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Université
Grenoble Alpes

Concept of Industry 4.0: PLC network extensions and Real Time Networks

Asean-Factori 4.0 project

Grenoble-Valence , March 22.03.2022

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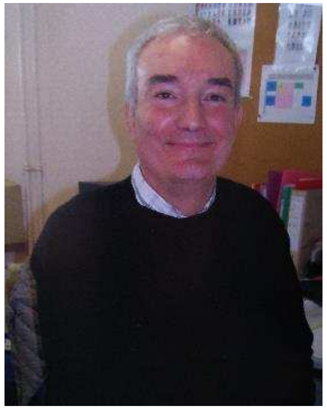
Condensed CV



-1993- Docteur (Ph.D.) Applied Physics from Joseph Fourier University
former name of Grenoble University Alpes
-1995 Teams for ESISAR engineer school foundation in Valence - Grenoble INP.
Head of the Electronics Department new curricula include 6 month Industrial project
-1998 New challenge Telecoms chair for the creation of the Telecoms and Networks Dpt.
IUT – Valence : Technological Institute in the University Grenoble Alpes.
- 2002- Founder and Head of the Administration and Security Networks Bachelor.
- 2010 to 2013 President of all French Networking and Telecommunication Departments
Design the new curricula for 29 Departments (still applied in 2021).

Research

-1996, one of three founders of the LCIS Laboratory first research labs in Valence.
ID: EA 3747 Research laboratory with 30 permanents researchers (ERC , MIT-35 Etienne Perret)
and up to 40 PhD Post Doctorate, internships students,..

Contributions research : Embedded systems and designing new architecture and protocols for some patents
(Fieldbus, low power RF and PLC communication system).

- IEEE, SPIE, ..member and since 2006 EAEEIE European association treasurer
- LCIS leader for several European projects : ITEA2-Osami, Artemis-Arrowhead,
and Frenchs industrials partnerships : ANR-POUCET, ANR-C3µ, BGLE- ADN4SE,..
Supervising many industrials PhD : Critical Fieldbus Networks, Smart Buildings, DC autonomous Buildings,..

Contact : Denis.genon-catalot@univ-grenoble-alpes.fr

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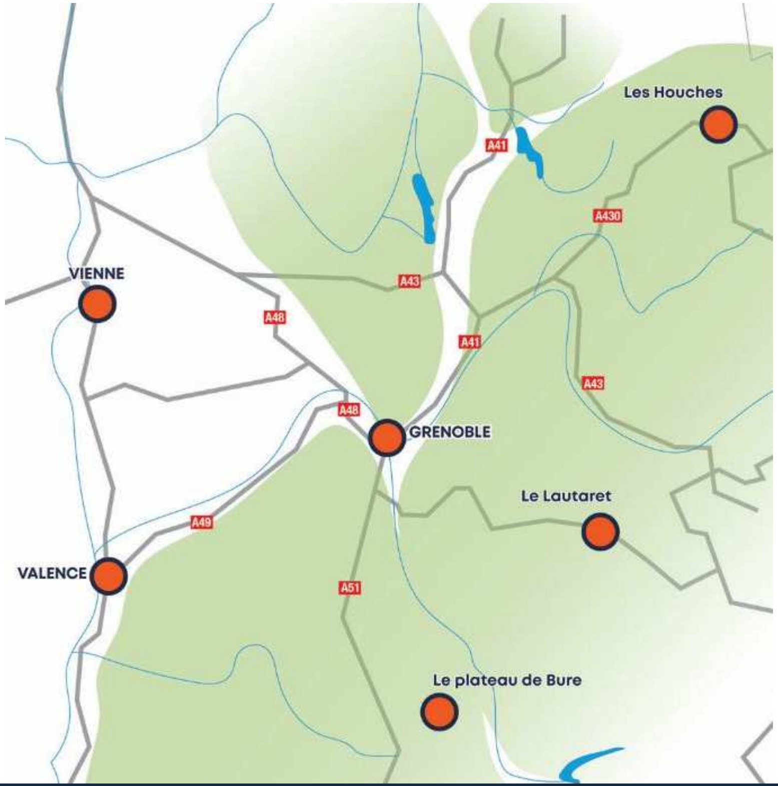
University Grenoble Alpes location and International position

UGA
Université Grenoble Alpes

- **56,000** students
- **3,400** PhD students (45% international)
- **7,500** employees, of which
  - **5,500** academic
  - **2,000** staff



Ranking 2020 : 99^{e} position over 1000 Universities

ACADEMIC RANKING OF WORLD UNIVERSITIES SINCE 2003

http://www.shanghairanking.com/Shanghairanking-Subject-Rankings/index.html

56 000	30	400	80
étudiants	écoles, facultés et instituts	diplômes proposés	laboratoires

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Summary :

UGA-1 From Sensors to PLC :

Requirements for automation architecture

UGA-2. Field bus network

RS232c / RS-485/ Modbus RTU/ Profibus…

UGA-3. Ethernet network

Modbus TCP/ Profibus IP/…

UGA-4. Real time Ethernet

Ethercat/Powerlink/ …

UGA-5. Wireless sensors/actuators

Mbus/LoRa

UGA-6. Unified communications

Informations over the cloud

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2. Automation architecture

Industrial communications will be the common thread of our PLC presentation

Communications : CIM pyramid

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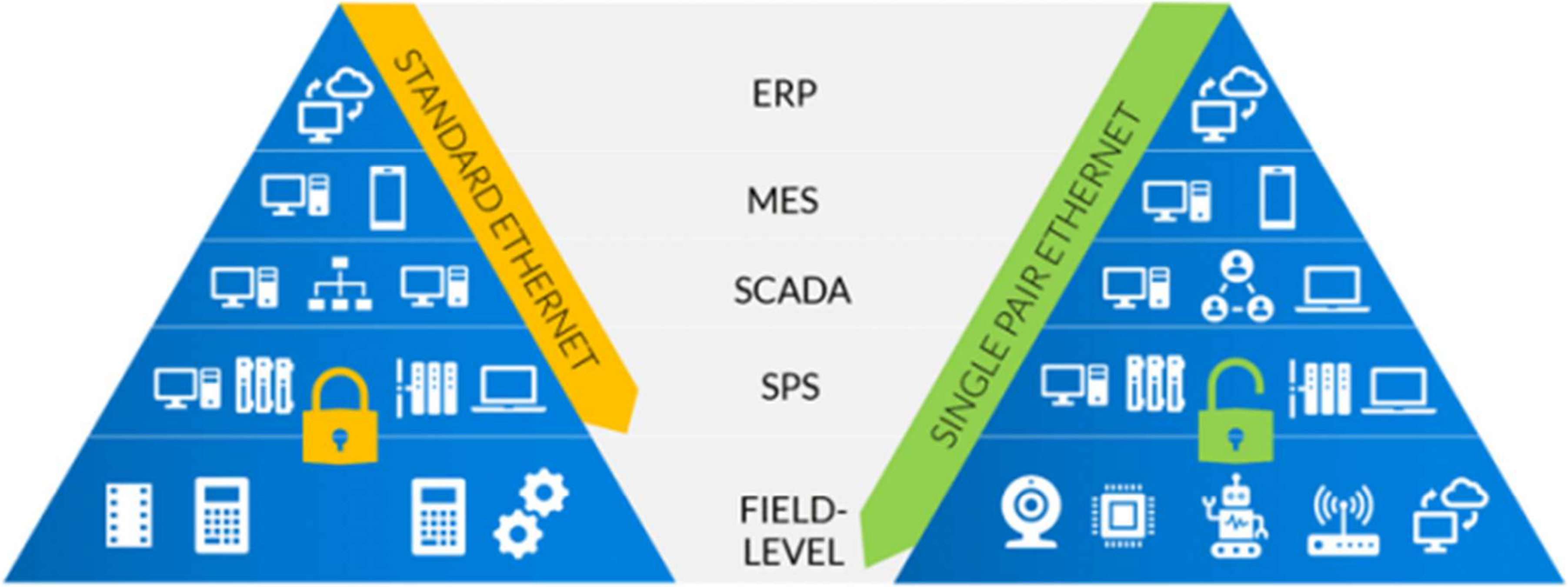

Computer Integrated manufacturing (**CIM**) : Describe integration layers

Example with the actual Ethernet standard (4 twisted pairs)
versus the new Single Pair Ethernet (1 twisted pair)

Small Hydro Power Plant : Automation Architecture

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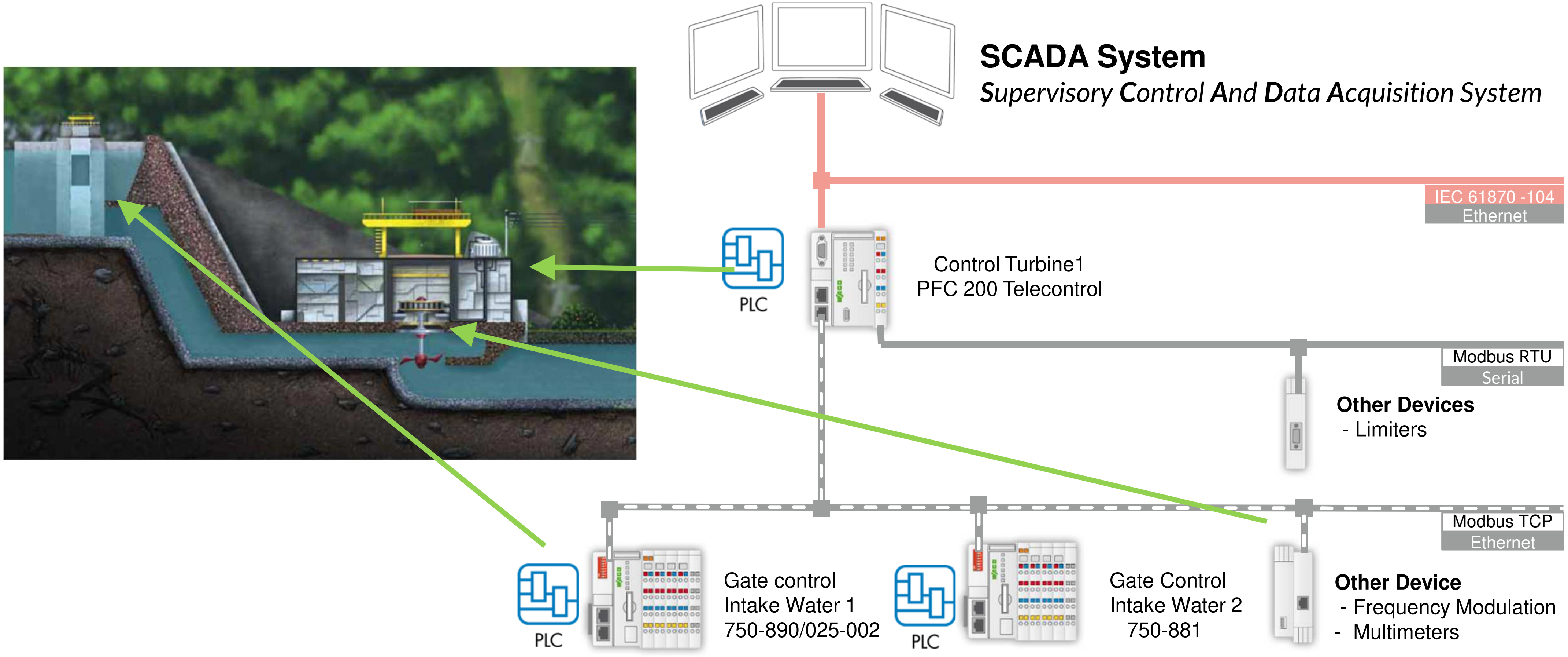

SCADA System

Supervisory Control And Data Acquisition System

courtesy WAGO

PLC languages: IEC 61131

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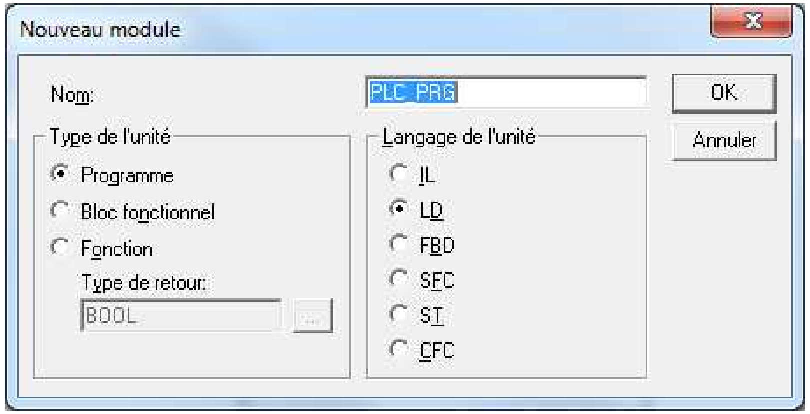


