits	Double Word	-2,147,483,648 +2,147,483,647
Real	Floating point	Real or floating Point	Larger than Dint or with Decimal point

Addressing

bit 0/1



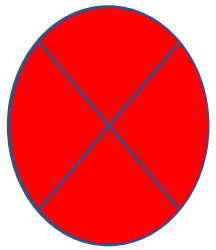
I0.7

I0.3

I 0.0 0

I2.7

I2.0



Q12.9

M20.6

Q125.6

Q2.6

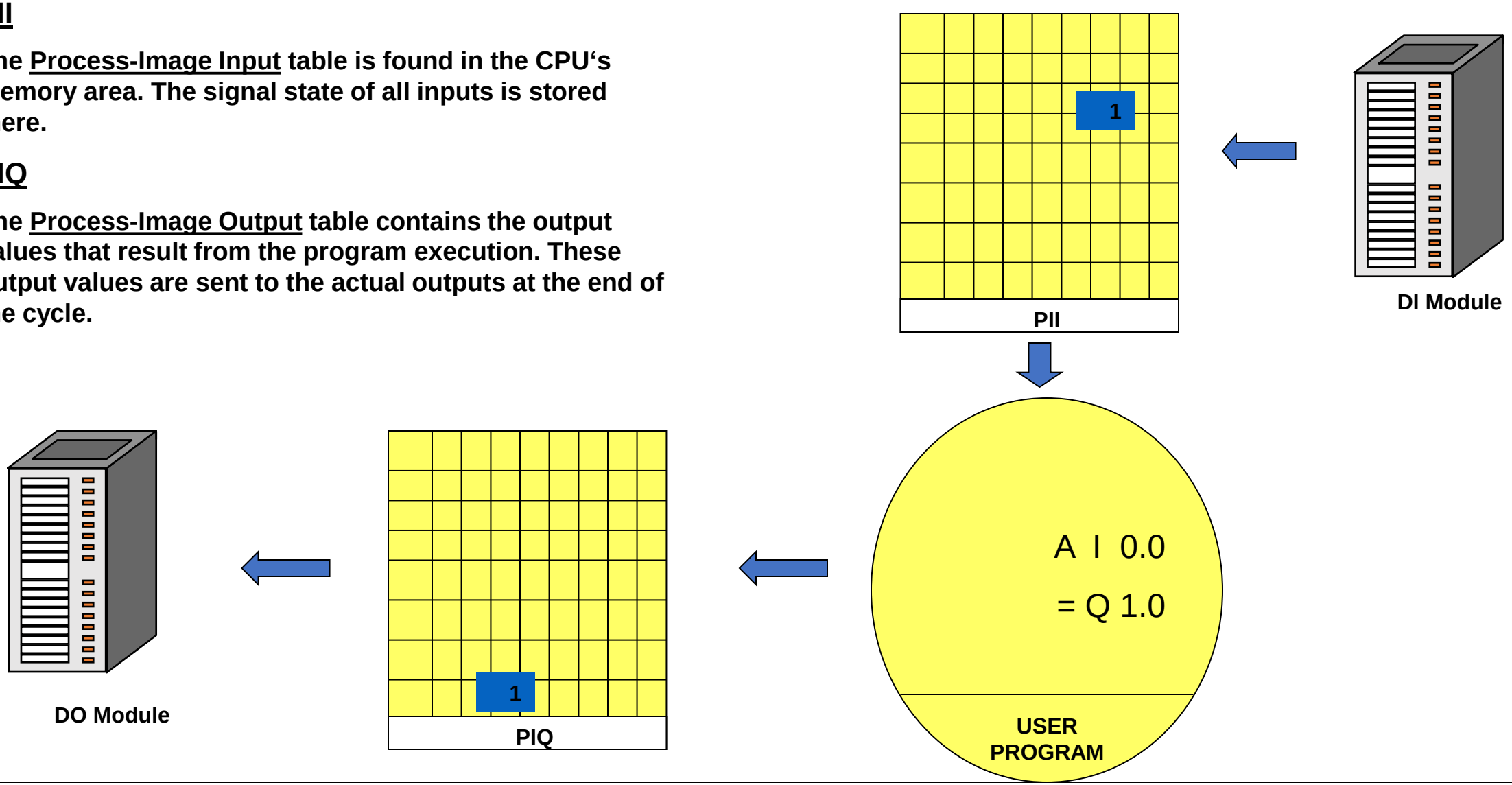
Process Image

PII

The Process-Image Input table is found in the CPU‘s memory area. The signal state of all inputs is stored there.

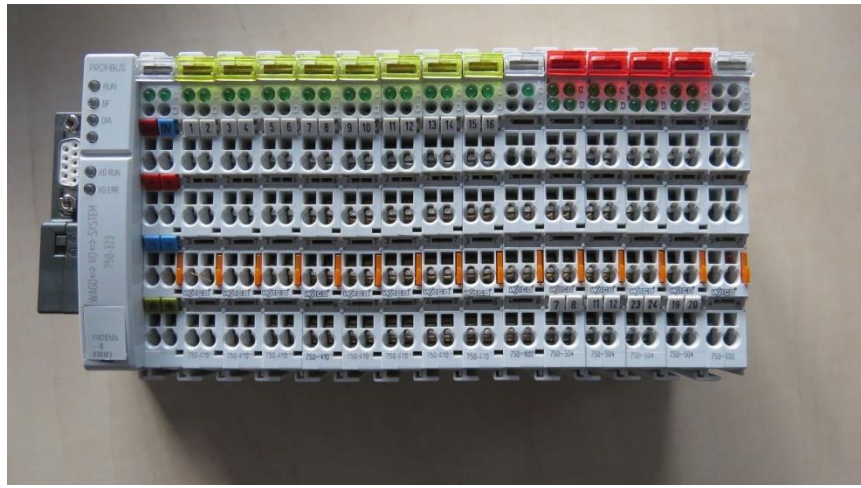
PIQ

The Process-Image Output table contains the output values that result from the program execution. These output values are sent to the actual outputs at the end of the cycle.



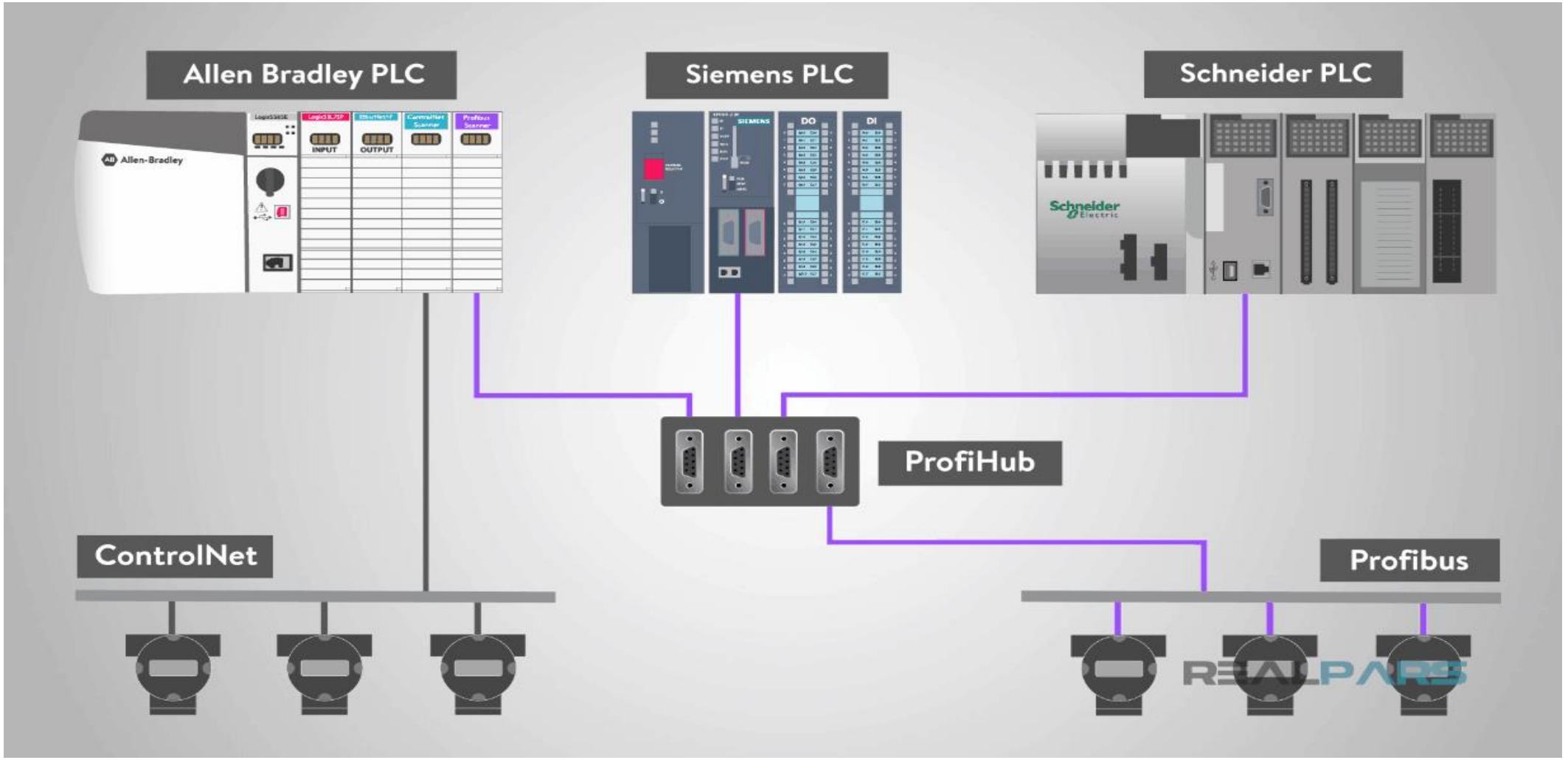
RTU’s

A **remote terminal unit** (**RTU**) is a microprocessor-controlled electronic device that interfaces objects in the physical world to a distributed control system or SCADA (supervisory control and data acquisition) system by transmitting telemetry data to a master system, and by using messages from the master supervisory system to control connected objects.[1] Other terms that may be used for RTU are **remote telemetry unit** and **remote telecontrol unit**.



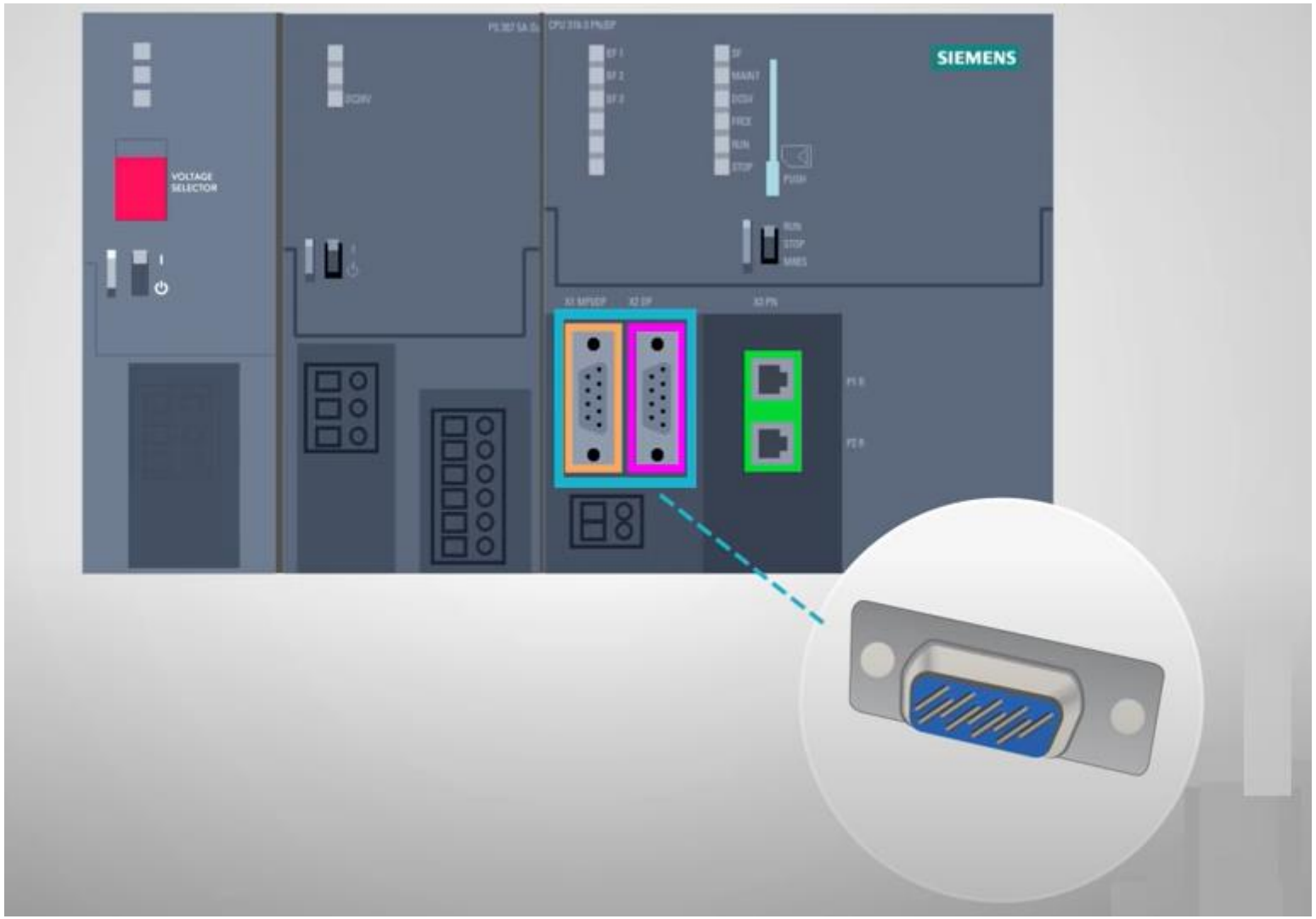
Communication Protocols

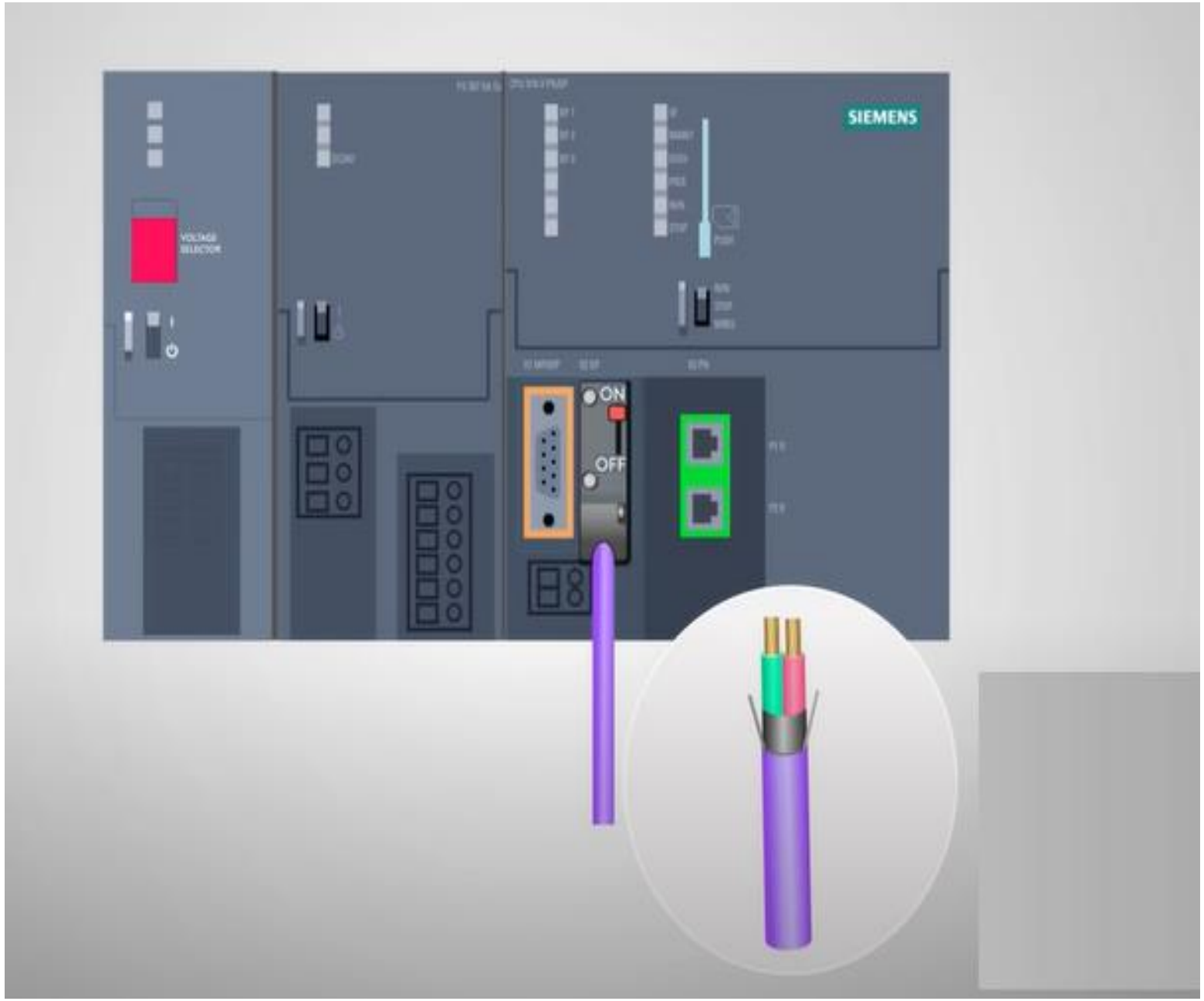
A ***protocol*** is a set of rules governing communications.