Nouveau module

Nom: PLC_PRG

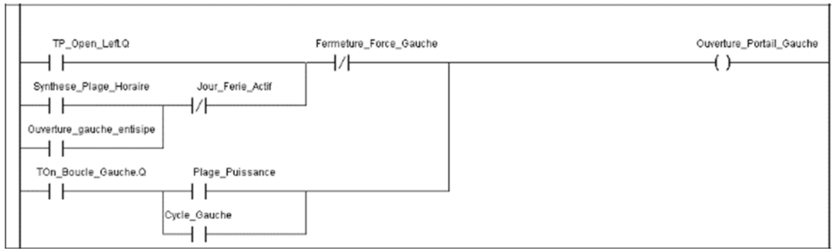
Type de l'unité

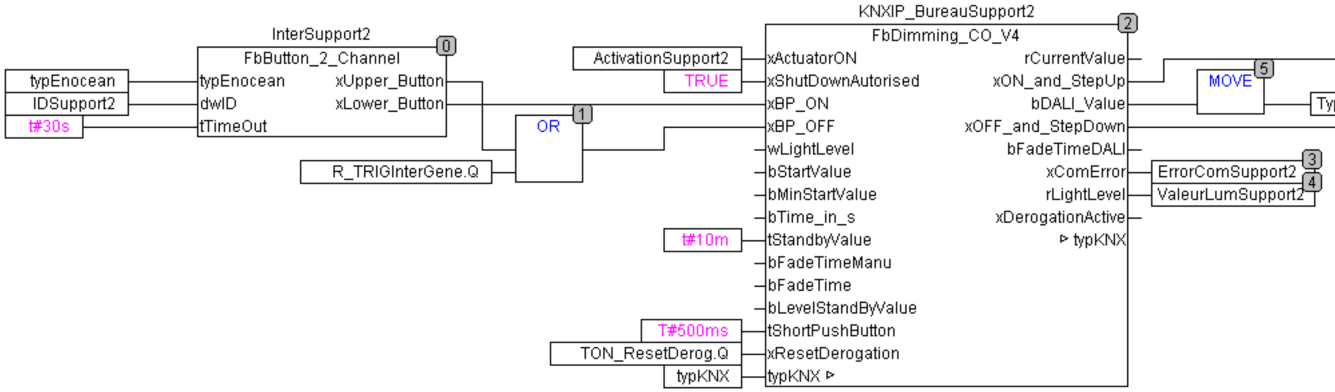
- ● Programme
- ○ Bloc fonctionnel
- ○ Fonction

Type de retour: BOOL

Langage de l'unité

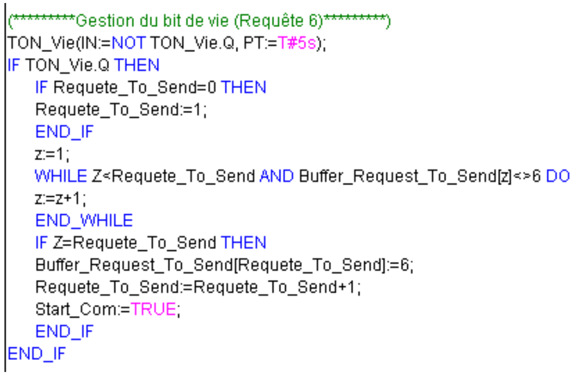
- ○ IL
- ● LD
- ○ FBD
- ○ SFC
- ○ ST
- ○ CFC





PLC languages according IEC 61131:

- **IL** (*Instruction List*)
- **LD** (*Ladder*, Schematic relais)
- **FBD** (*Function Bloc Diagramm*)
- **SFC** (*Sequence Flow Chart*, GRAFCET)
- **ST** (*Structured Text*)
- **CFC** (*Continuous Function Chart*)



```
(*********Gestion du bit de vie (Requête 6)*********)
TON_Vie(IN:=NOT TON_Vie.Q, PT:=T#5s);
IF TON_Vie.Q THEN
    IF Requete_To_Send=0 THEN
    Requete_To_Send:=1;
    END_IF
    z:=1;
    WHILE Z<Requete_To_Send AND Buffer_Request_To_Send[z]<>6 DO
    z:=z+1;
    END_WHILE
    IF Z=Requete_To_Send THEN
    Buffer_Request_To_Send[Requete_To_Send]:=6;
    Requete_To_Send:=Requete_To_Send+1;
    Start_Com:=TRUE;
    END_IF
END_IF
```

2.2 Intelligent centralized automation

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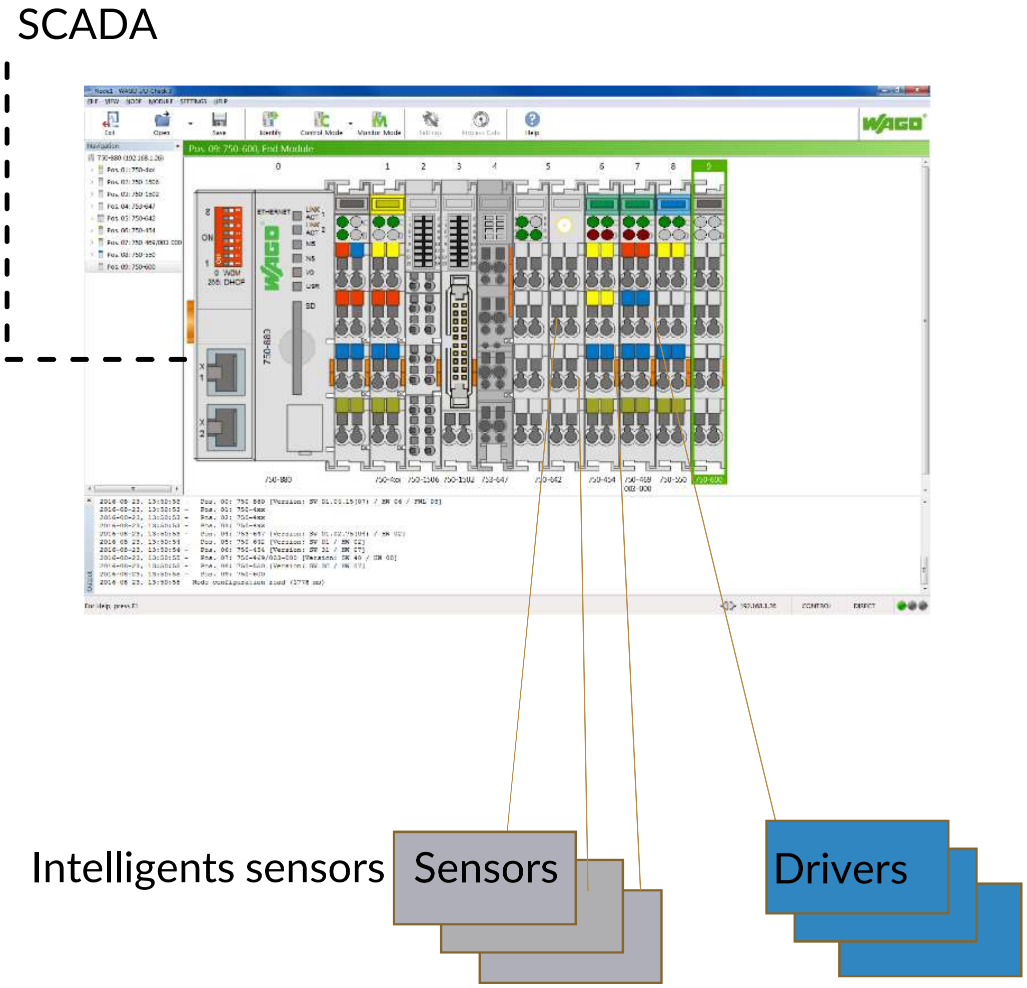

```
2016-08-23, 13:50:52 - Pos. 00: 750-880 [Version: SW 01.00.15(07) / HW 06 / FWL 03]
2016-08-23, 13:50:53 - Pos. 01: 750-4xx
2016-08-23, 13:50:53 - Pos. 02: 750-4xx
2016-08-23, 13:50:53 - Pos. 03: 750-4xx
2016-08-23, 13:50:53 - Pos. 04: 753-647 [Version: SW 01.02.76(04) / HW 02]
2016-08-23, 13:50:54 - Pos. 05: 750-652 [Version: SW 01 / HW 02]
2016-08-23, 13:50:54 - Pos. 06: 750-454 [Version: SW 31 / HW 07]
2016-08-23, 13:50:55 - Pos. 07: 750-469/003-000 [Version: SW 40 / HW 00]
2016-08-23, 13:50:55 - Pos. 08: 750-560 [Version: SW 30 / HW 07]
2016-08-23, 13:50:56 - Pos. 09: 750-600
2016-08-23, 13:50:56   Node configuration read (2778 ms)
For Help, press F1
```

Analog sensors actuators information's become numerical information !

Connexions systems needs to understand each other
….must be more "smart"

Point to point communication protocol with "intelligent" sensors

Protocol specifications for energy metering : Modbus
Binary date exchange with differents ranges

2.3 Communication : physical layer

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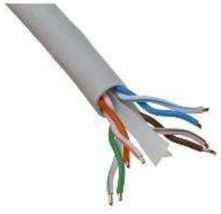
TIA : Telecommunication Industry Association previously
EIA : Electrical Industry Association

ITU-T : International Telecommunicaiton Union
- Technical (normalization)
previously
CCITT : Consultative Comity International Telephony Telegraphique

TIA/ EIA ITU-T / CCITT	**RS232C V24/V28**	**RS422 V11/X27**	**RS485 V11/X27**	**TTY**
Interface	Bipolar	Differential	Differential	Current Loop
Signal level	± 25 V max	± 5 V	± 5 V	0-20 mA
Sensibility	± 3 V	± 0,2 V	± 0,2 V	± 0,4 mA
Distance	10 to 15 m	1200 m	1200 m	1 to 2 km
Maximum throughput	19200 bds	10 Mbds	10 Mbds	19200 bds
Multipoint	Point to point	Point to multipoint	Point to multipoint	Point to multipoint
Nb. Transmitter	1	1	32	
Nb. Receivers	1	10	32	



2.4 Point to point connexion

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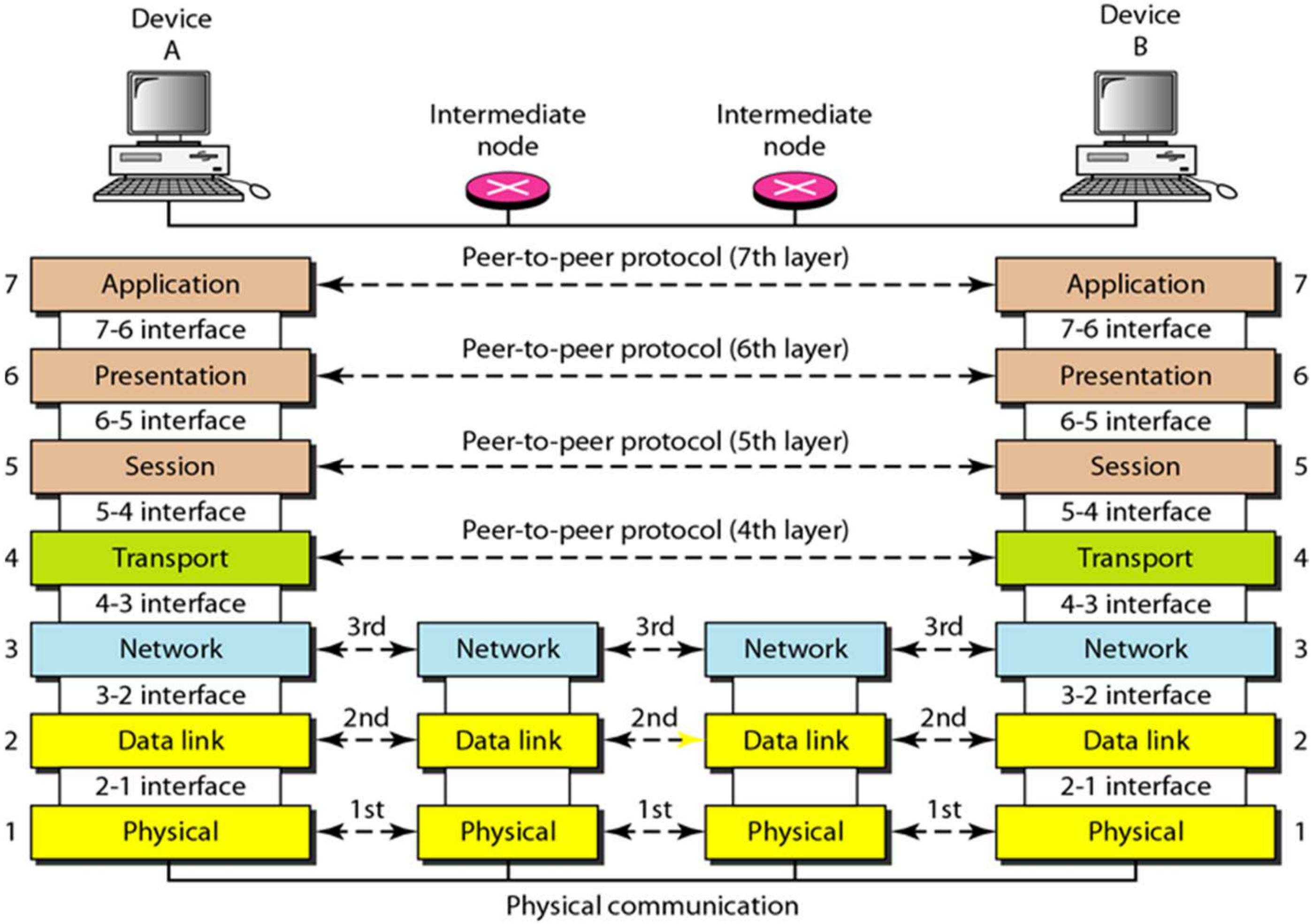