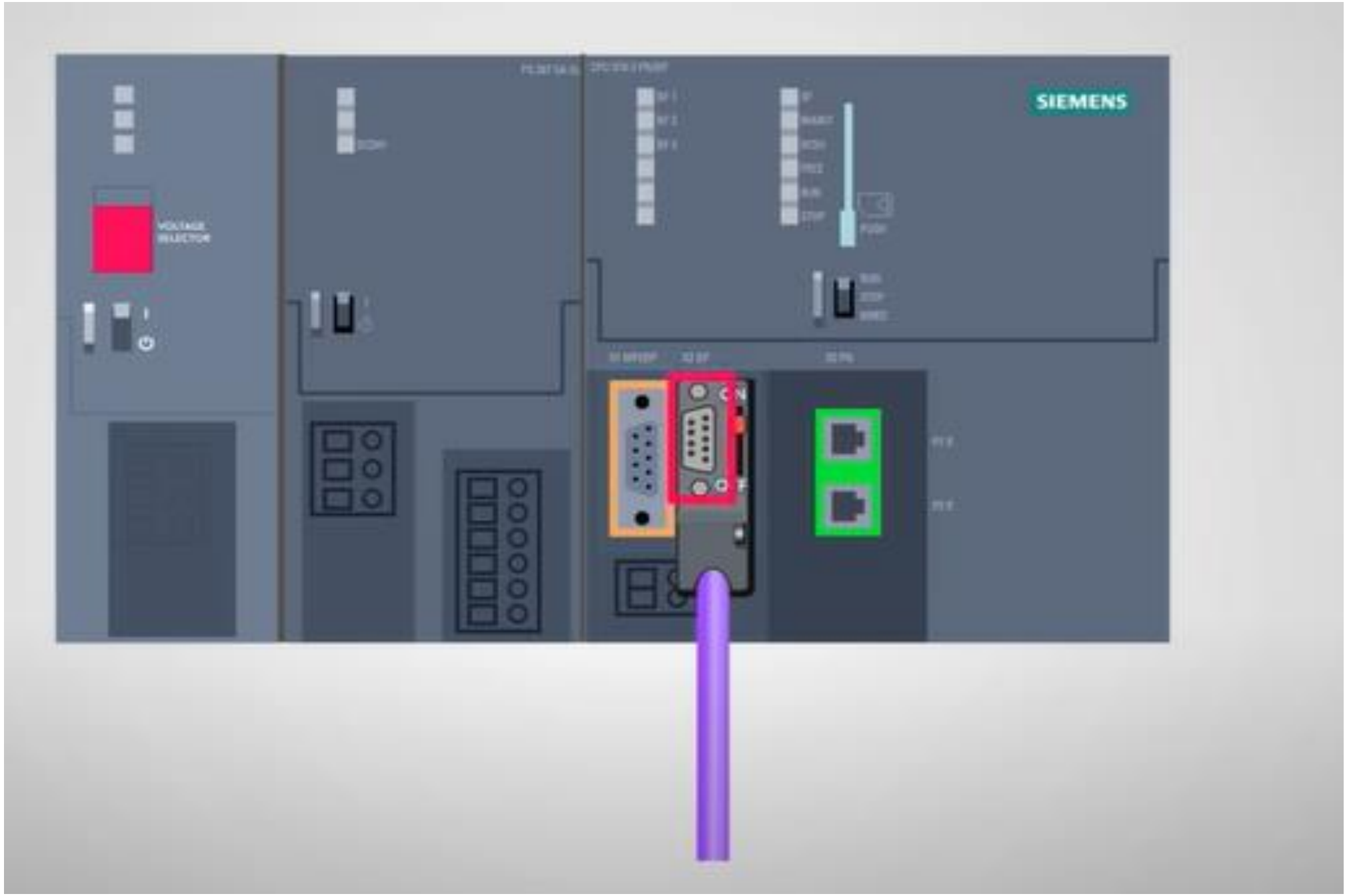


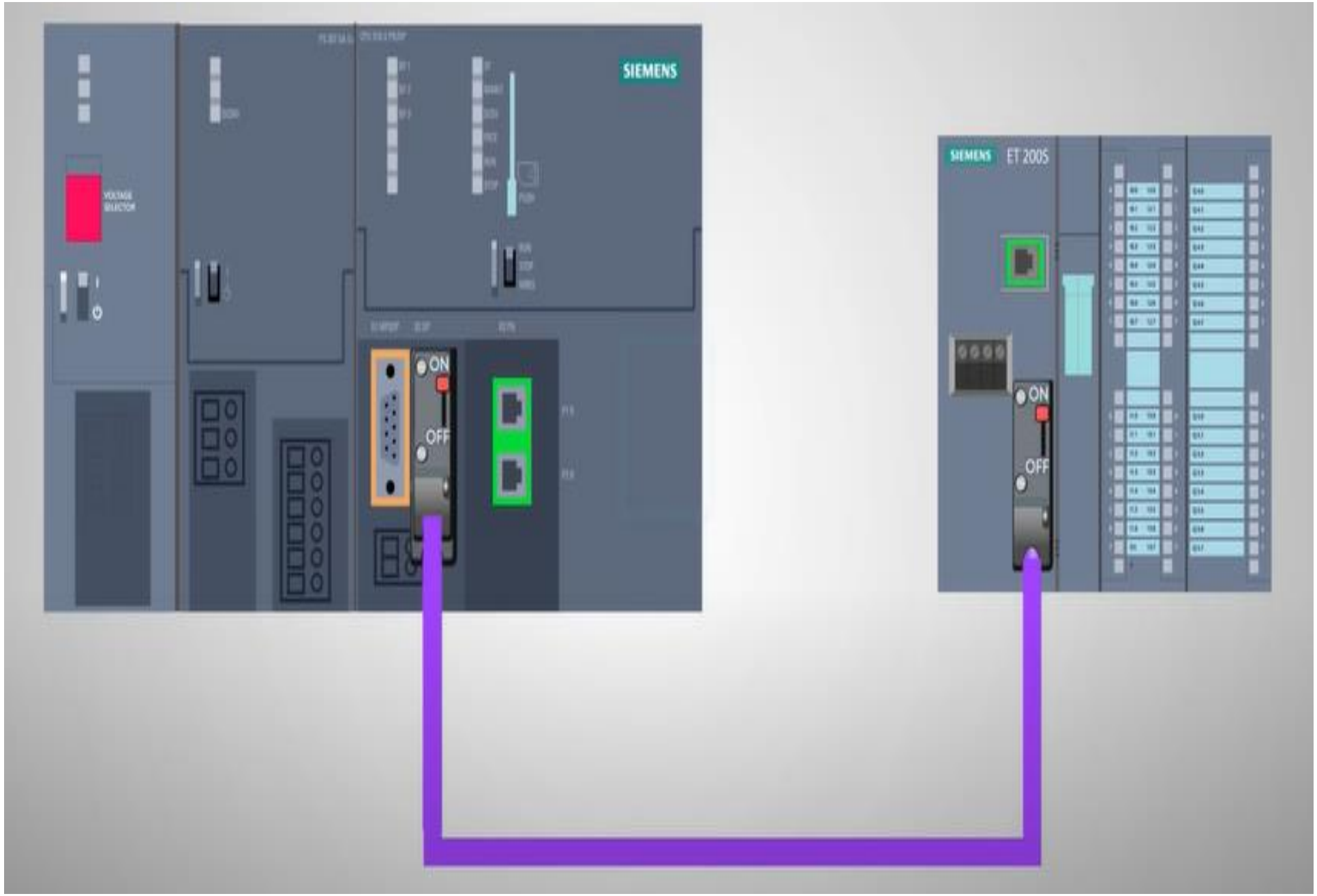

PROFI
BUS
PROFI
NET

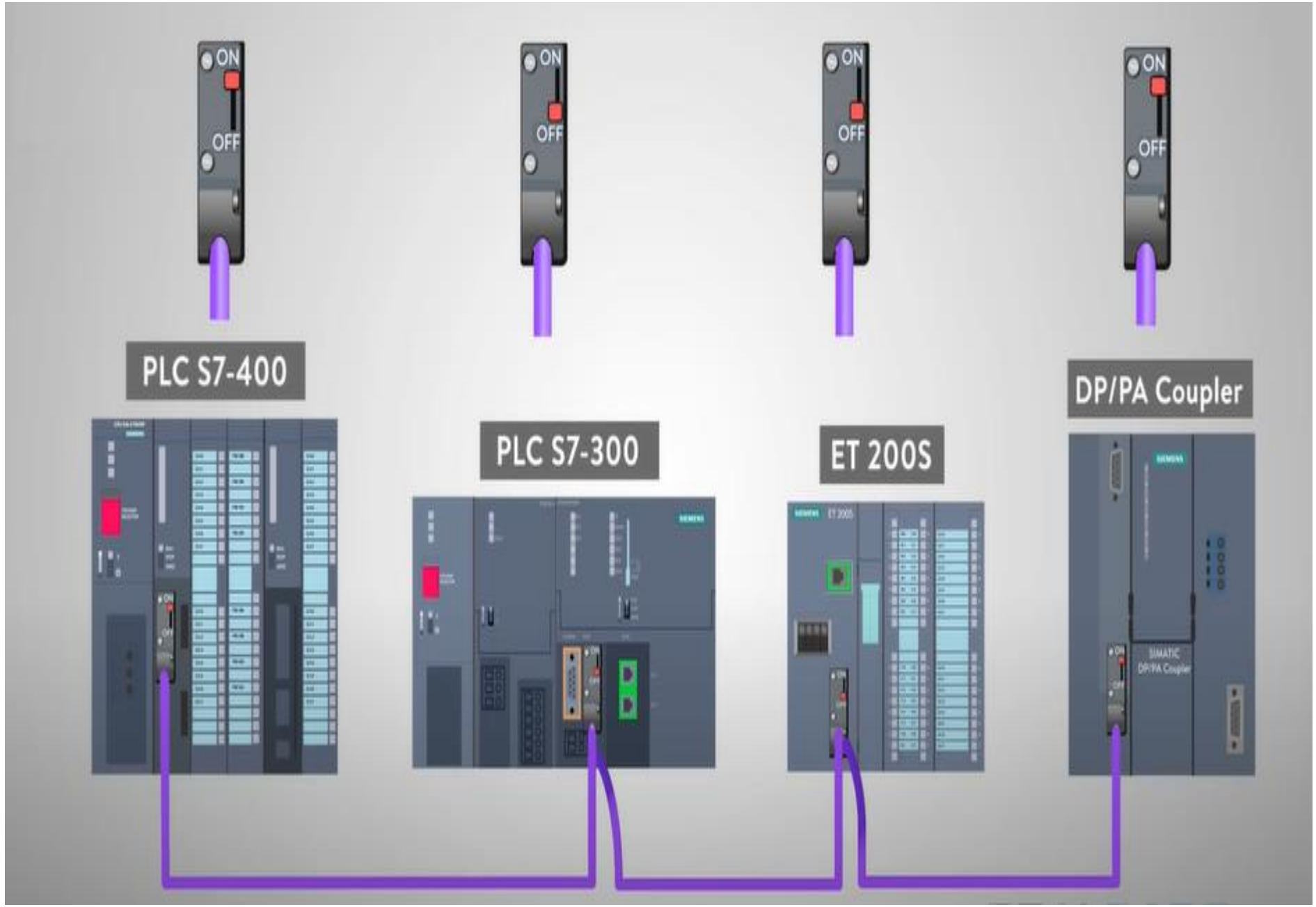

PROFI
BUS
1993
PROcess Fleld BUS

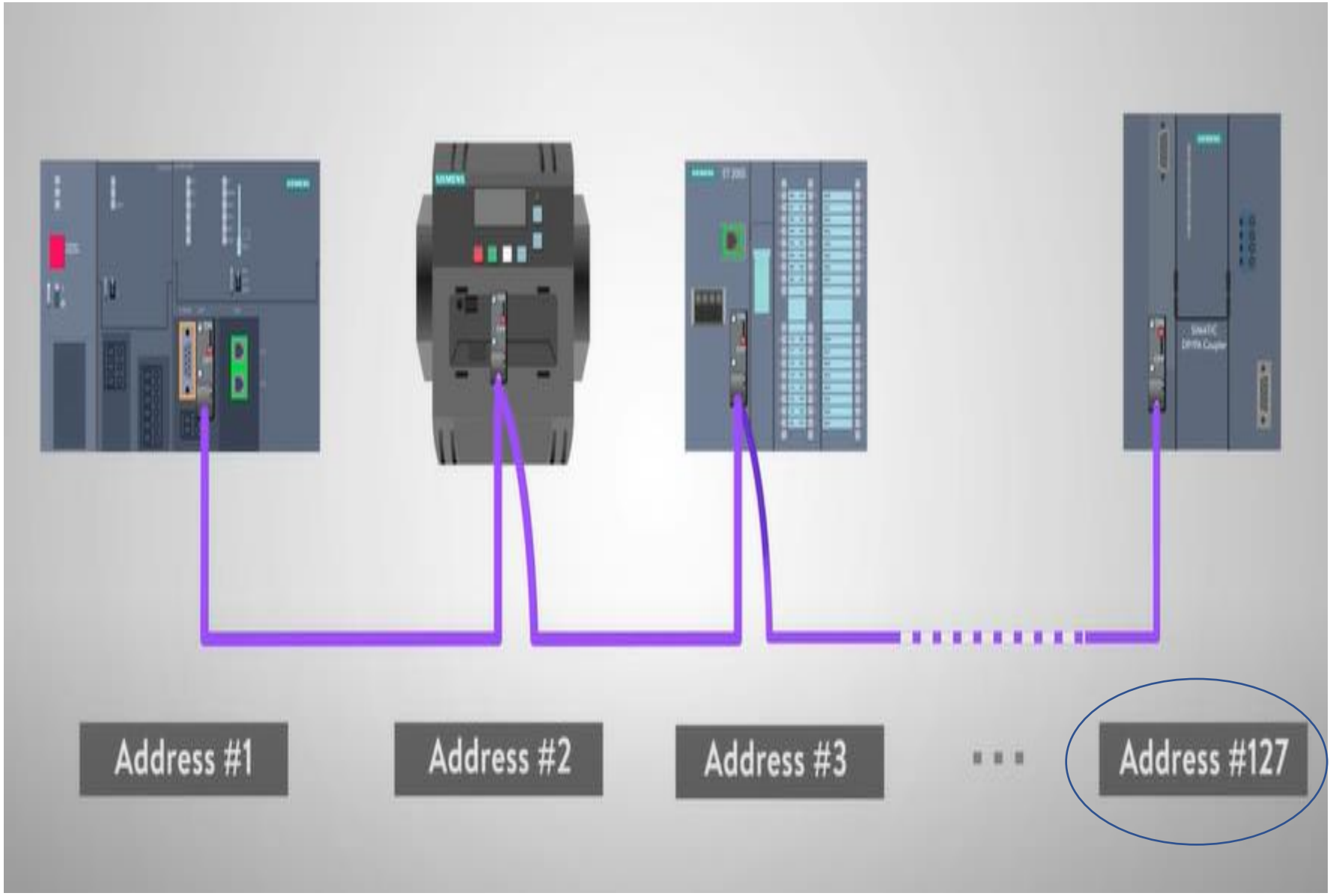

VOLTAGE
SELECTOR
SIEMENS

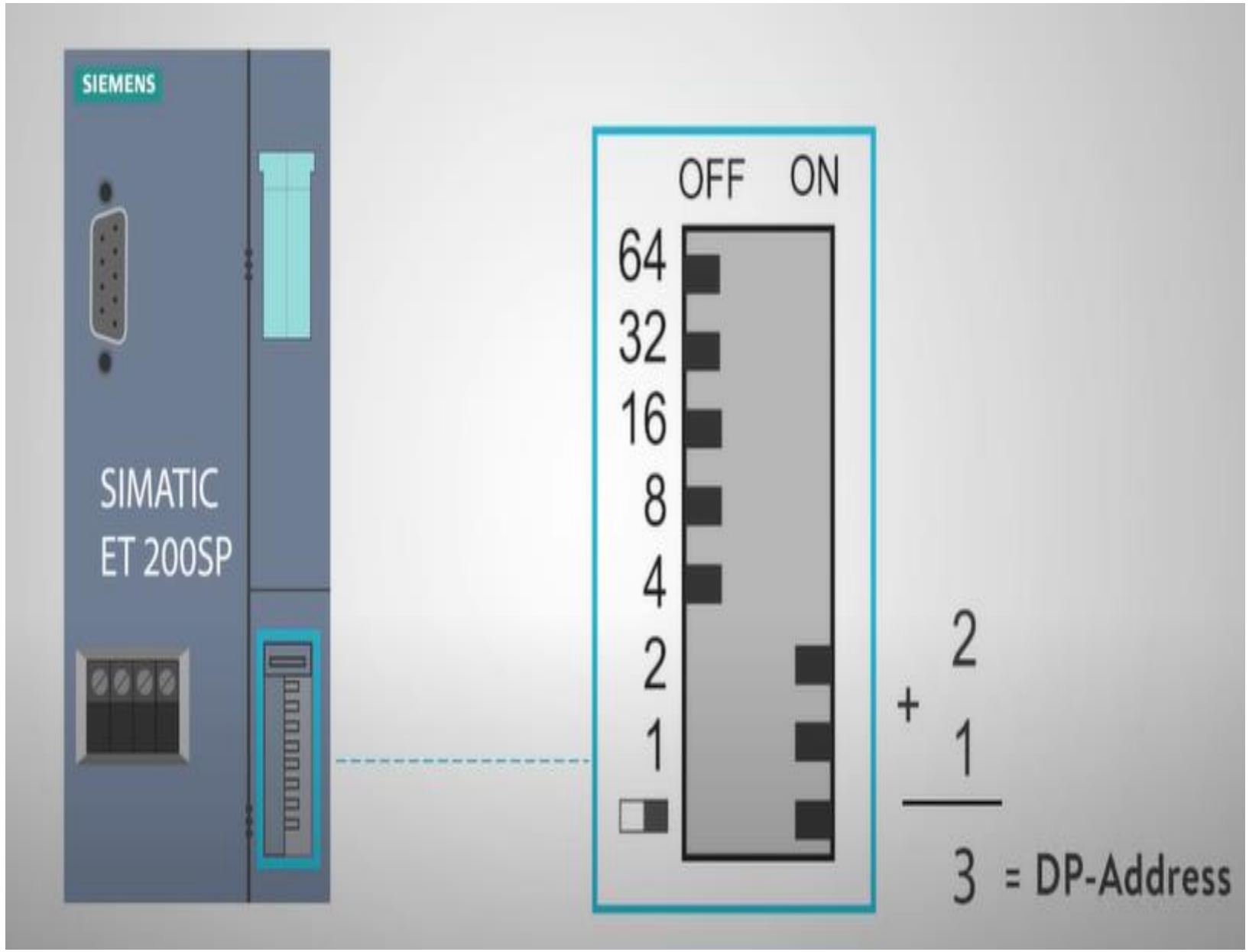

SIEMENS
ON
OFF

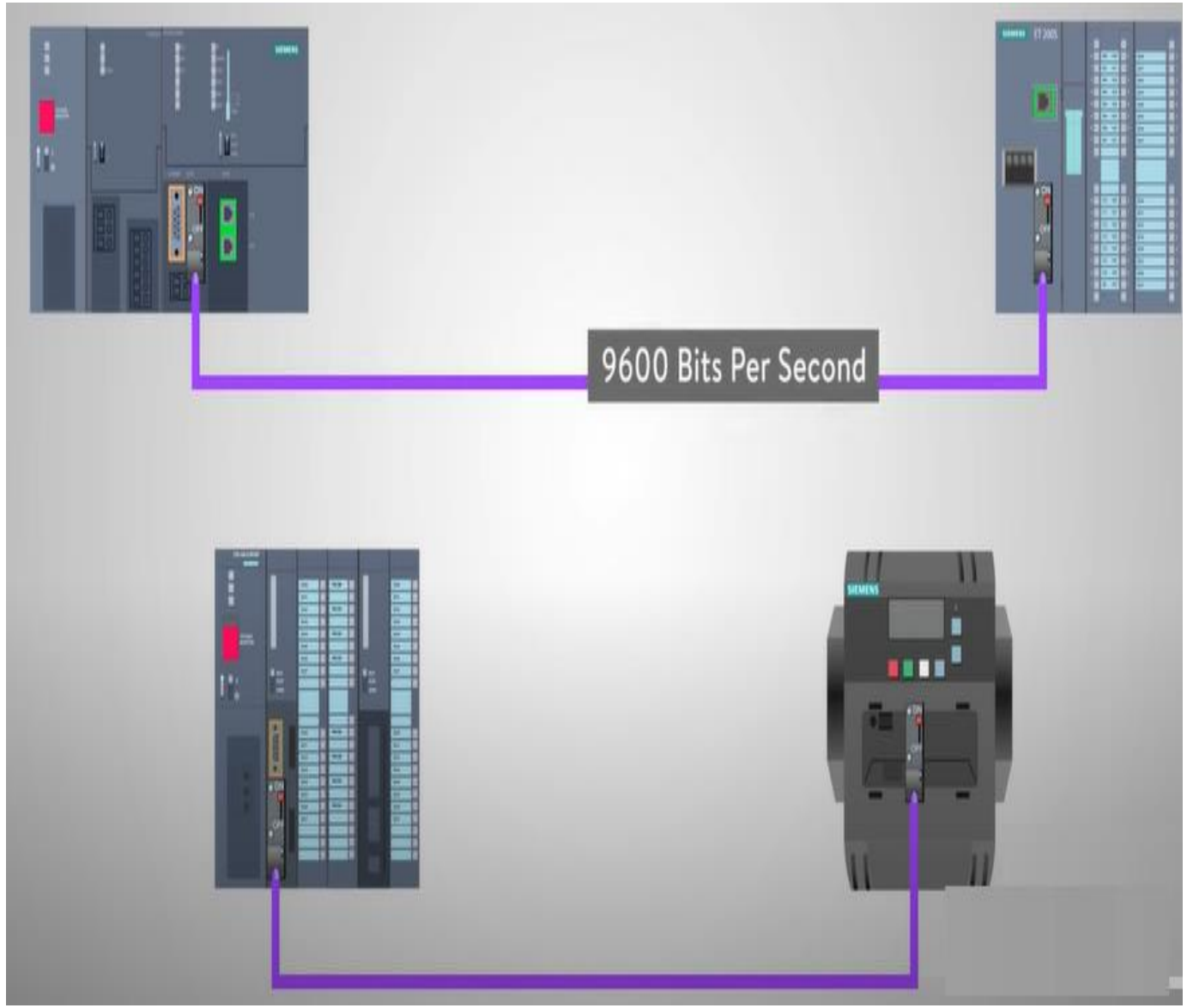

SIEMENS

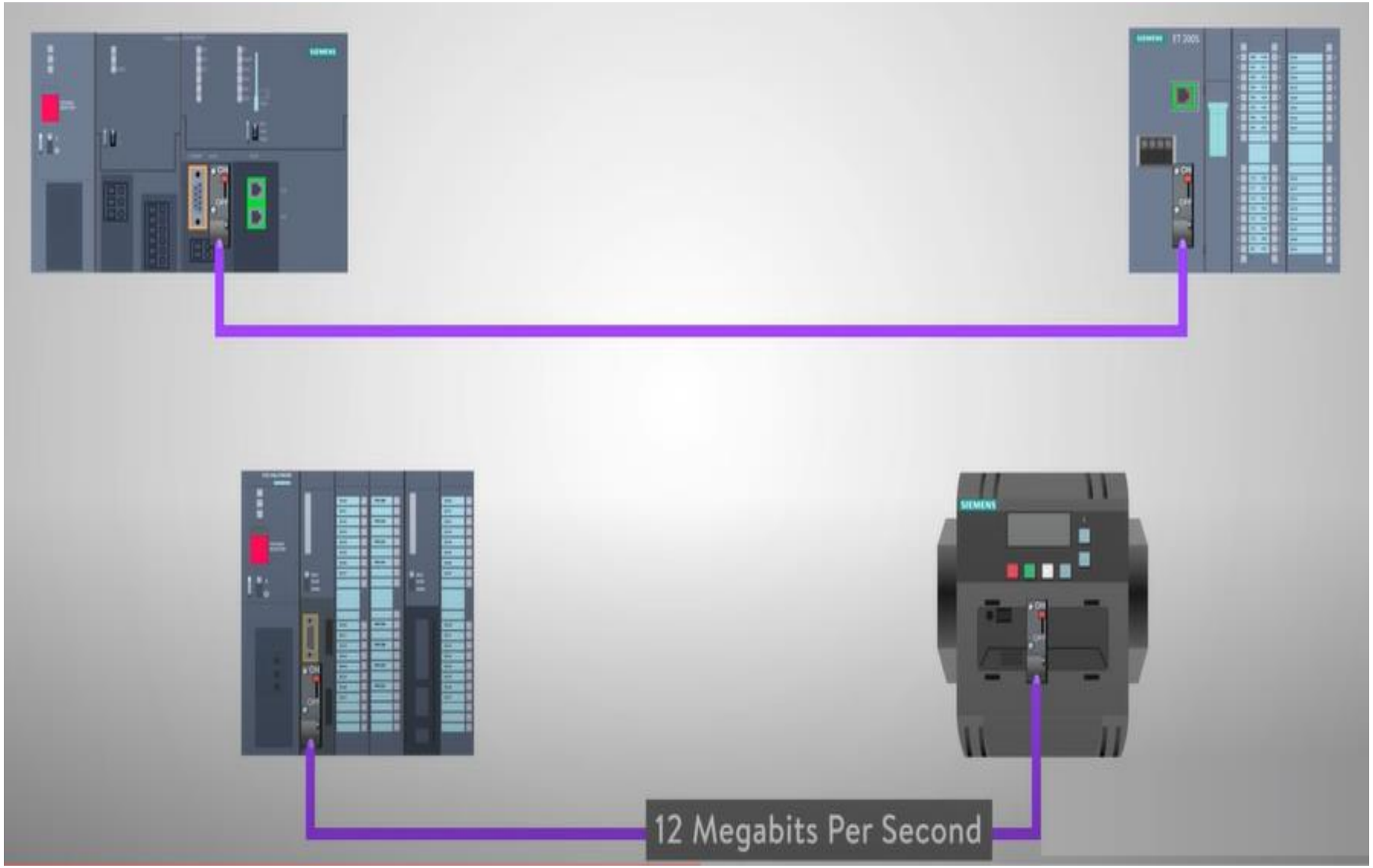

SIEMENS
ON
OFF
SIEMENS ET 200S
ON
OFF

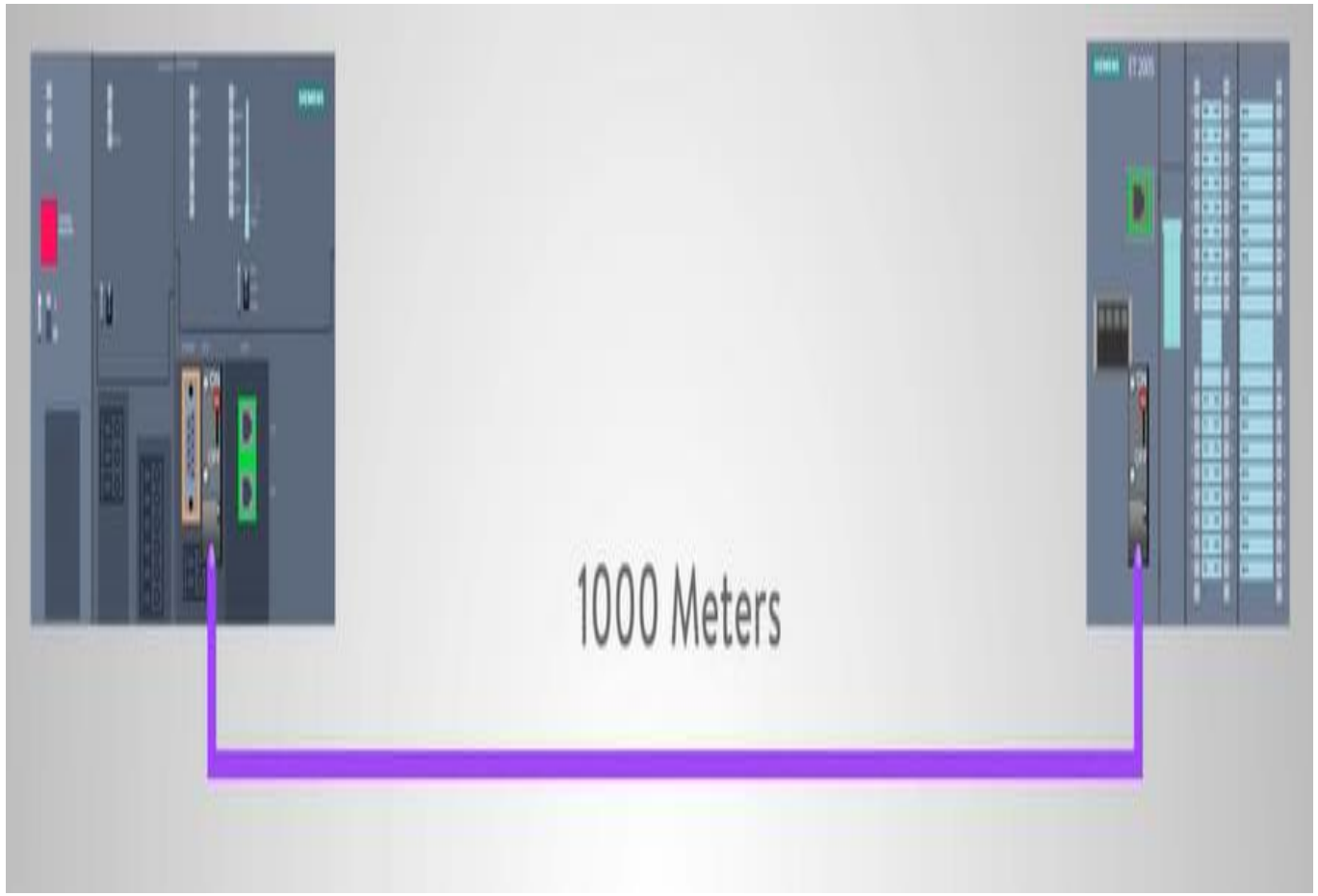

ON
OFF
ON
OFF
ON
OFF
ON
OFF
PLC S7-400
PLC S7-300
ET 200S
DP/PA Coupler


Address #1
Address #2
Address #3
Address #127

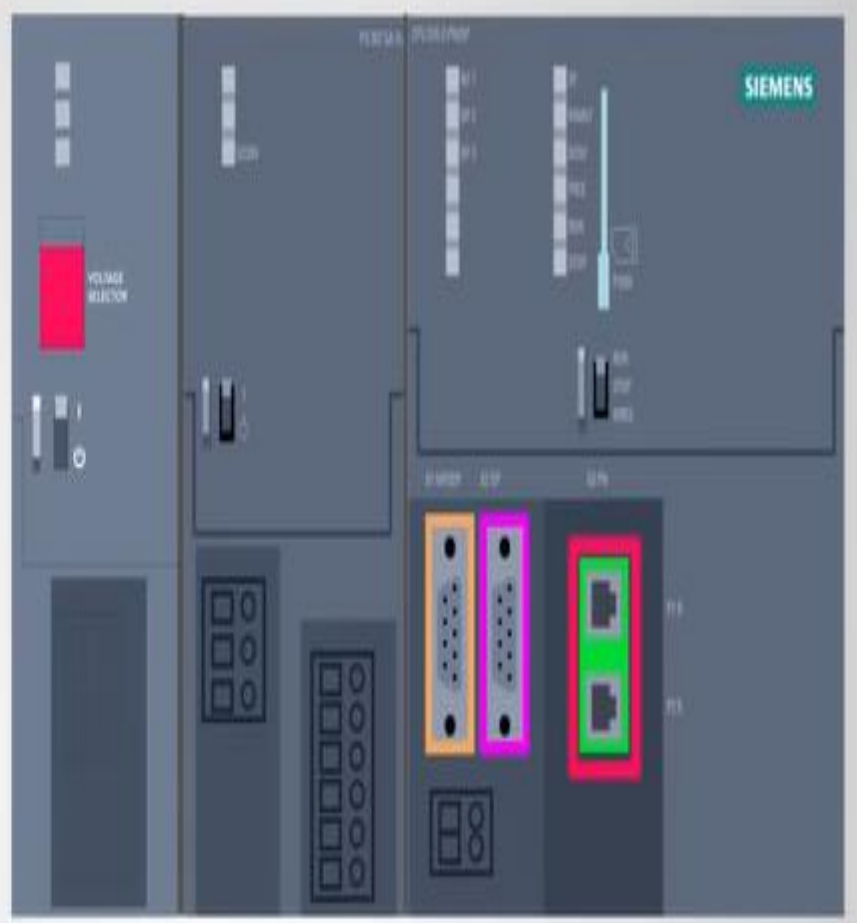

SIEMENS
SIMATIC