2.5- Network layers protocols map

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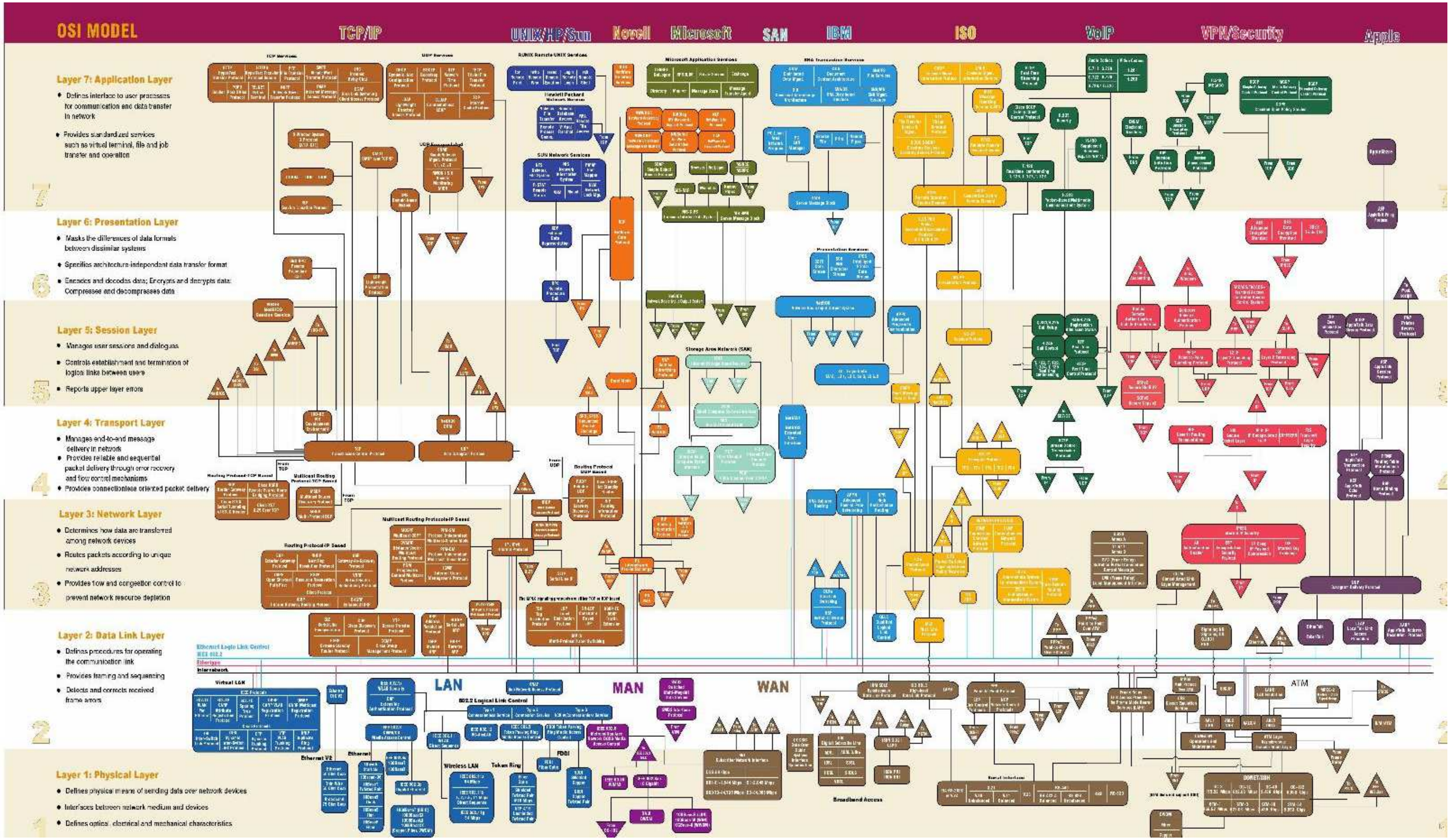
OSI MODEL
TCP/IP
UNIX/HP/Sun
Novell
Microsoft
SAN
IBM
ISO
VoIP
VPN/Security
Apple
Layer 7: Application Layer
Defines interface to user processes for communication and data transfer in network
Provides standardized services such as virtual terminal, file and job transfer and operation
7
Layer 6: Presentation Layer
Masks the differences of data formats between dissimilar systems
Specifies architecture-independent data transfer format
Encodes and decodes data; Encrypts and decrypts data; Compresses and decompresses data
6
Layer 5: Session Layer
Manages user sessions and dialogues
Controls establishment and termination of logical links between users
Reports upper layer errors
5
Layer 4: Transport Layer
Manages end-to-end message delivery in network
Provides reliable and sequential packet delivery through error recovery and flow control mechanisms
Provides connectionless oriented packet delivery
4
Layer 3: Network Layer
Determines how data are transferred among network devices
Routes packets according to unique network addresses
Provides flow and congestion control to prevent network resource depletion
3
Layer 2: Data Link Layer
Defines procedures for operating the communication link
Provides framing and sequencing
Detects and corrects received frame errors
2
Layer 1: Physical Layer
Defines physical means of sending data over network devices
Interfaces between network medium and devices
Defines optical, electrical and mechanical characteristics
1
Ethernet Logic Link Control
IEEE 802.2
Etherigpe
Internetwork
Virtual LAN
LAN
MAN
WAN
ATM
802.2 Logical Link Control
Ethernet
Ethernet V2
Wireless LAN
Token Ring
FDDI
Broadband Access

2.6 - Protocols for datas exchange

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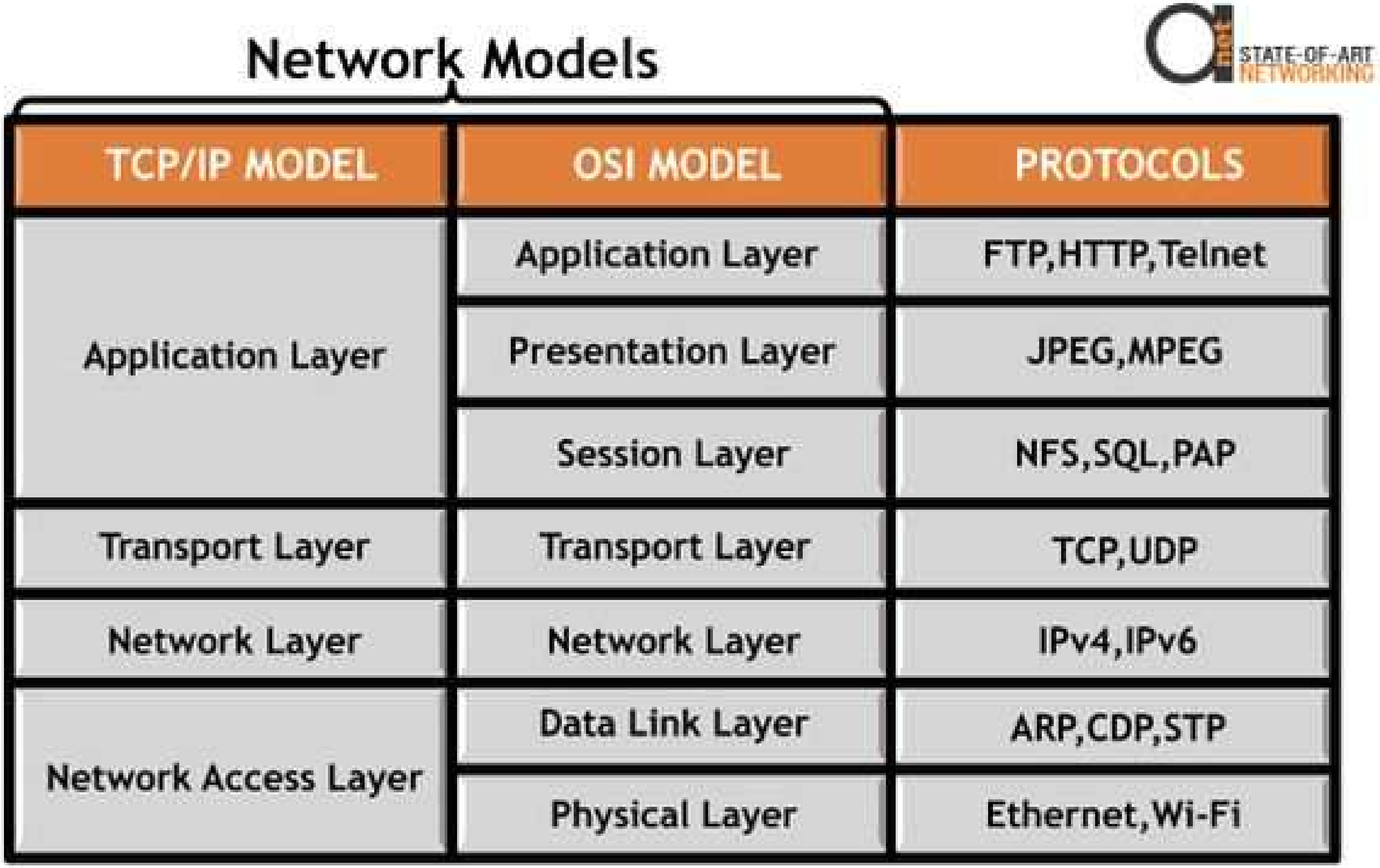

Network Models

TCP/IP MODEL	OSI MODEL	PROTOCOLS
Application Layer	Application Layer	FTP,HTTP,Telnet
	Presentation Layer	JPEG,MPEG
	Session Layer	NFS,SQL,PAP
Transport Layer	Transport Layer	TCP,UDP
Network Layer	Network Layer	IPv4,IPv6
Network Access Layer	Data Link Layer	ARP,CDP,STP
	Physical Layer	Ethernet,Wi-Fi

STATE-OF-ART
NETWORKING

Adressage IP

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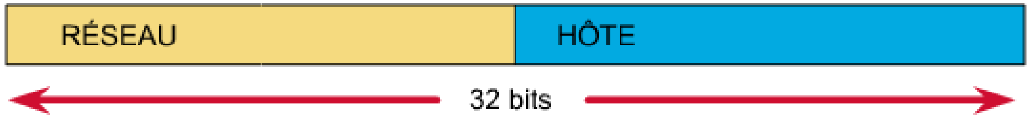
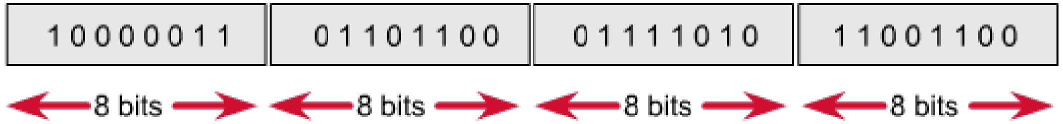
- Adresse Internet Protocole (Version 4 -) :
  - **32 bits address encoded (4 bytes)**
  - **Split in 2 complementary parts :**
  - Network reference number network()
  - Unit/machine host number (host)

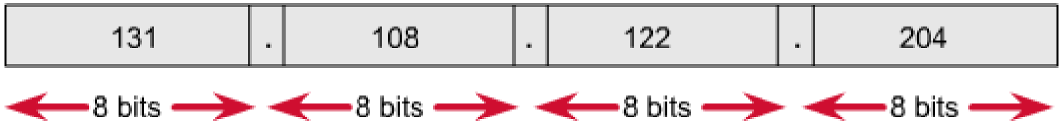


  - **Division en groupe de 8 bits (1 octet) séparé par des points**



10000011	01101100	01111010	11001100
8 bits	8 bits	8 bits	8 bits

  - **Par souci de simplicité, représentation au format décimal**



131	.	108	.	122	.	204
8 bits		8 bits		8 bits		8 bits

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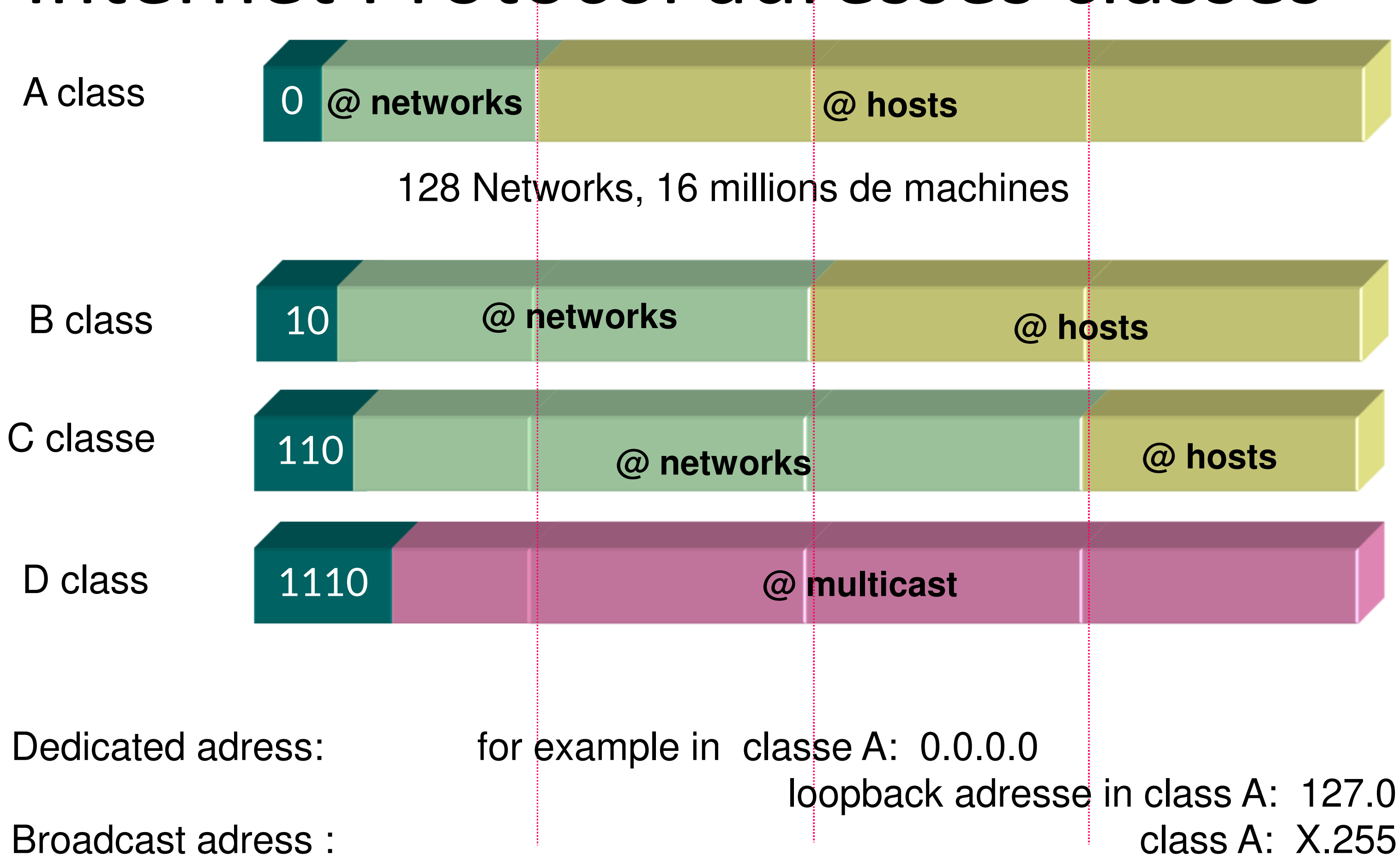
Internet Protocol adresses classes



Dedicated adress: for example in classe A: 0.0.0.0

loopback adresse in class A: 127.0.0.0

Broadcast adress : class A: X.255.255.255

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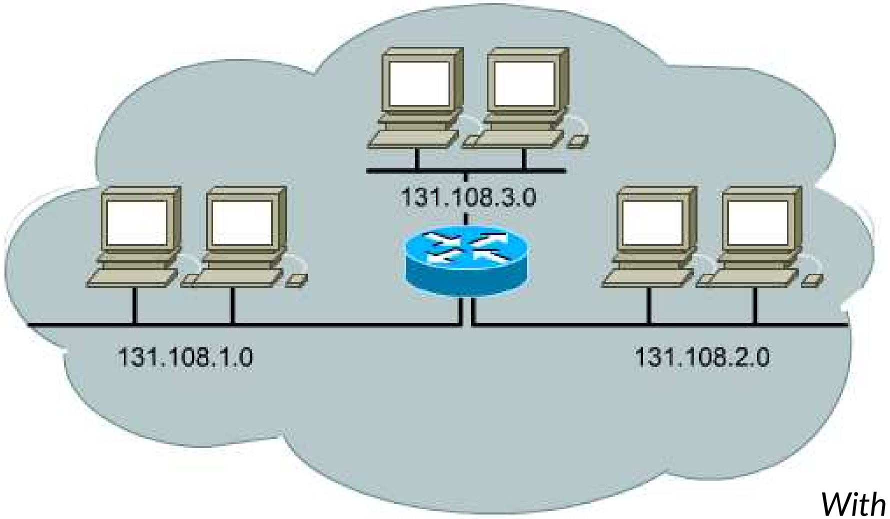
IP Subnets network exemple

- Exemple:
  - **B class** with IP address : **131.108.0.0**,
  - We want to split or local area network (LAN) in **3 subnets class network with the adress :**
    - 131.108.1.0
    - 131.108.2.0
    - 131.108.3.0



With the courtesy – JMT- UGA Mistre

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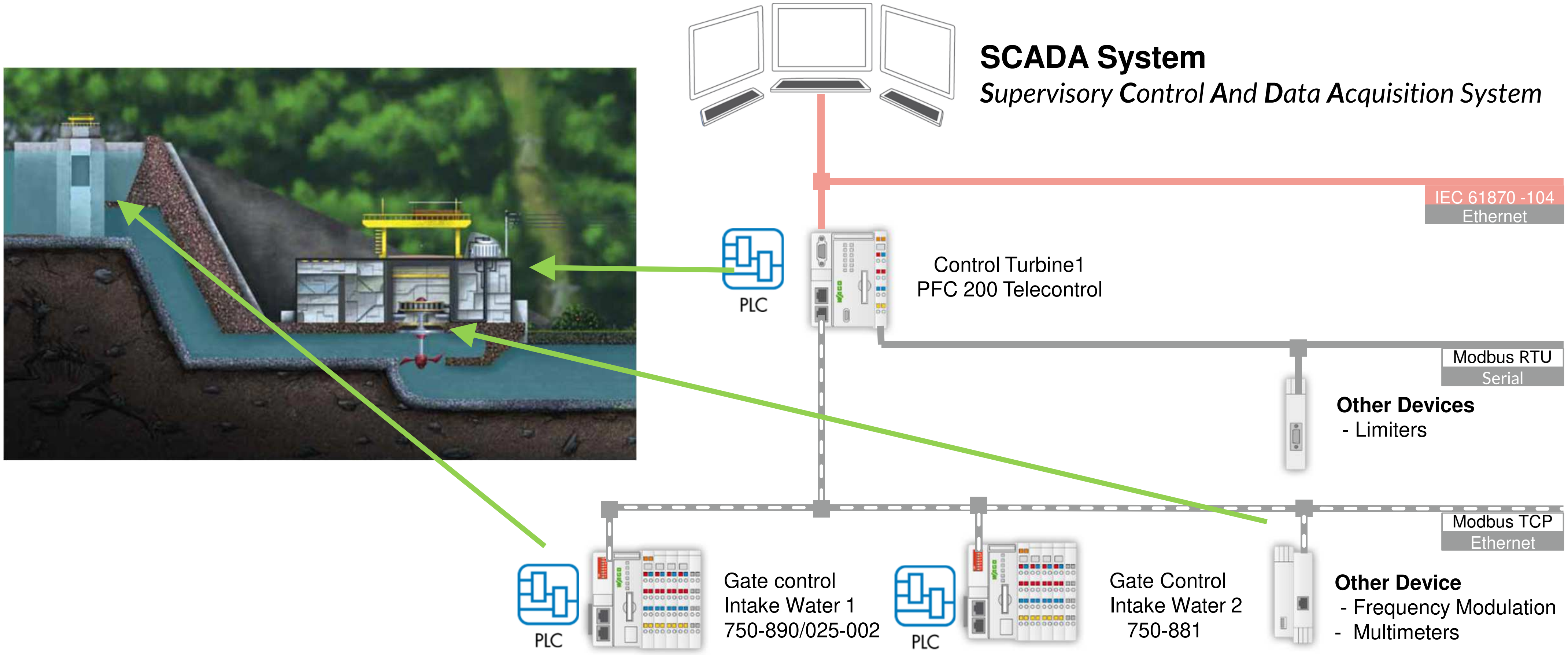
Small Hydro Power Plant : Automation Architecture



SCADA System

Supervisory Control And Data Acquisition System

courtesy WAGO

2-7 ModBus Protocol

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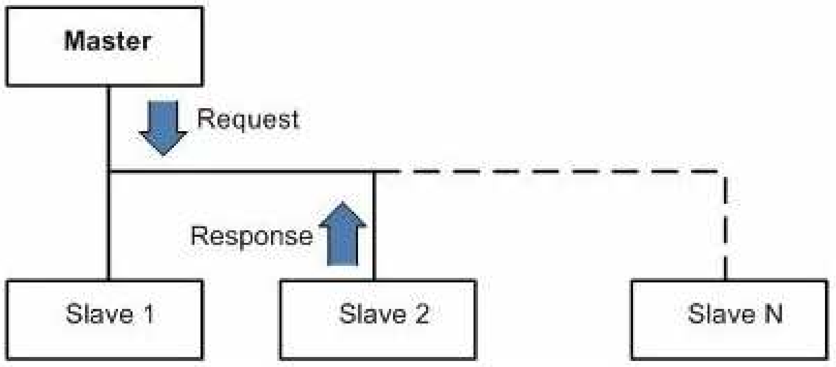
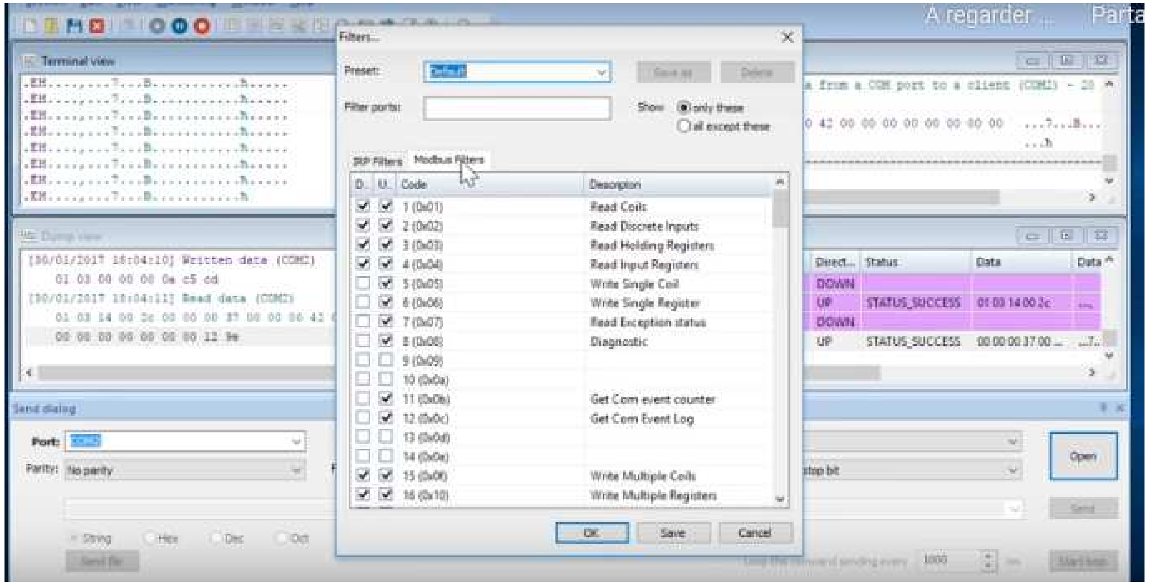
Serial protocol based on master (s) / slave (s) dialogue
Data exchange with “Request / Response”





```
[30/01/2017 18:04:10] Written data (COM2)
    01 03 00 00 00 0a c5 cd
[30/01/2017 18:04:11] Read data (COM2)
    01 03 14 00 2c 00 00 00 37 00 00 00 42 0
    00 00 00 00 00 00 00 12 9e
```

Filters...

Preset: Default

Filter ports:

Show: ● only these ○ all except these

IRP Filters | Modbus Filters

D..	U..	Code	Description
☑	☑	1 (0x01)	Read Coils
☑	☑	2 (0x02)	Read Discrete Inputs
☑	☑	3 (0x03)	Read Holding Registers
☑	☑	4 (0x04)	Read Input Registers
□	☑	5 (0x05)	Write Single Coil
□	☑	6 (0x06)	Write Single Register
□	☑	7 (0x07)	Read Exception status
□	☑	8 (0x08)	Diagnostic
□	□	9 (0x09)	
□	□	10 (0x0a)	
□	☑	11 (0x0b)	Get Com event counter
□	☑	12 (0x0c)	Get Com Event Log
□	□	13 (0x0d)	
□	□	14 (0x0e)	
☑	☑	15 (0x0f)	Write Multiple Coils
☑	☑	16 (0x10)	Write Multiple Registers

OK | Save | Cancel

Direct...	Status	Data	Data
DOWN			
UP	STATUS_SUCCESS	01 03 14 00 2c	...
DOWN			
UP	STATUS_SUCCESS	00 00 00 37 00 ...	...7..