ET 200SP
OFF
ON
64
32
16
8
4
2
1
+ 2
1
3 = DP-Address


9600 Bits Per Second

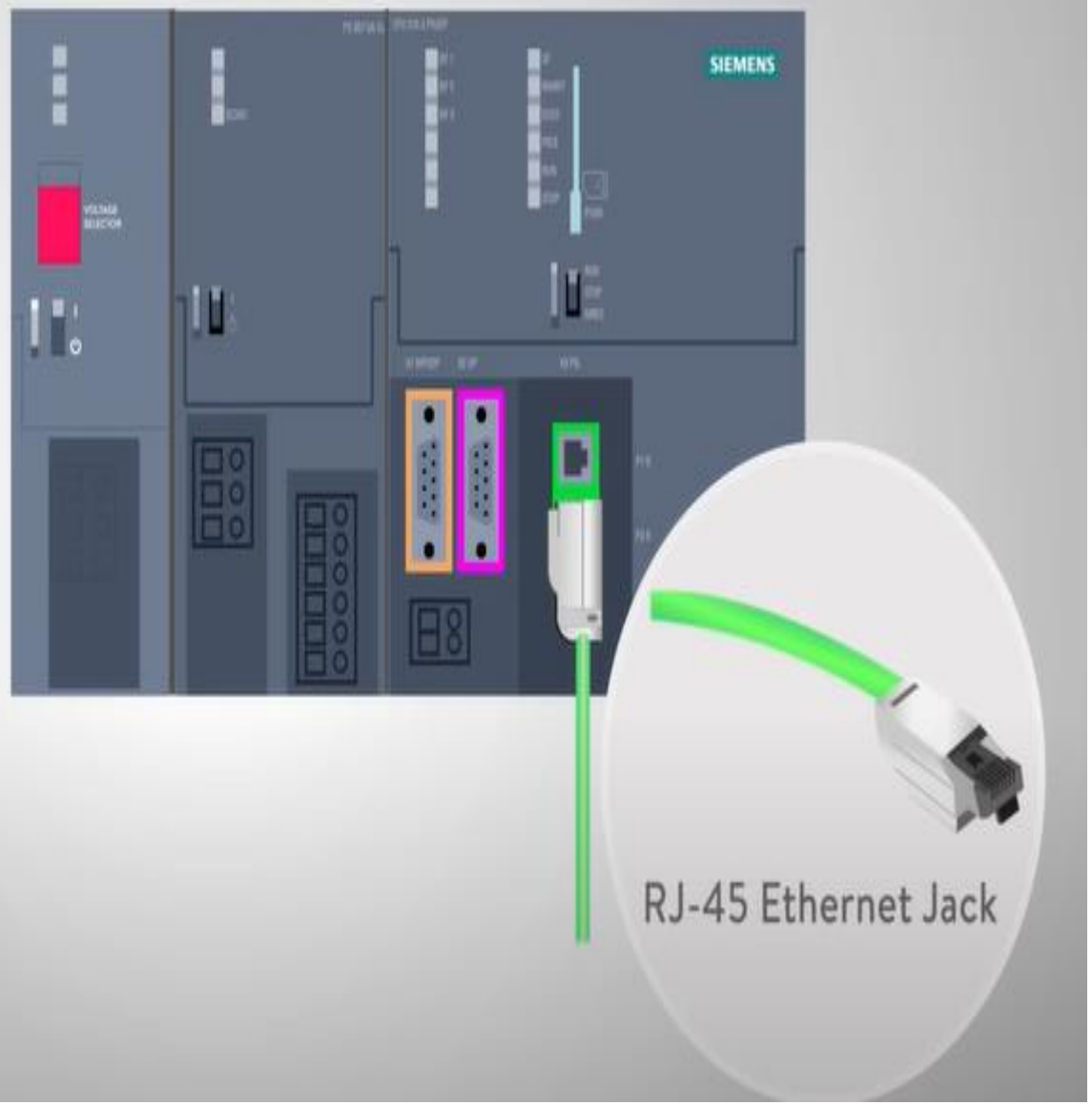

12 Megabits Per Second

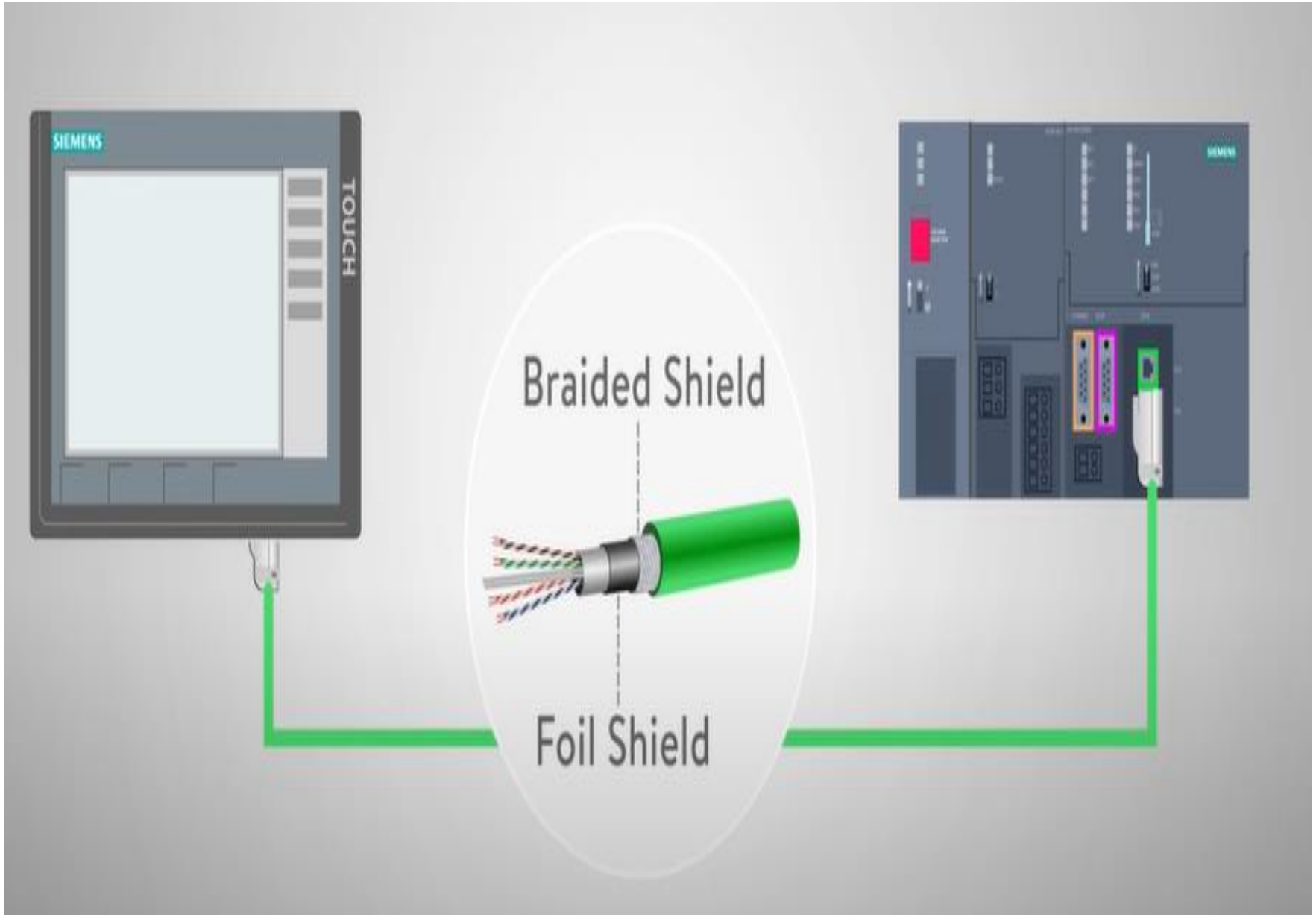

1000 Meters

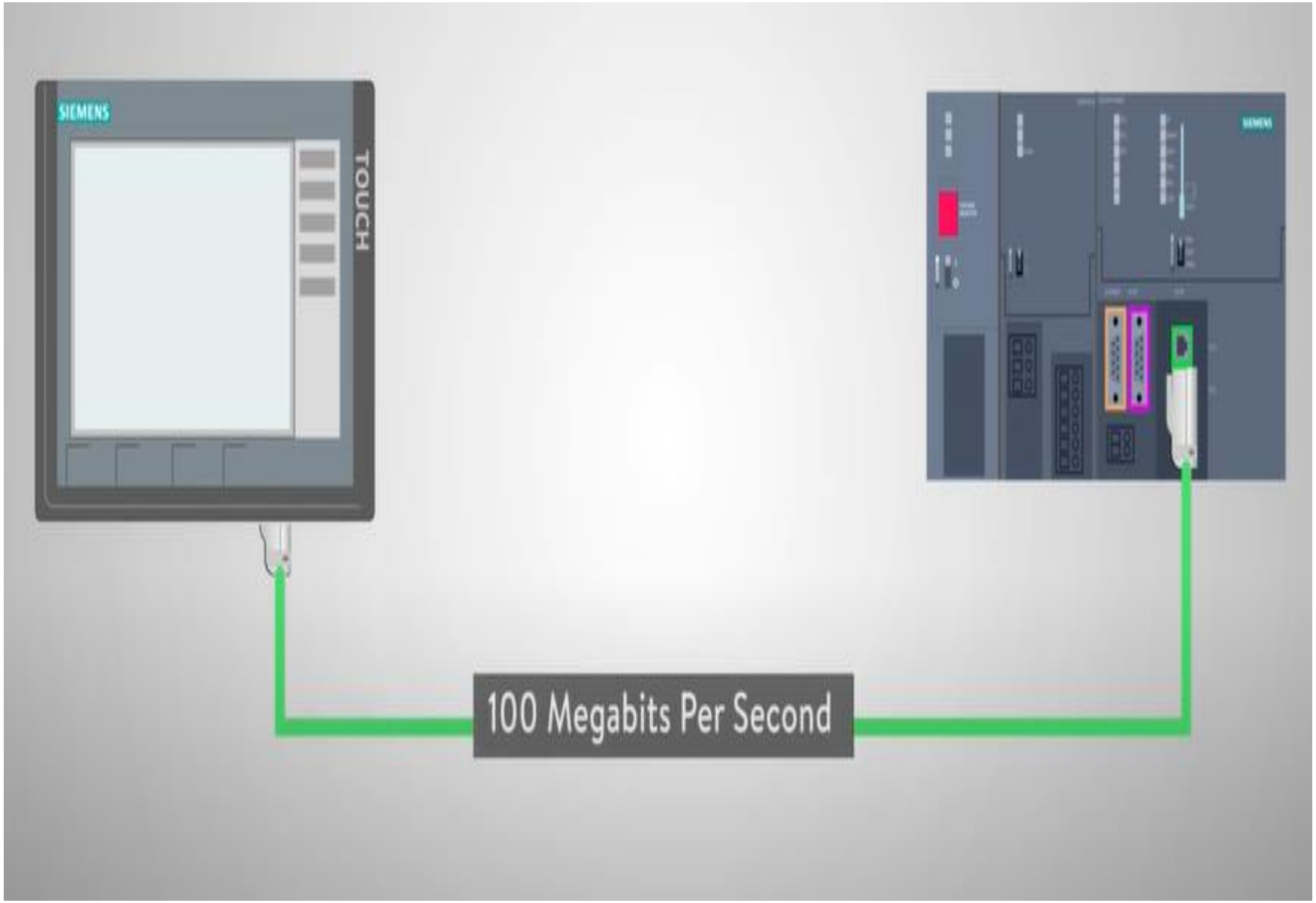
PROFINET

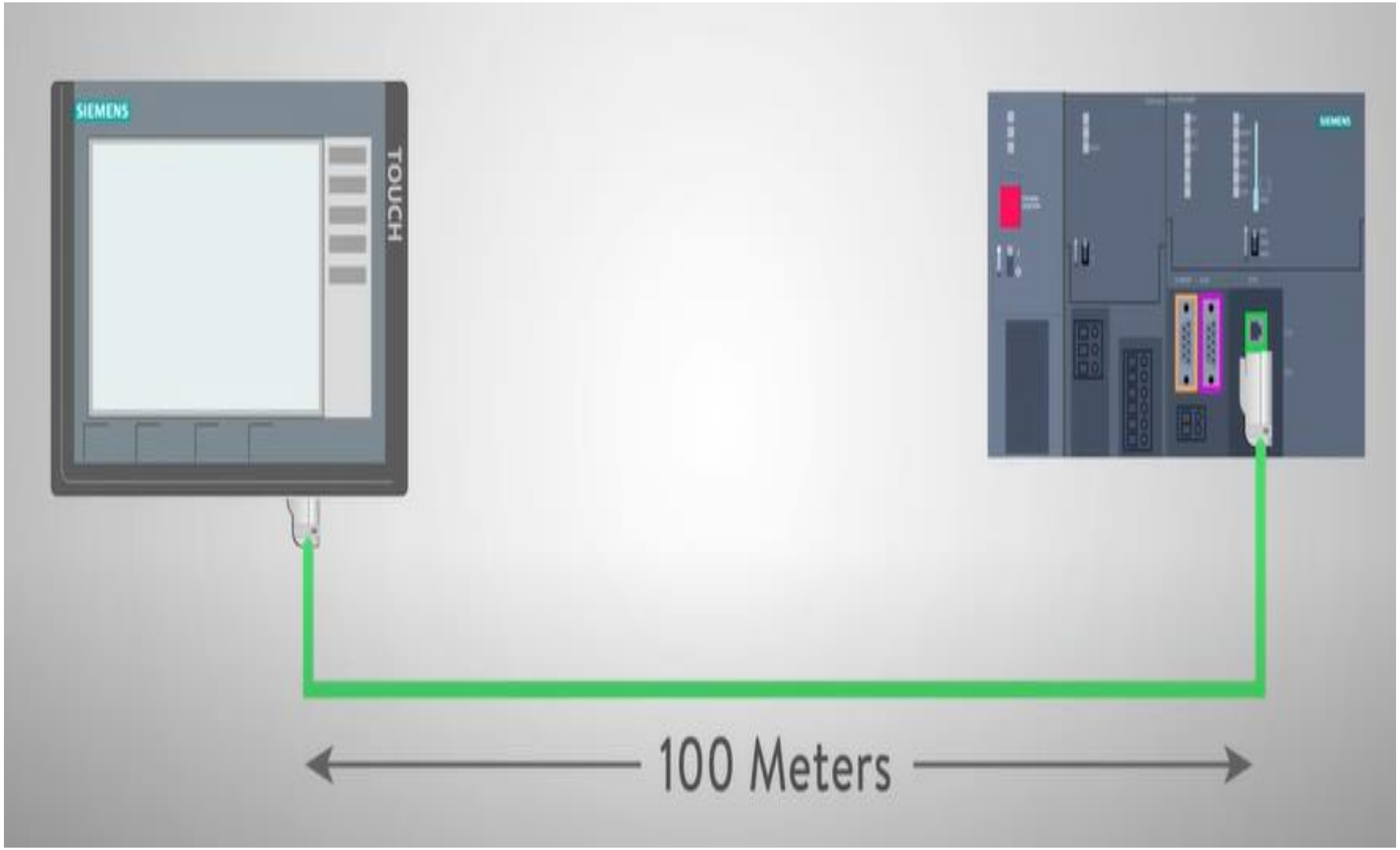


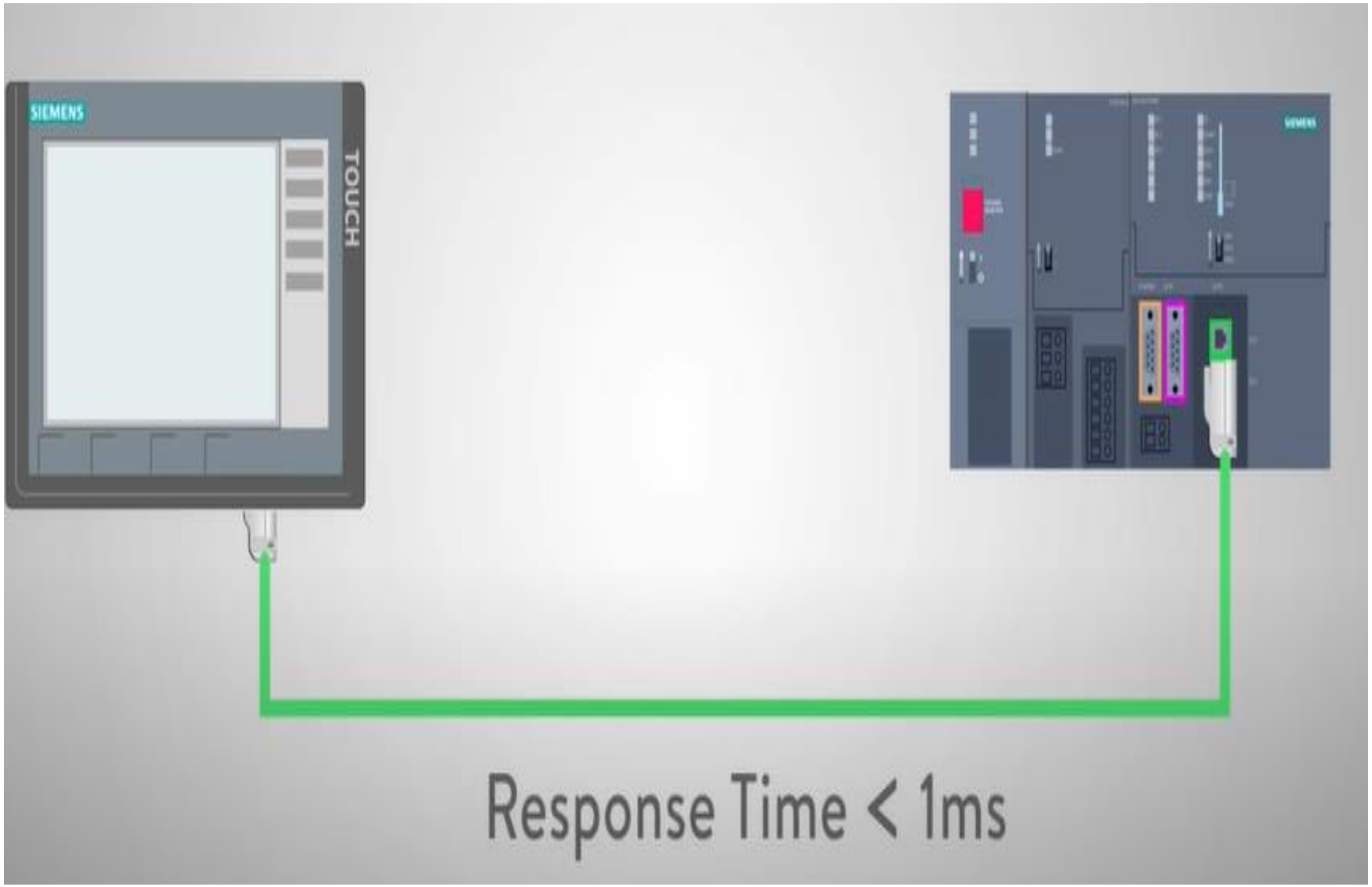
PROFI
NET



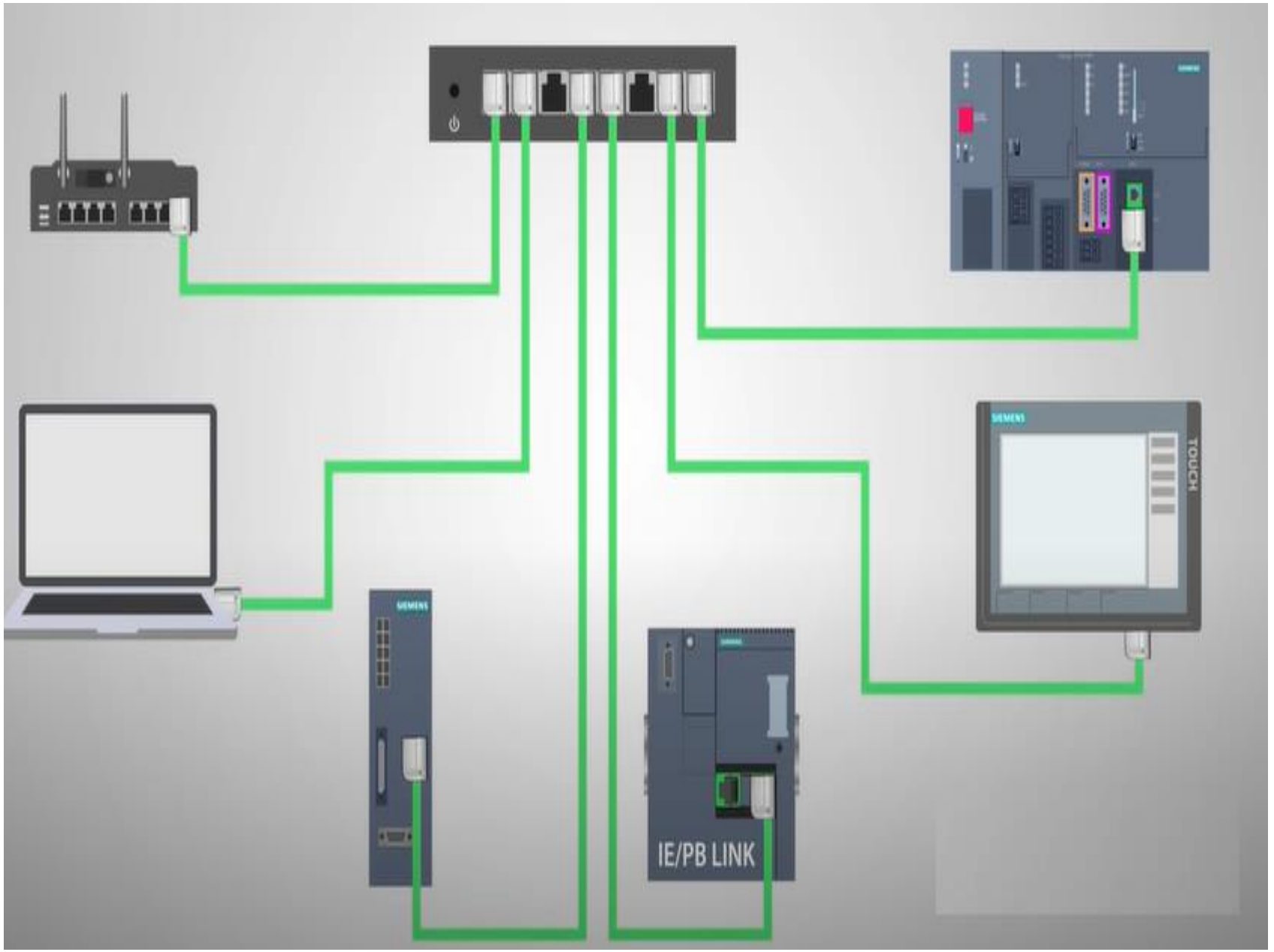

SIEMENS
TOUCH
Braided Shield
Foil Shield

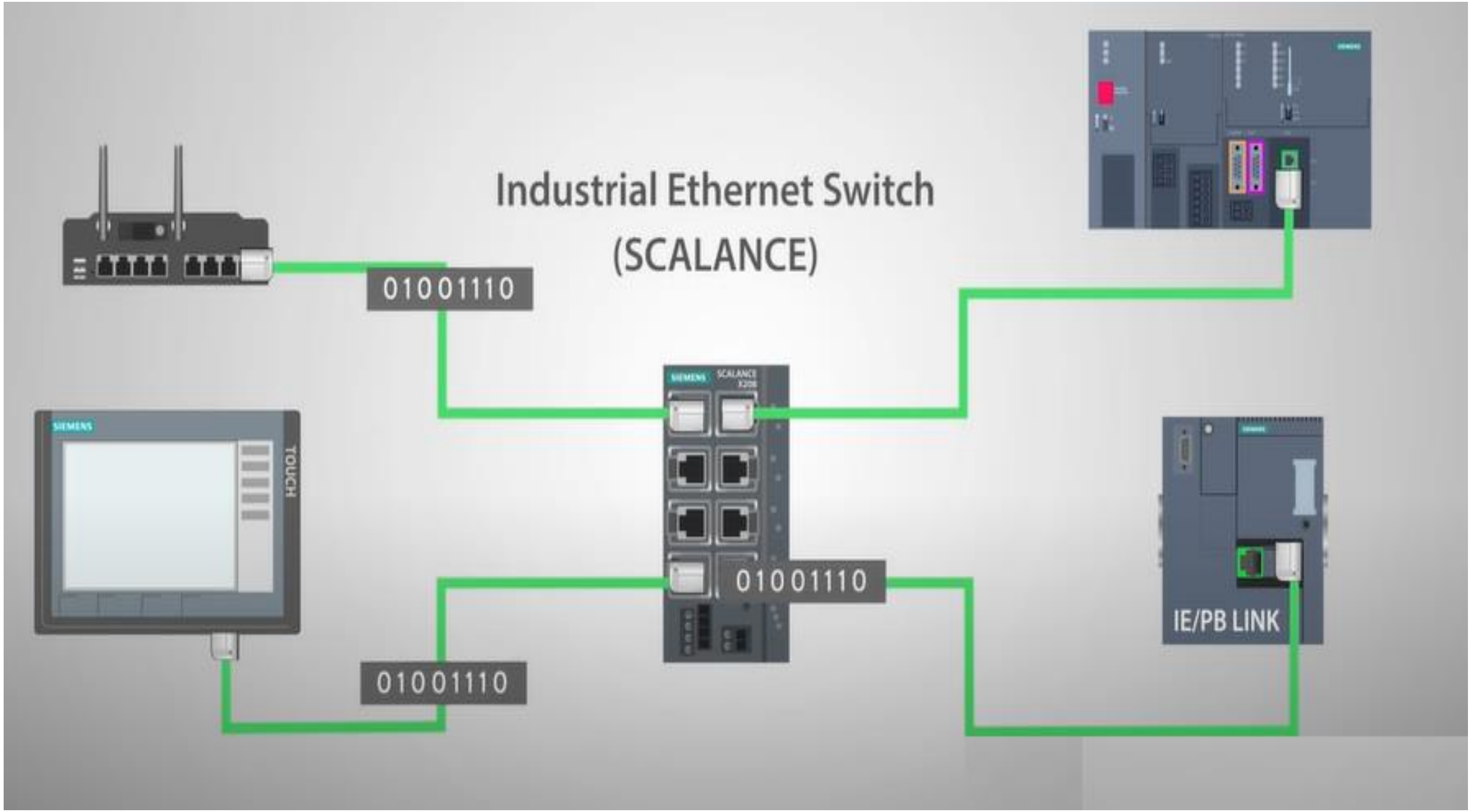

SIEMENS
TOUCH
100 Megabits Per Second

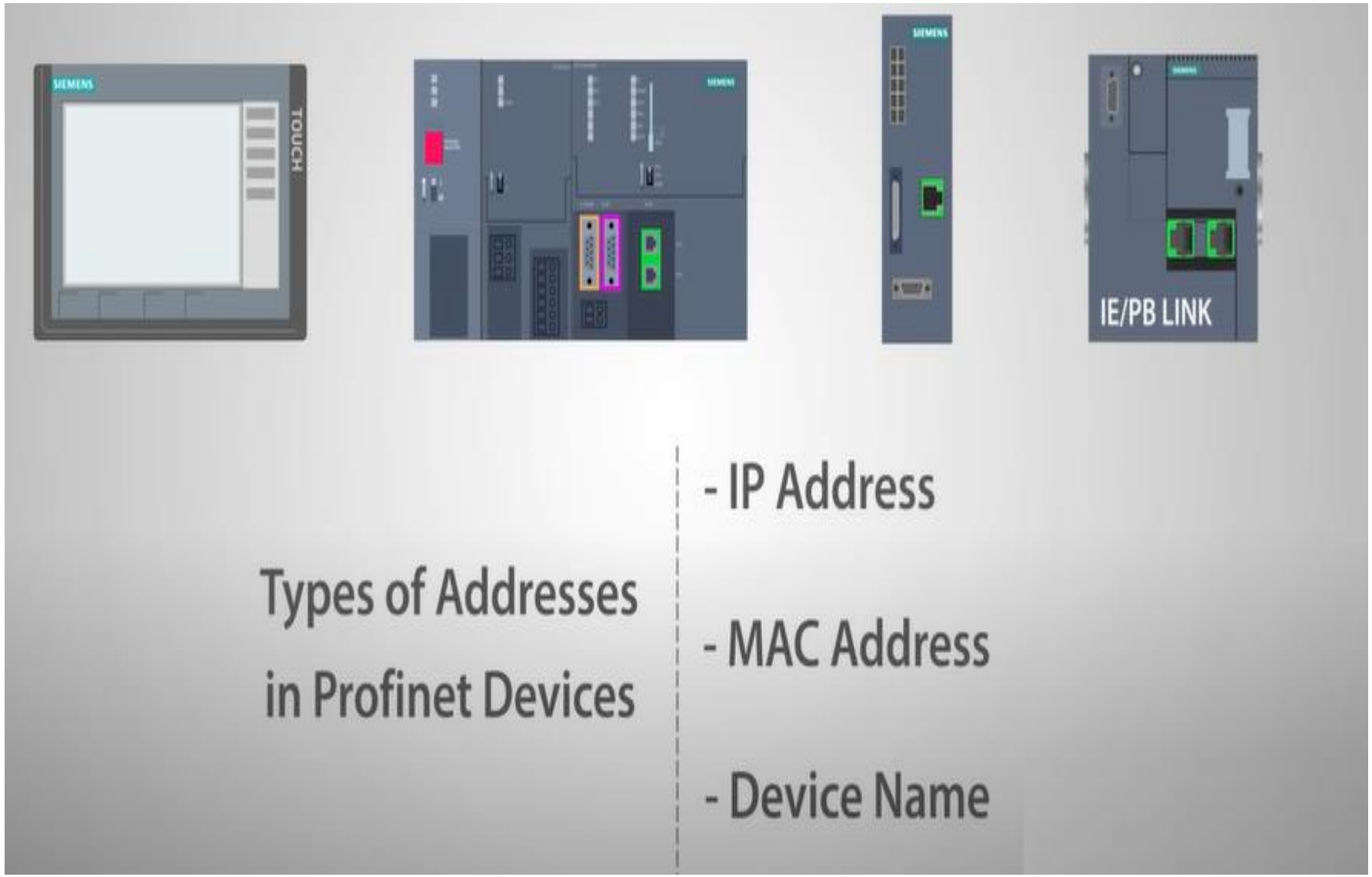

SIEMENS
TOUCH
SIEMENS
100 Meters


SIEMENS
TOUCH
Response Time < 1ms

Standard Ethernet Switch