Port: COM2

Parity: No parity

○ String ○ Hex ○ Dec ○ Oct

Open

Extension on Internet protocol
Internet Protocol based on Client / Server dialogue

Data exchange in the form “Request / Response”

Most PLC support both Client/Server modes

2-8 Modbus frames

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First and simple implementation

ASCII Mode

ASCII : American Standard Code for Information Interchange

Start sequence	Address	Function	Payload Data	LRC	End sequence
“:”	1 Byte	1 Byte	Nb Bytes	1 Byte	“CR + LF”

95% of deployed installations

RTU Mode

RTU : Remote Terminal Unit

Start sequence	Address	Function	Payload Data	CRC	End sequence
3.5 Ts	1 Byte	1 Byte	Nb Bytes	2 Bytes	4 Ts

2.10- Modbus frames

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Basic Frame layer Link layer independent

- PDU :

  (Protocol Data Unit)

Code Function	Data

- ADU : RTU

  (Application Data Unit)

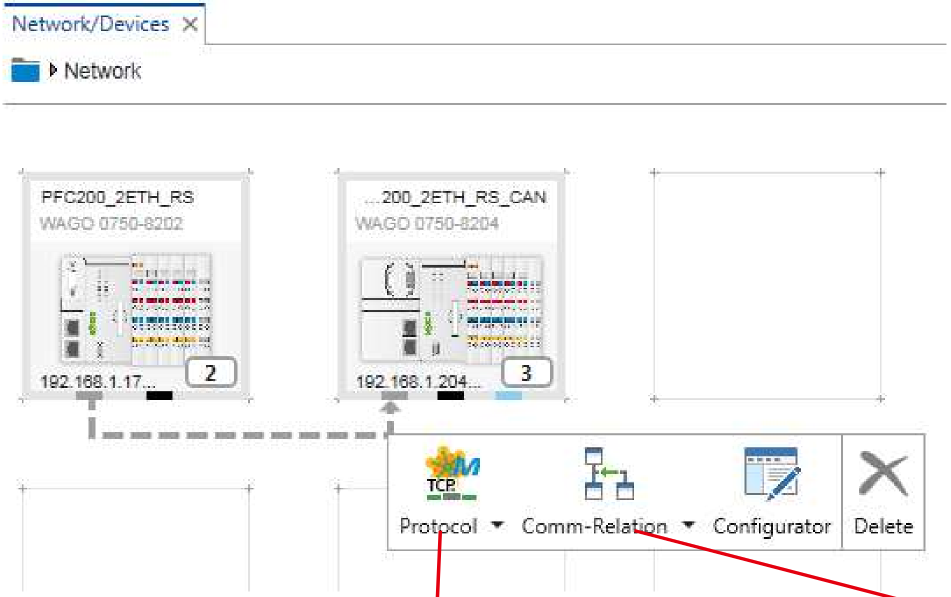
Address	Modbus PDU	CRC

- ADU : TCP

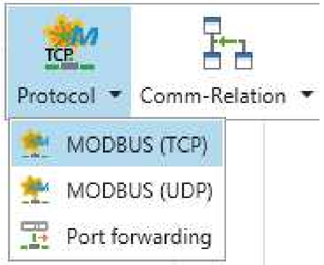
Transaction	Protocol	Length	Unit ID	Modbus PDU

(Transmission Control Protocol
.....over Internet Protocol)

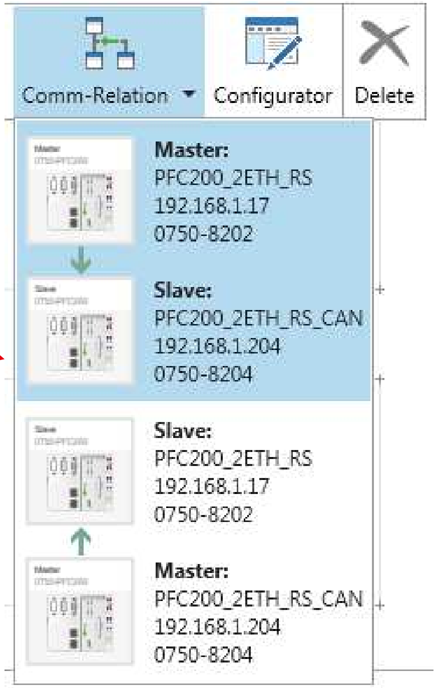
2-9 Modbus – Simple configuration link layer



Link sélection type



Participants' roles



Master:
PFC200_2ETH_RS
192.168.1.17
0750-8202

Slave:
PFC200_2ETH_RS_CAN
192.168.1.204
0750-8204

Slave:
PFC200_2ETH_RS
192.168.1.17
0750-8202

Master:
PFC200_2ETH_RS_CAN
192.168.1.204
0750-8204

2.11- Modbus bridging

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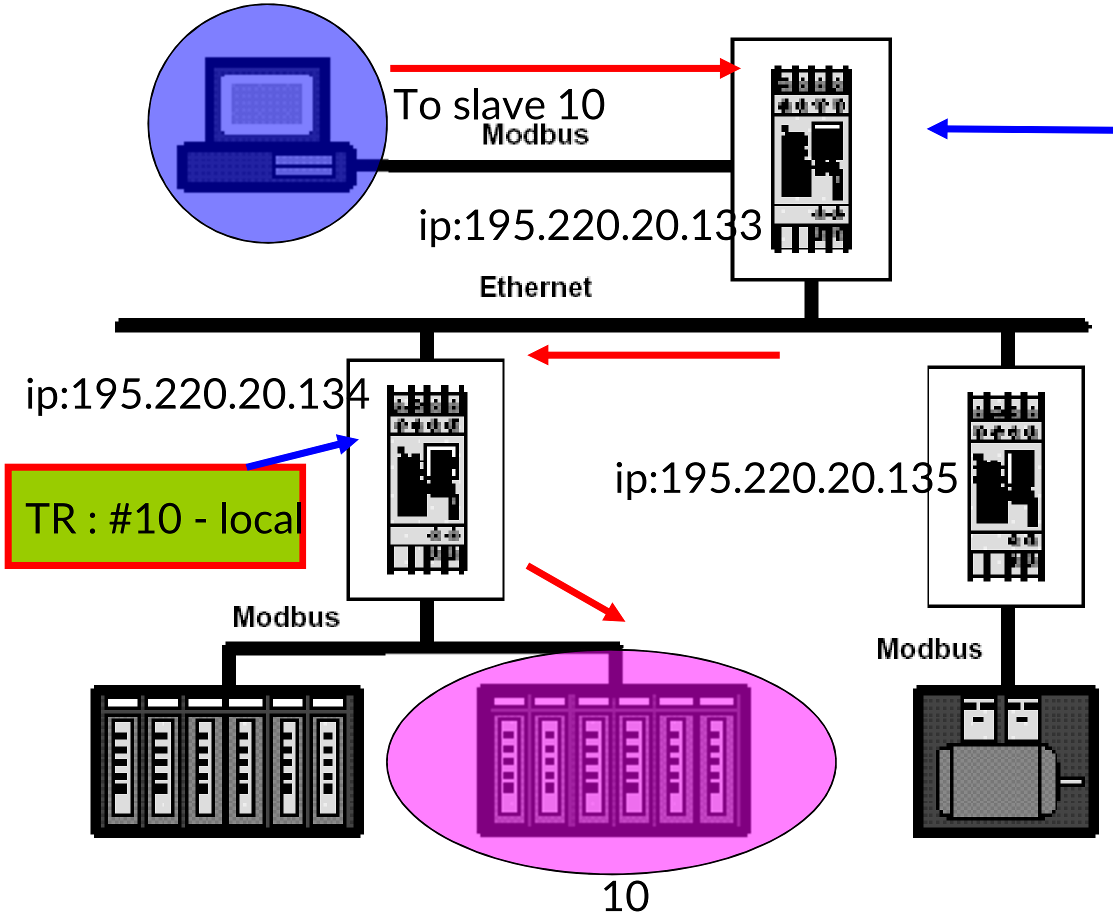

Table routage

Statique : #10 - 195.220.20.134

Diffusion : #10 non local

3-Fieldbus specifications : IEC 61158/ 61784 series Industrial communication networks

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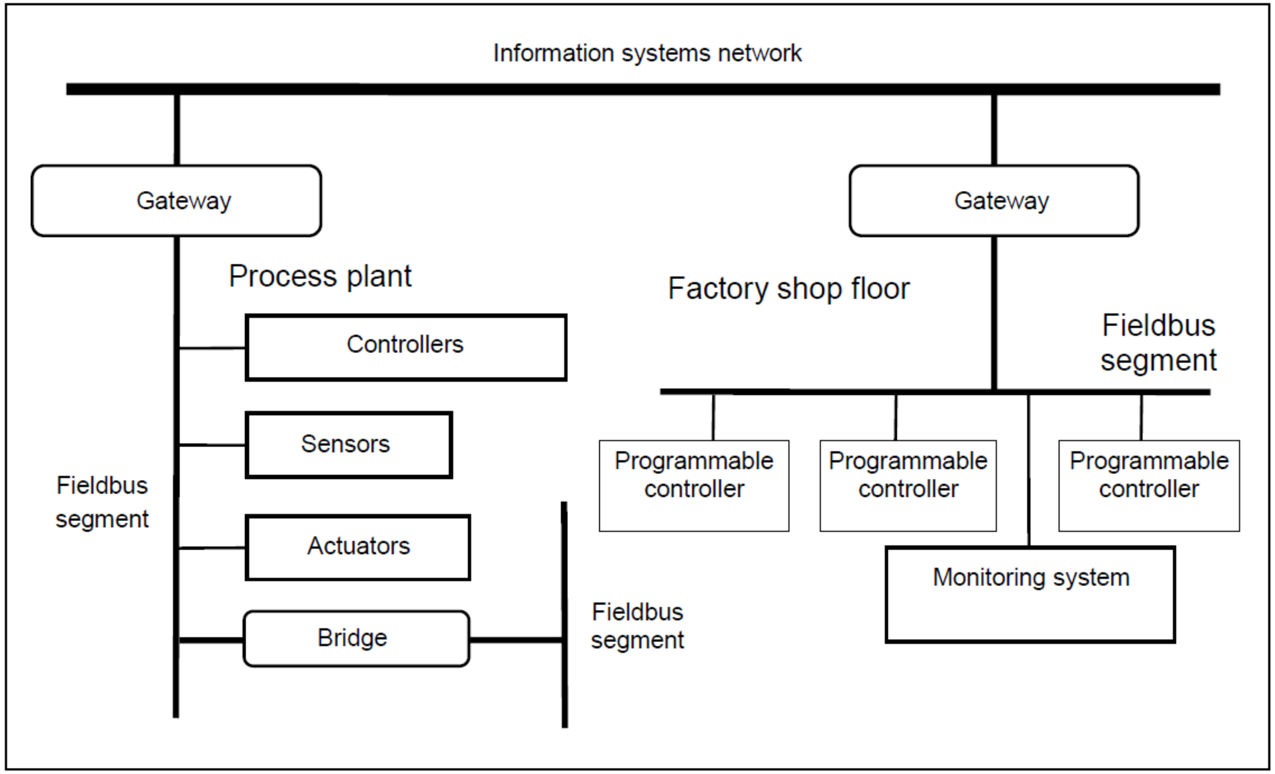
Industrial process measurement and control
Data communication networks
Multilayer applications



3.1 Protocols normalized by IEC 61138/ 61784

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	Name	Vendor
1.	Fieldbus Foundation,	EU
2.	ControlNet, EtherNet/IP, DeviceNet	ODVA
3.	PROFIBUS, PROFInet	Siemens
4.	P-Net,	Danmark
5.	WordFIP	Alstom, Cegelec
6.	INTERBUS	Phoenix Contact
7.	Swiftnet (retired)	Boeing
8.	CC-Link	Mitsubishi
9.	HART	Hart
10.	Vnet/IP	Yokogawa
11.	Tcnet	Japon
12.	EtherCAT	EtherCAT group
13.	ETHERNET Powerlink	Open source
14.	EPA	Chine
15.	MODBUS-RTPS	Schneider
16.	SERCOS	Sercos
17.	RAPIEnet	Korea
18.	SafetyNET p	Pilz Gmbh

All these protocols are incompatible each other
IP gateway is the solution to transfer data

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3.2 Profibus – Serial Bus

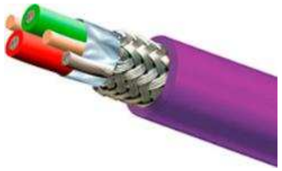
In 1987, in Germany, 21 companies (mainly Germans including Siemens)) and institutions joined forces to work on a project called “field bus”. The goal was to develop a serial communication field bus.
These association members have agreed on a common technical concept for production and for automation.
First denomination : Profibus-PA (Process Automation)
For highly communicative tasks, the Profibus-FMS (Field bus Message Specification) protocol, which is particularly complex, was specified.

PROFI®
PROCESS FIELD BUS
BUS

In 1993, the Profibus-DP (Decentralized Peripherals) protocol improved its predecessor in terms of simplicity and above all speed.

Profibus is part of the IEC 61158 recommendation.

Communication over twisted pair RS-485 type (characteristic impedance 150 ohms)
Data transmission support numerical base band in NRZ mode on physical medium.



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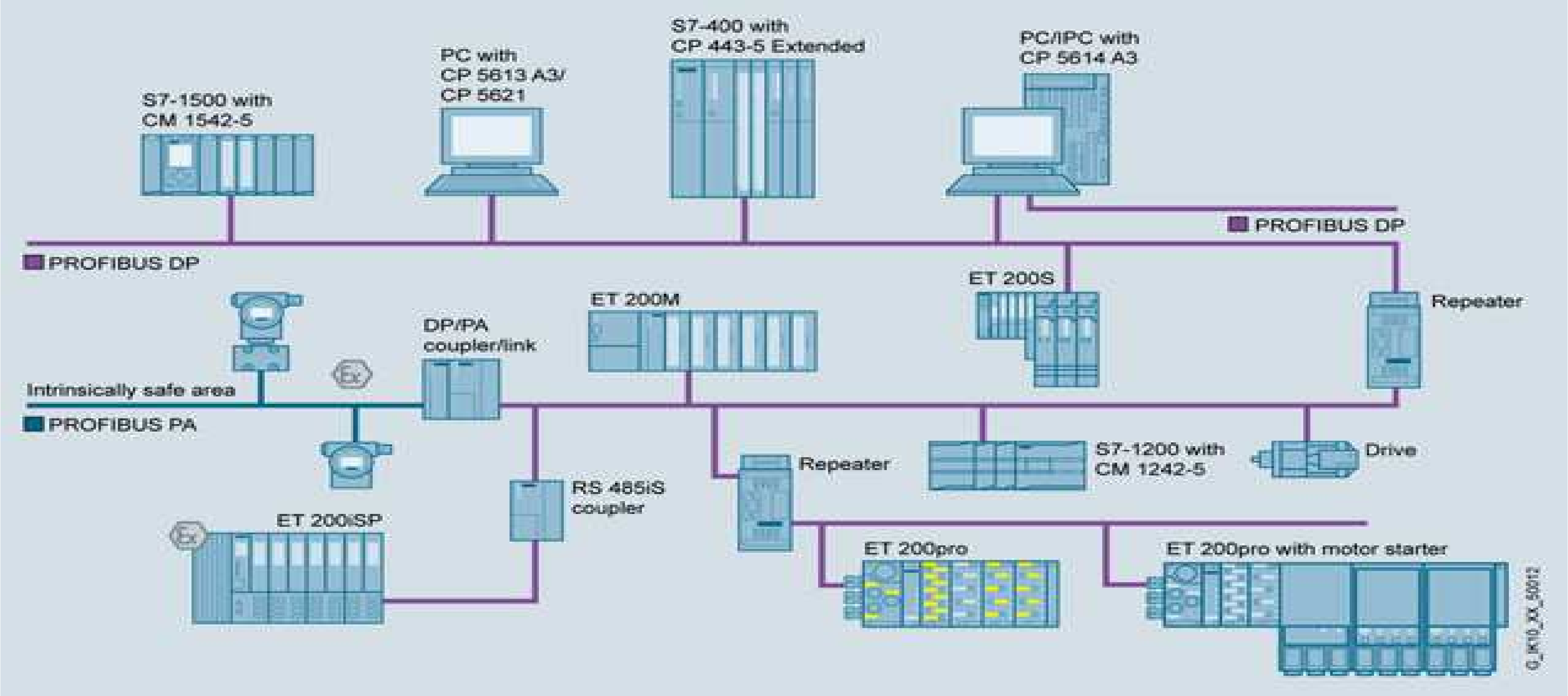
3.3 Profibus DP/ PA

Bus or tree topology with repeaters
RS– 485 transmission line



courtesy SIEMENS

3.4 Profibus DP : Ethernet version

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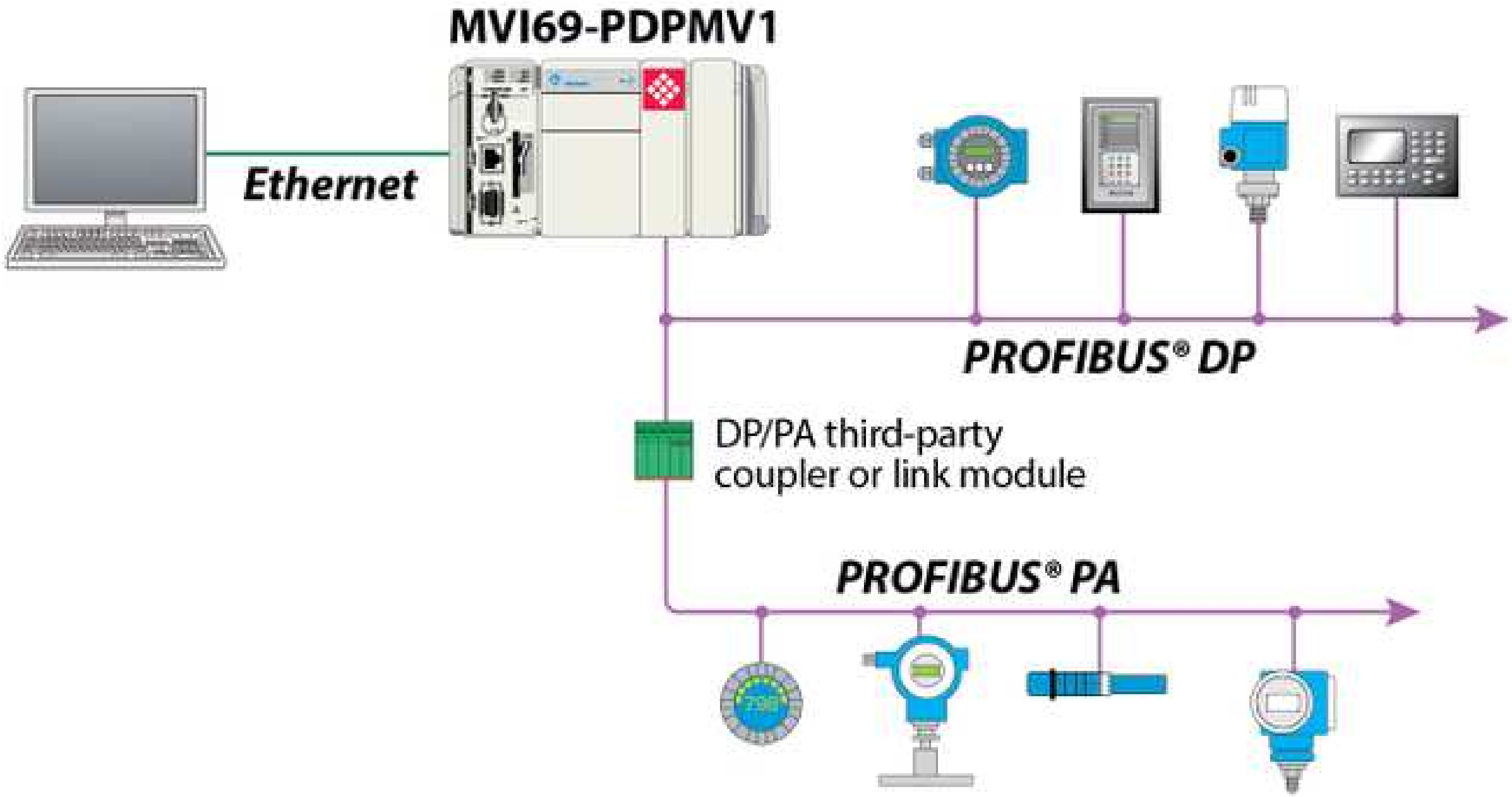
Profibus-DP for Decentralized Peripheral bus is used "real-time" deterministic control of sensors and actuators by performing automation and regulation functions on PLC.

Used for the connection of a “distributed intelligence”,

Communication between several PLCs (with each other analog and digital input/output) supporting PROFIBUS-FMS.

Data rate reach up to 12 Mbits/s on
Twisted pair : STP, UTP, FTP or optical fiber.



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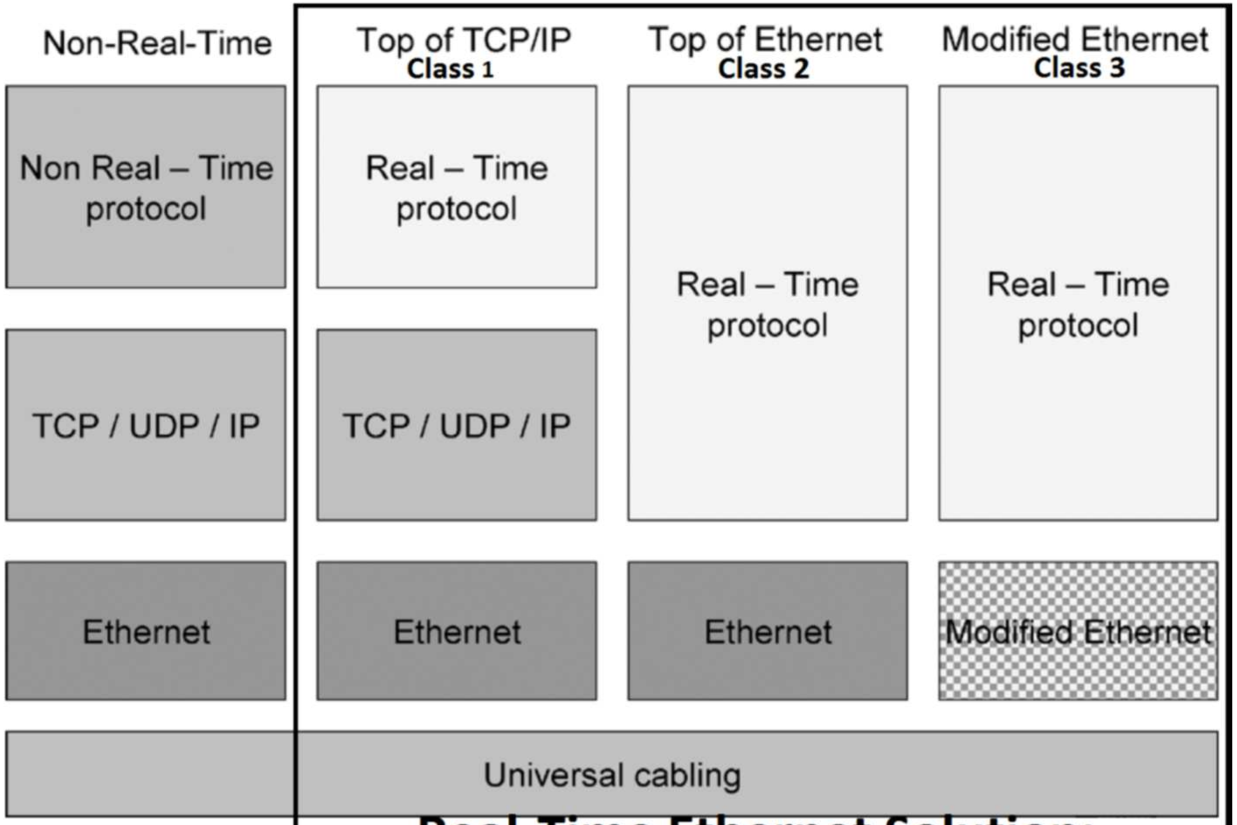
4. Industrial Ethernet



Non-Real-Time

Non Real – Time protocol

TCP / UDP / IP

Ethernet

Top of TCP/IP
Class 1

Real – Time protocol

TCP / UDP / IP

Ethernet

Top of Ethernet
Class 2

Real – Time protocol

Ethernet

Modified Ethernet
Class 3

Real – Time protocol

Modified Ethernet

Universal cabling

Real-Time Ethernet Solution:
3 approaches

Ethernet protocol is not deterministic
best effort for frames distribution

Industrial reality required time constraints and need Ethernet evolution.

4. Industrial Ethernet : Powerlink

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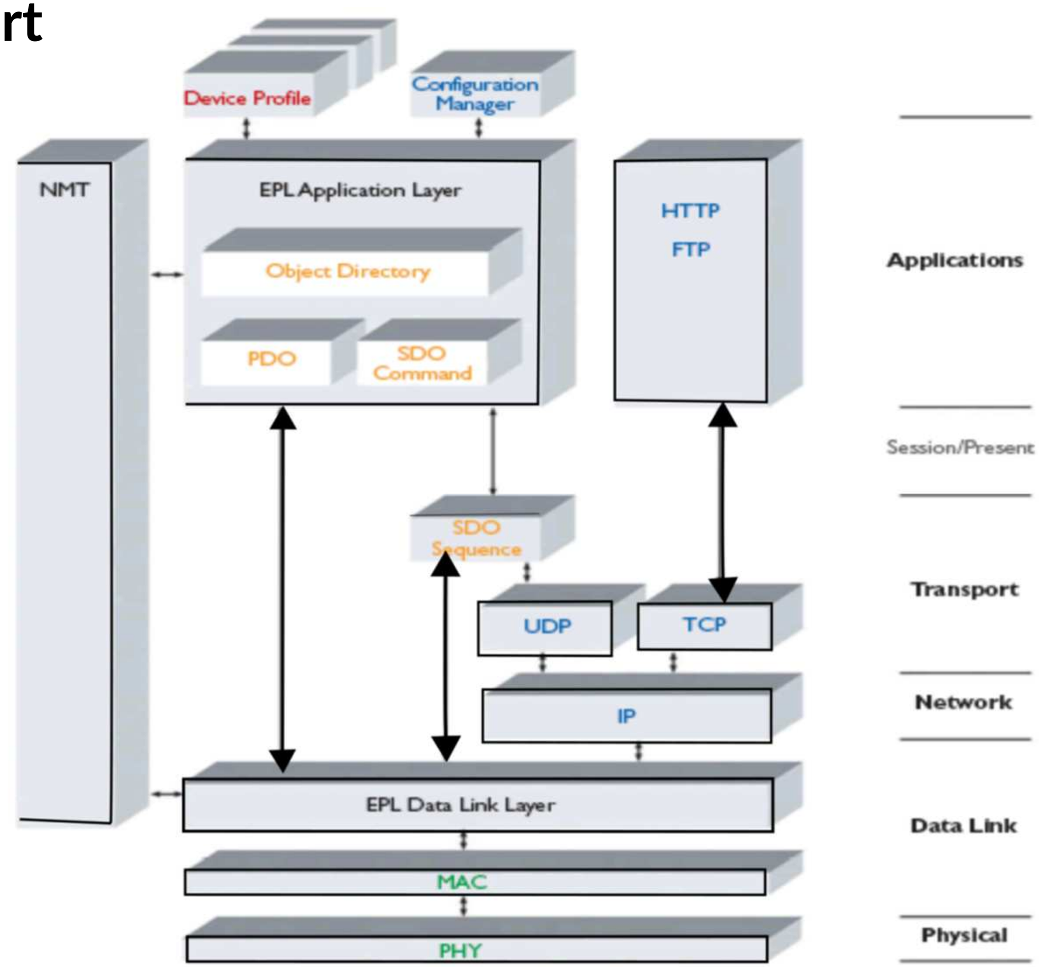
CAN protocol over Ethernet support