Industrial Ethernet Switch
(SCALANCE)
01001110
01001110
01001110
SIEMENS
TOUCH
IE/PB LINK


SIEMENS
TOUCH
IE/PB LINK
Types of Addresses
in Profinet Devices
- IP Address
- MAC Address
- Device Name

				
Device Name	HMI_1	PLC_1	Drive_1	IE-PB_1
IP Address	192.168.0.1	192.168.0.2	192.168.0.3	192.168.0.4
MAC Address	28-63-36-0E-F6-E8	00-1C-06-0B-F2-46	00-1F-F8-F4-70-89	00-00-24-1A-35-C8

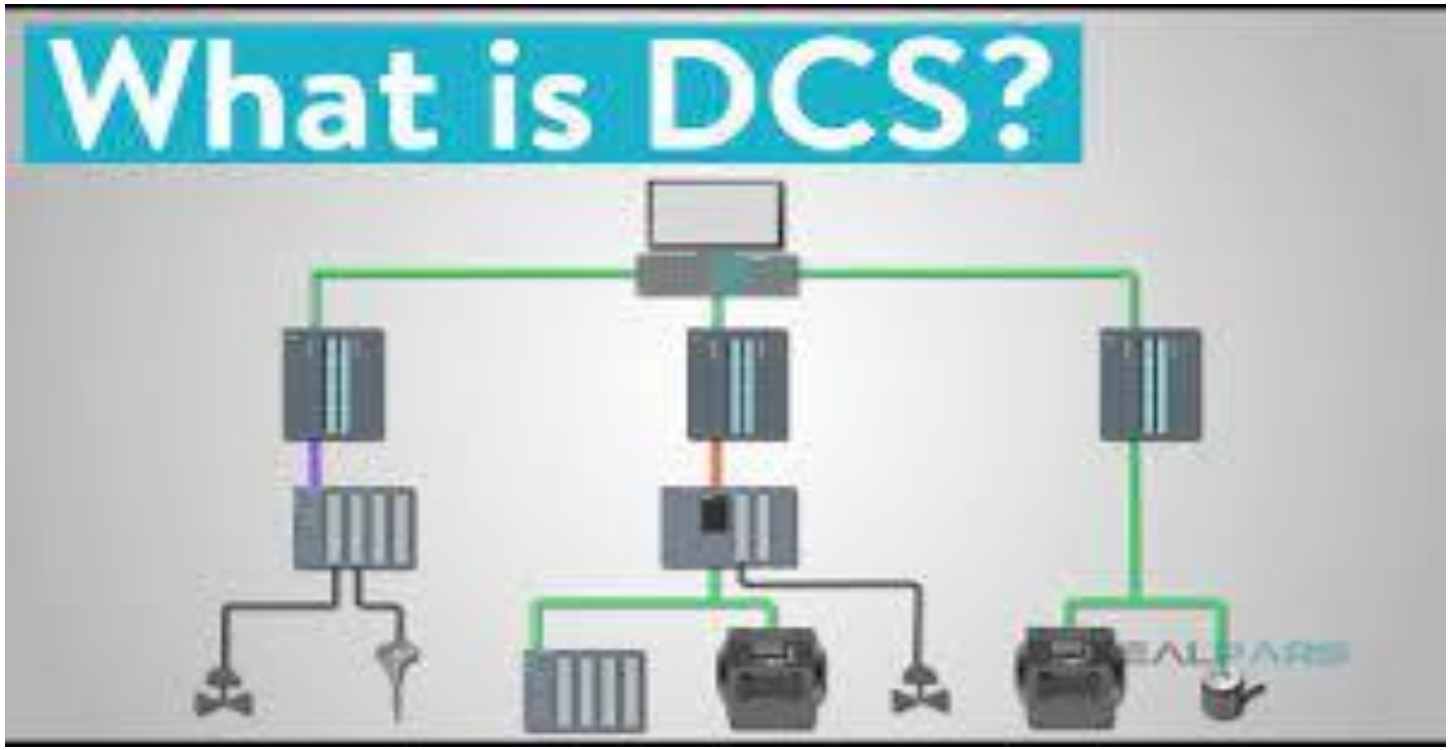
List of Communication Protocols

1.AS-i – Actuator-sensor interface
2.BSAP – Bristol Standard Asynchronous Protocol
3.CC-Link Industrial Networks
4.CIP (Common Industrial Protocol)
5.ControlNet
6.DeviceNet
7.DF-1
8.DNP3
9.DirectNet
10.EtherCAT