4. Switched Ethernet : IEC 61850

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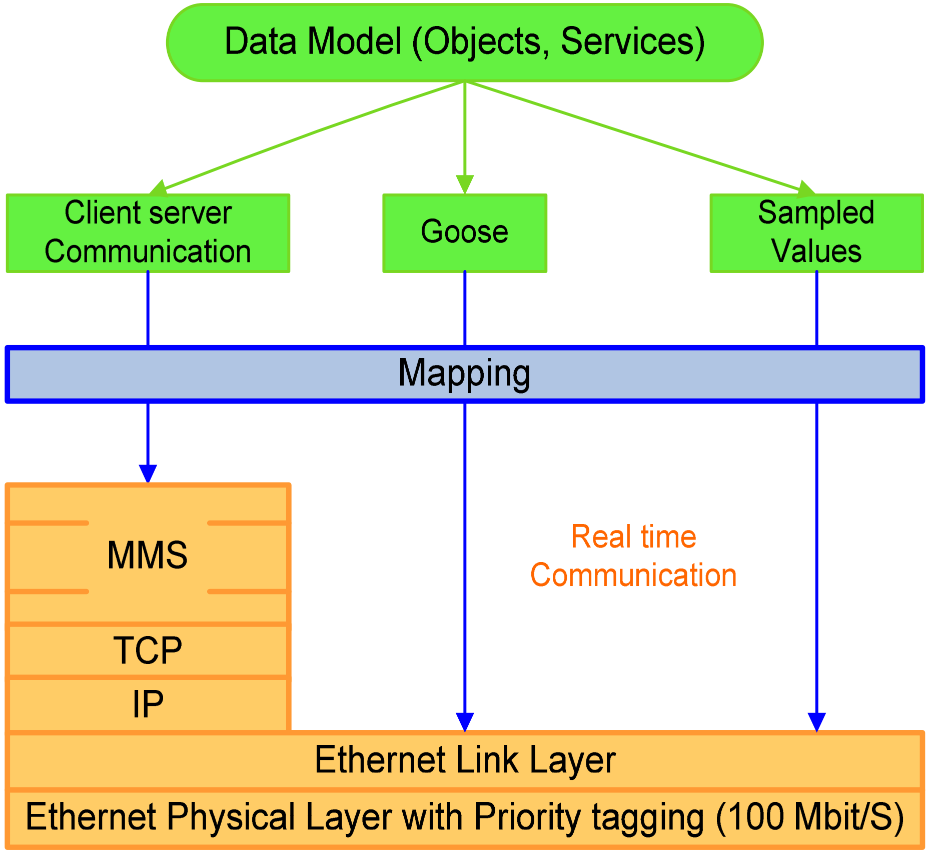
Data Model (Objects, Services)
Client server Communication
Goose
Sampled Values
Mapping
MMS
TCP
IP
Real time Communication
Ethernet Link Layer
Ethernet Physical Layer with Priority tagging (100 Mbit/S)

Network for Smart Grids

- Satisfying real-time performance by the standard in developing extension cards that can transmit critical real-time signals at network level
- Development of a new application layer allowing to track the dialogue according to the IEC 61850 standard
- New equipment design playing the role of Ethernet switch/ IEC 61850

5. Wireless network

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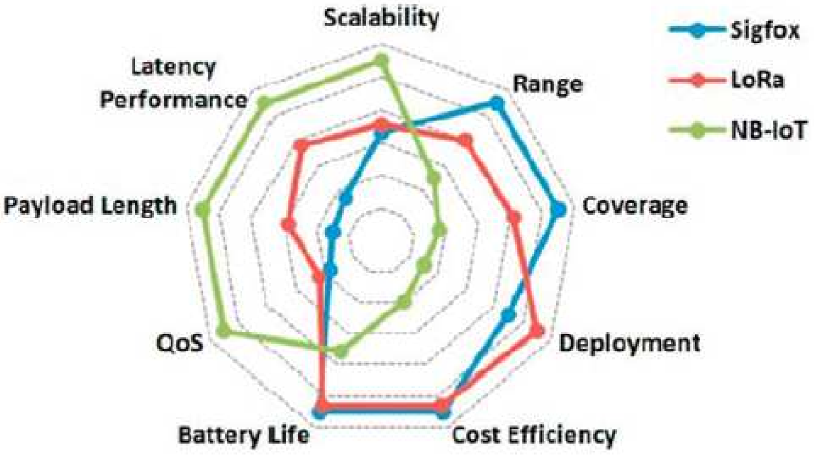
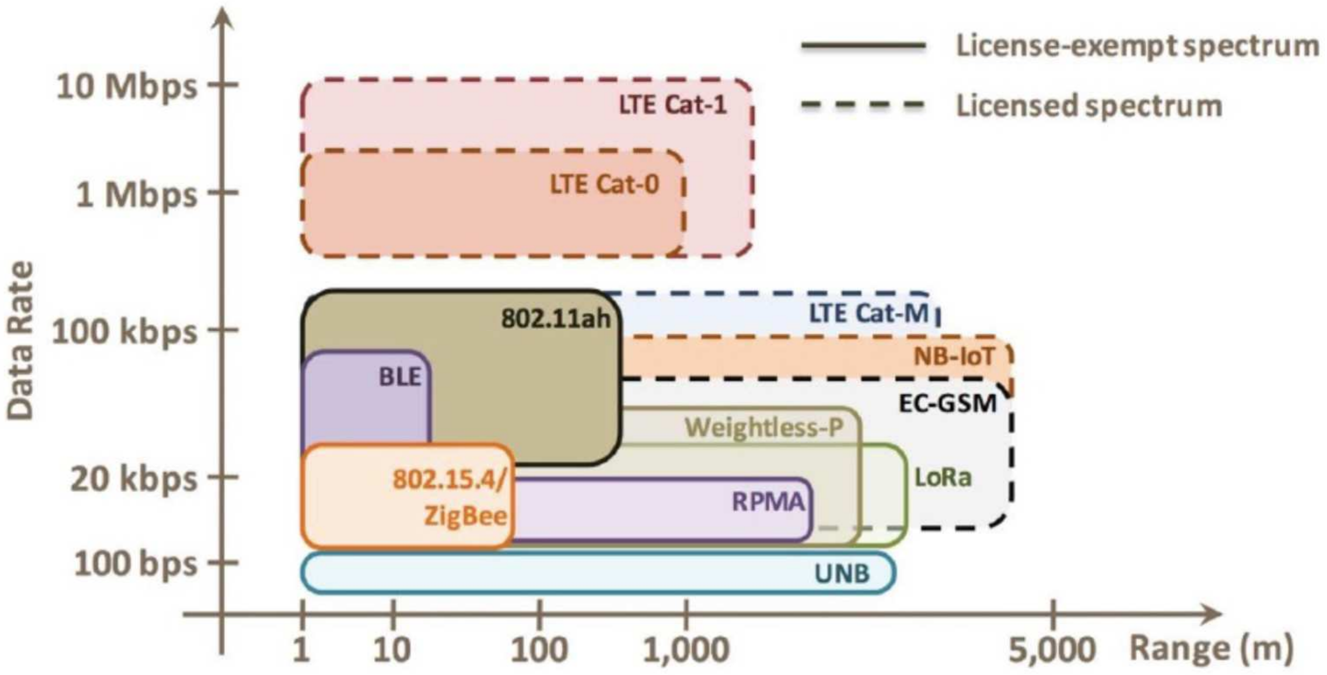
The main evaluation criteria for Low Power Wide Area Network - LWPAN:

- Range / Coverage
- Deployment / infrastructure cost
- Payload / Latency / Performance
- Consumption (battery life)
- Quality of service / Latency





Source https://iotfactory.eu/

5. Industriel scientifique et Médical Band

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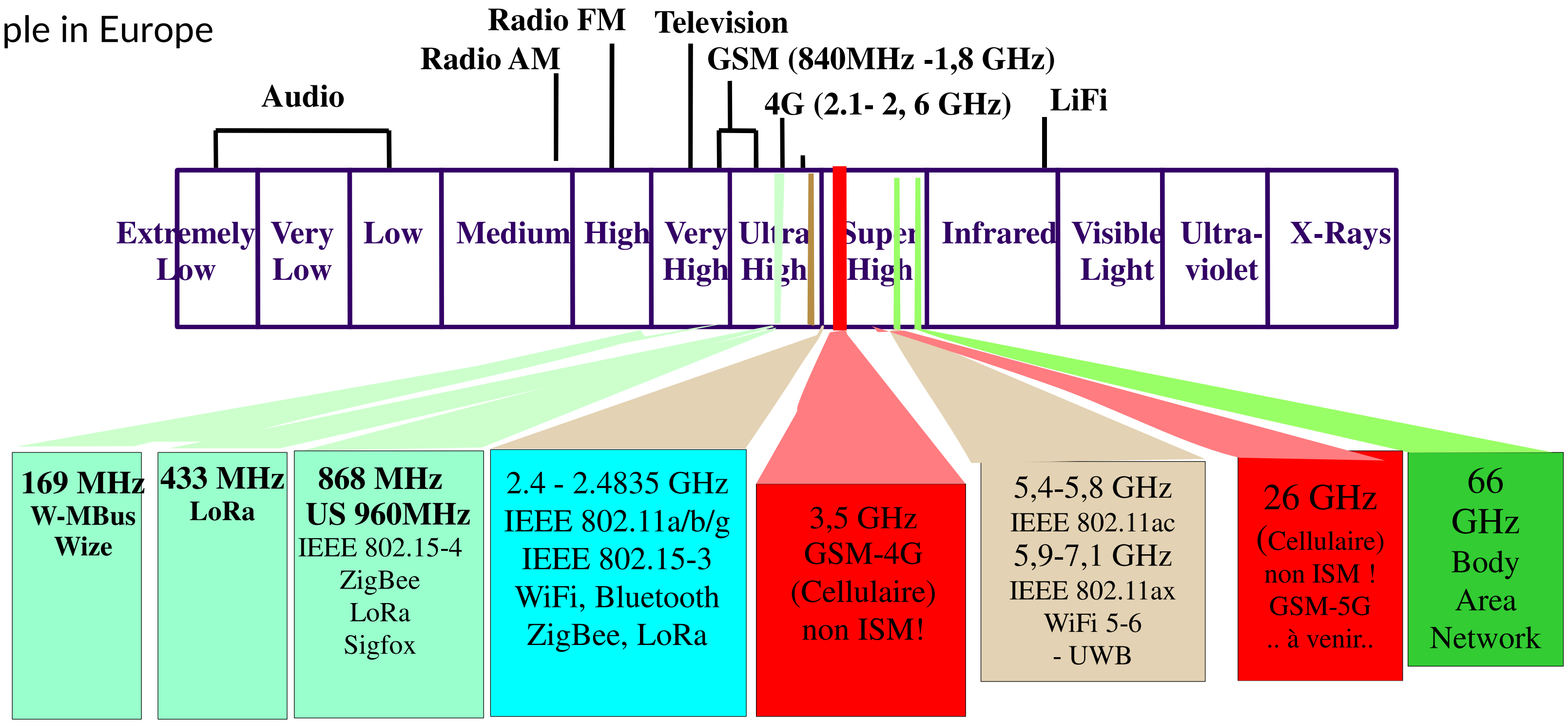
ISM Frequency Band ISM (Industrial, Scientific, and Medical)

Licence free – free for your transmissions, but with limited power transmission

As exemple in Europe



Radio FM

Television

Radio AM

GSM (840MHz -1,8 GHz)

Audio

4G (2.1- 2, 6 GHz)

LiFi

Extremely Low | Very Low | Low | Medium | High | Very High | Ultra High | Super High | Infrared | Visible Light | Ultra-violet | X-Rays

169 MHz
W-MBus
Wize

433 MHz
LoRa

868 MHz
US 960MHz
IEEE 802.15-4
ZigBee
LoRa
Sigfox

2.4 - 2.4835 GHz
IEEE 802.11a/b/g
IEEE 802.15-3
WiFi, Bluetooth
ZigBee, LoRa

3,5 GHz
GSM-4G
(Cellulaire)
non ISM!