11.Ethernet Global Data (EGD)
12.EtherNet/IP
13.Ethernet Powerlink
14.FINS
15.FOUNDATION Fieldbus – H1 & HSE
16.HART Protocol
17.HostLink Protocol
18.Interbus

1.MECHATROLINK
2.MelsecNet, and MelsecNet II, /B, and /H
3.Modbus PEMEX
4.Modbus Plus
5.Modbus RTU or ASCII or TCP
6.OSGP – The Open Smart Grid Protocol
7.OpenADR – Open Automated Demand Response
8.Optomux
9.PieP – An Open Fieldbus Protocol
10.Profibus
11.PROFINET
12.RAPIEnet
13.Honeywell SDS
14.SERCOS III
15.SERCOS interface
16.GE SRTP
17.Sinec H1
18.SynqNet
19.TTEthernet
20.MPI – Multi-Point Interface

Protocol	Baud Rate	Network Length	Number of nodes
Ethernet	100 Mb/s	100 m	255
Profibus	9.6 Kb/s – 12 Mb/s	1.2 km – 100 m	127
RS-232	19.2 Kb/s	10 m	1
RS-485	10 Mb/s	1.2 Km	32
MPI	19.2 – 38.4 Kb/s	50 m	32
PPI	187.5 Kb/s	500 m	1
DH	230.4 Kb/s	3.048 m	64
ControlNet	5 Mb/s	1000 m	99
DeviceNet	500 Kb/s	100 m	64

A **distributed control system** (**DCS**) is a computerised control system for a process or plant usually with many control loops, in which autonomous controllers are distributed throughout the system, but there is no central operator supervisory control.

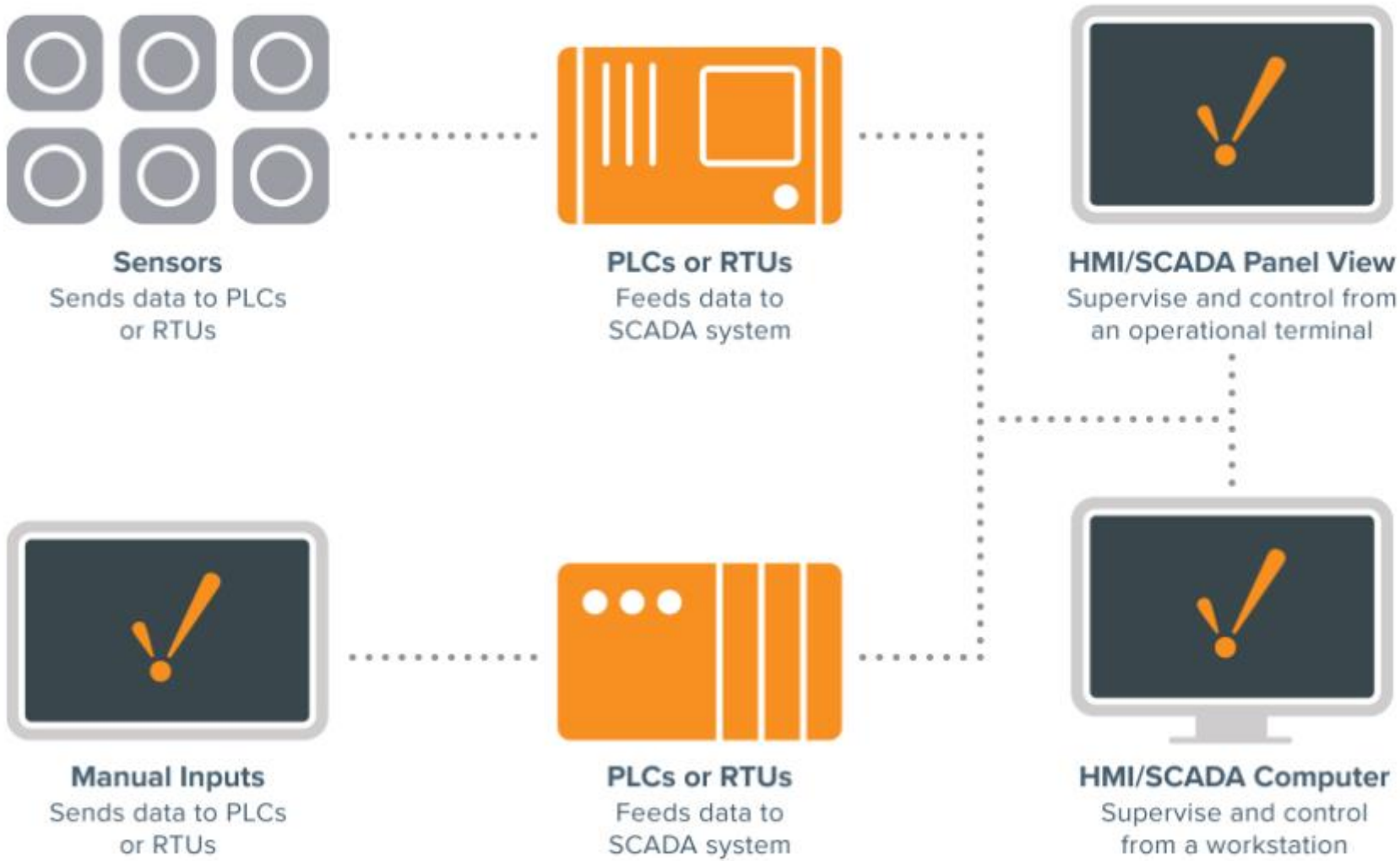


SCADA

Supervisory control and data acquisition (SCADA) is a system of software and hardware elements that allows industrial organizations to:

- Control industrial processes locally or at remote locations
- Monitor, gather, and process real-time data
- Directly interact with devices such as sensors, valves, pumps, motors, and more through human-machine interface (HMI) software
- Record events into a log file

A Basic SCADA Diagram

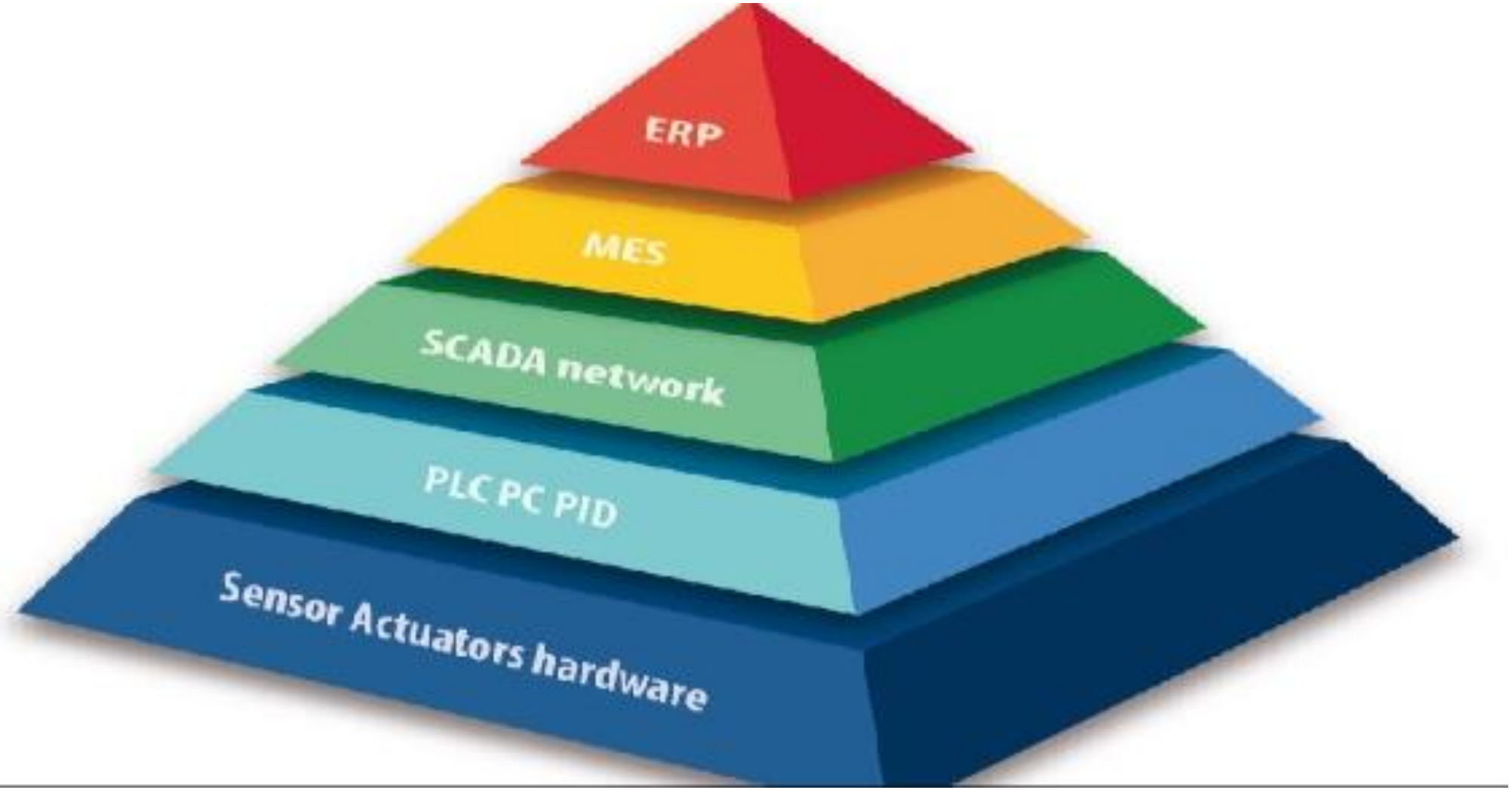


Who Uses SCADA?

SCADA systems are used by industrial organizations and companies in the public and private sectors to control and maintain efficiency, distribute data for smarter decisions, and communicate system issues to help mitigate downtime. SCADA systems work well in many different types of enterprises because they can range from simple configurations to large, complex installations. SCADA systems are the backbone of many modern industries, including:

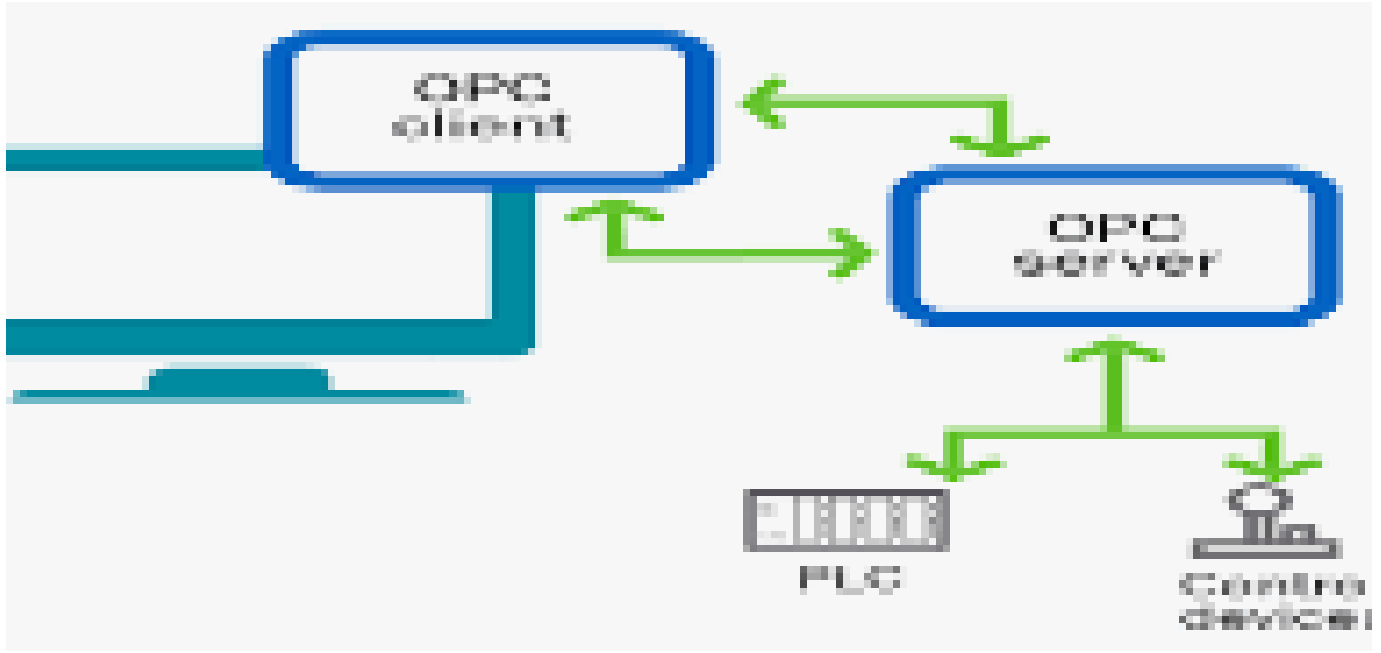
Energy
Food and beverage
Manufacturing
Oil and gas
Power
Recycling
Transportation
Water and waste water
And many more

Finally, We get Automation Pyramid

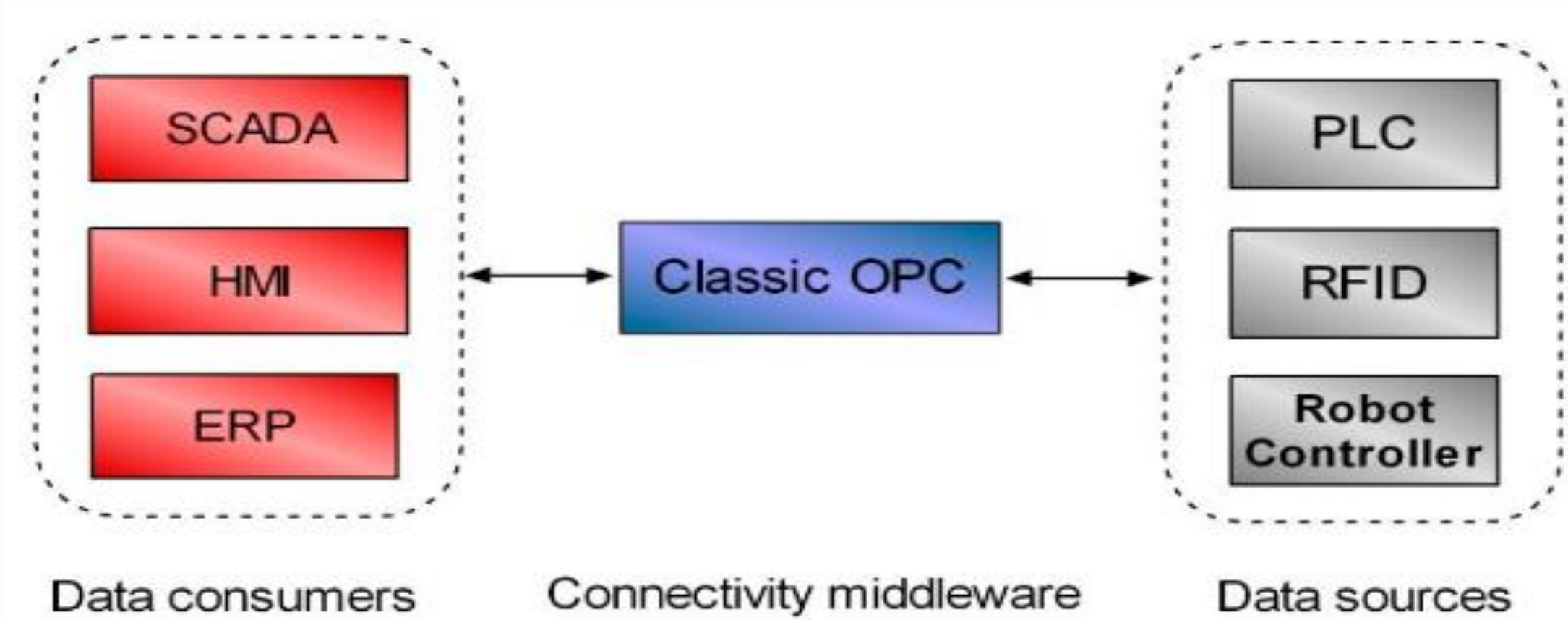


OPC (Open Platform Client)

OPC is a client/server technology. One application acts as the server providing data, and the other acts as a client using data.



OPC (Open Platform Client)



OPC is a widely accepted industrial communication standard that enables the exchange of data between multi-vendor devices and control applications without any proprietary restrictions.

An OPC server can communicate data continuously among PLCs on the shop floor, RTUs in the field, HMI stations, and software applications on desktop PCs. Even when the hardware and software are from different vendors, OPC compliance makes continuous real-time communication possible.

جمهورية مصر العربية

وزارة الإنتاج الحربي

Questions and Discussion


THANK YOU
THANK YOU
THANK YOU
THANK YOU