5,4-5,8 GHz
IEEE 802.11ac
5,9-7,1 GHz
IEEE 802.11ax
WiFi 5-6
- UWB

26 GHz
(Cellulaire)
non ISM !
GSM-5G
.. à venir..

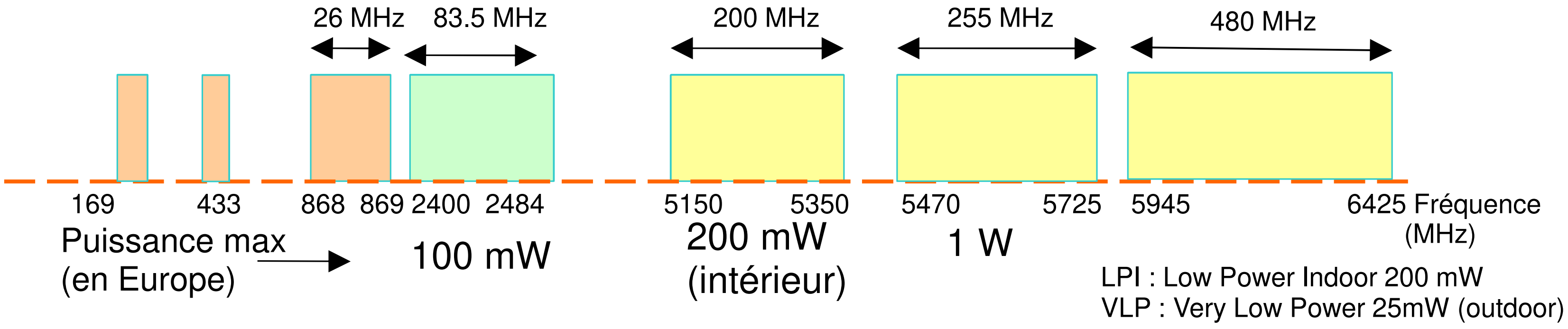
66
GHz
Body
Area
Network

Source https://iotfactory.eu/

5. Industriel scientifique et Médical Band

Co-funded by the Erasmus+ Programme of the European Union

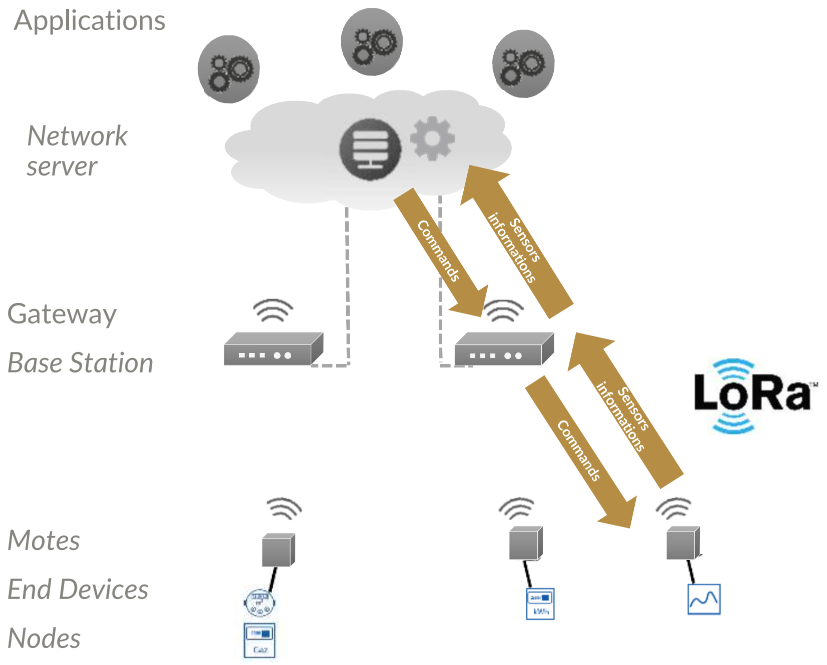
- Standards IEEE 802.11 et débits associés (* théorique maximun)
  - IEEE 802.11 (1997) 1 Mbps and 2 Mbps (bande 2.4 GHz) plus supporté
  - IEEE 802.11a (1999) **WiFi 1** : 54 Mbps* (bande UNI -5 GHz)
  - IEEE 802.11b (1999) **WiFi 2** : 11 Mbps* (bande 2.4 GHz)
  - IEEE 802.11g (2003) **WiFi 3** : 54 Mbps* (bande 5,4GHz)
  - IEEE 802.11n (2009) **WiFi 4** : 150 Mbps* (2.4 + 5,4GHz)
  - IEEE 802.11ac (2013) **WiFi 5** jusqu'à 910 Mbps* (bande UNI- I et II 5,4 GHz)
  - IEEE 802.11ax (2019) **WiFi 6** jusqu'à 10 Gb/s* (2.4 + 5,4 GHz)
  - IEEE 802.11ax (02/2021) **WiFi 6E** jusqu'à 11 Gb/s* t (2.4 + 5,4 + 6 GHz)
  - IEEE 802.11ay (03/2021) **………**jusqu'à 176 Gb/s* (58,3 à 70,2 GHz uniquement US !)



5. Wireless network

Co-funded by the Erasmus+ Programme of the European Union

Low Power Wide Area Network LWPAN : LoRa Long Range Wireless Network



Nom	DevEUI	OTA_AppKey	OTA_AppEUI
Temp extérieure	70:B3:D5:E7:5E:00:2F:07	45B36F05429E6B3D74AAAA2A12740***	70B3D5E75F600000
Contact porte	70:B3:D5:E7:5E:00:35:72	49A5495E312BBBB614CD354140341***	70B3D5E75F600000
Compteur Gaz	70:B3:D5:E7:5E:00:36:C4	718E1F2F315B0D933DCCC1F725D53***	70B3D5E75F600000
Temp Humidité RDC	70:B3:D5:E7:5E:00:37:F4	7EE54A7745E82D5AAAAE5E3A25B839***	70B3D5E75F600000
Anémomètre	70:B3:D5:E7:5E:00:41:93	23411FF30200BBBB560A226527713***	70B3D5E75F600000
Temp Etage 1	70:B3:D5:E7:5E:00:41:B3	1ED153B417E60DF35233CC1C716D4***	70B3D5E75F600000
Centrale de mesure	70:B3:D5:E7:5E:00:44:75	74730B42770D752AAAAD1BEA47D53***	70B3D5E75F600000

Severals gateways listening

frequencies Motes messages

Only the gateway with the best signal

sends messages to the network server

Sensors Motes

Actuators Motes

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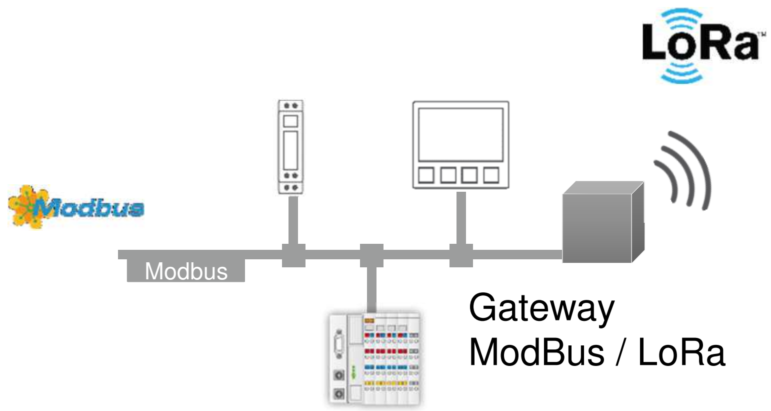
5- Wireless Mbus or LoRa

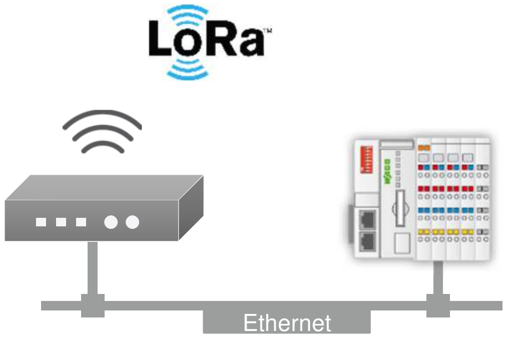
- Wireless Modbus versus Lora transmetteur



Gateway
ModBus / LoRa

M-Bus wireless

Wireless sensors /actuators



Gateway
IP/ LoRa

6- Convergent information through various fieldbus network and IT network

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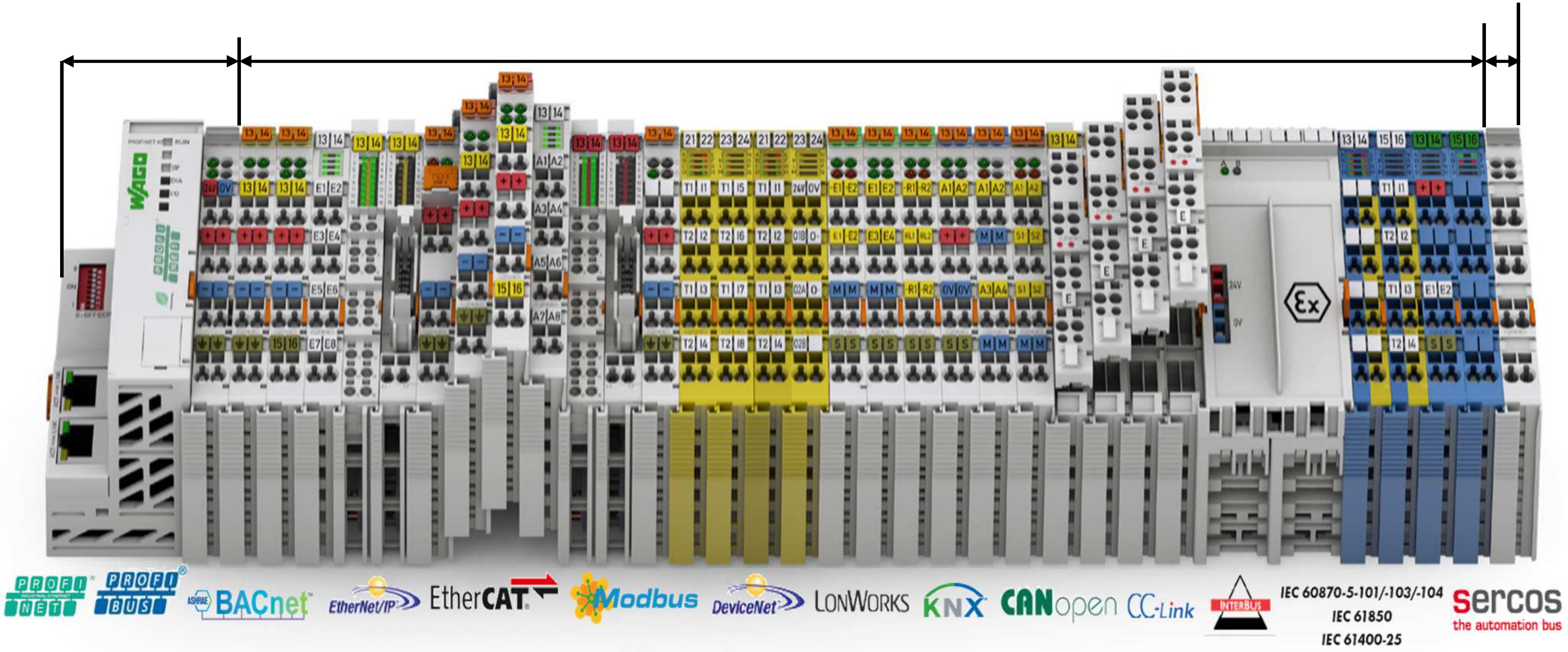
❶ PLC Ethernet controller ❷ I/O connexions ❸ Borderline

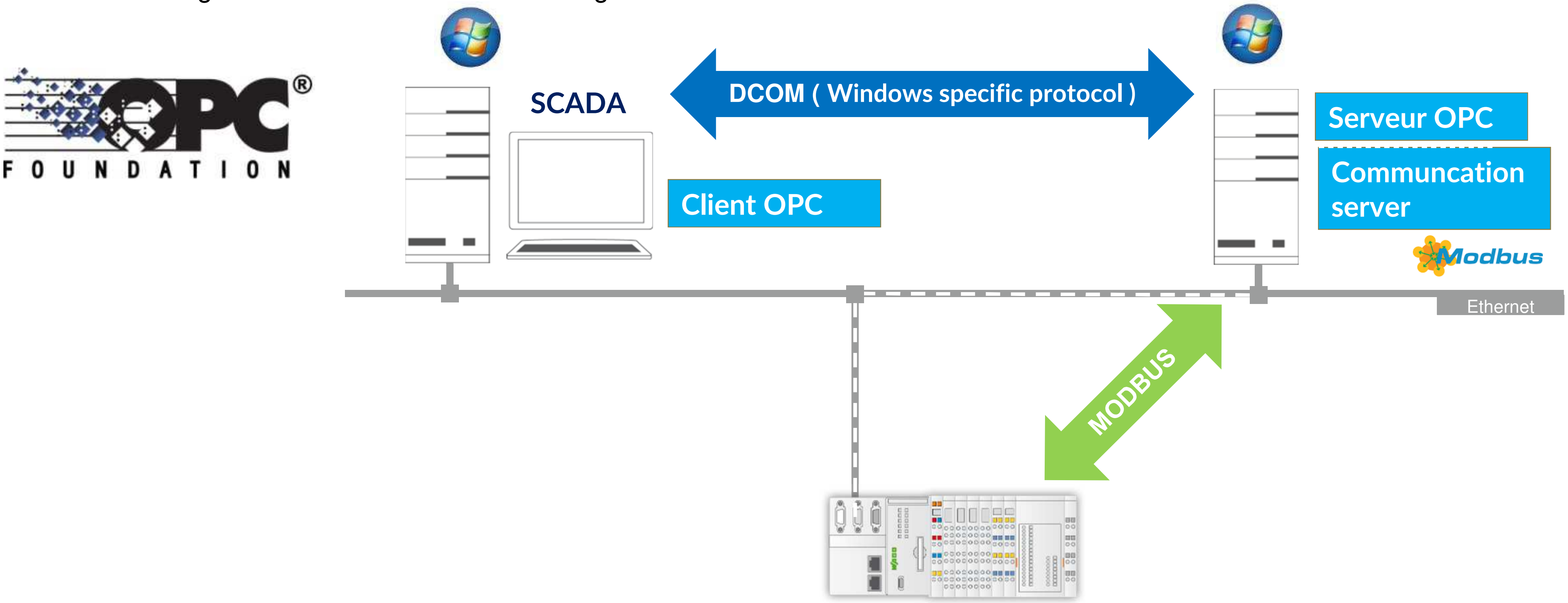


6-1 Open Platform Communications

Co-funded by the Erasmus+ Programme of the European Union

- **First implementation with Microsoft system sharing informations over DCOM for SCADA**
- First reference OPC: **O**(bject Linking and Embedding) for **P**rocess **C**ontrol
- Reference (2011) : **O**pen **P**latform **C**ommunications

OPC standard exchange based on Windows technologies



6.2 -OPC Unified Architecture

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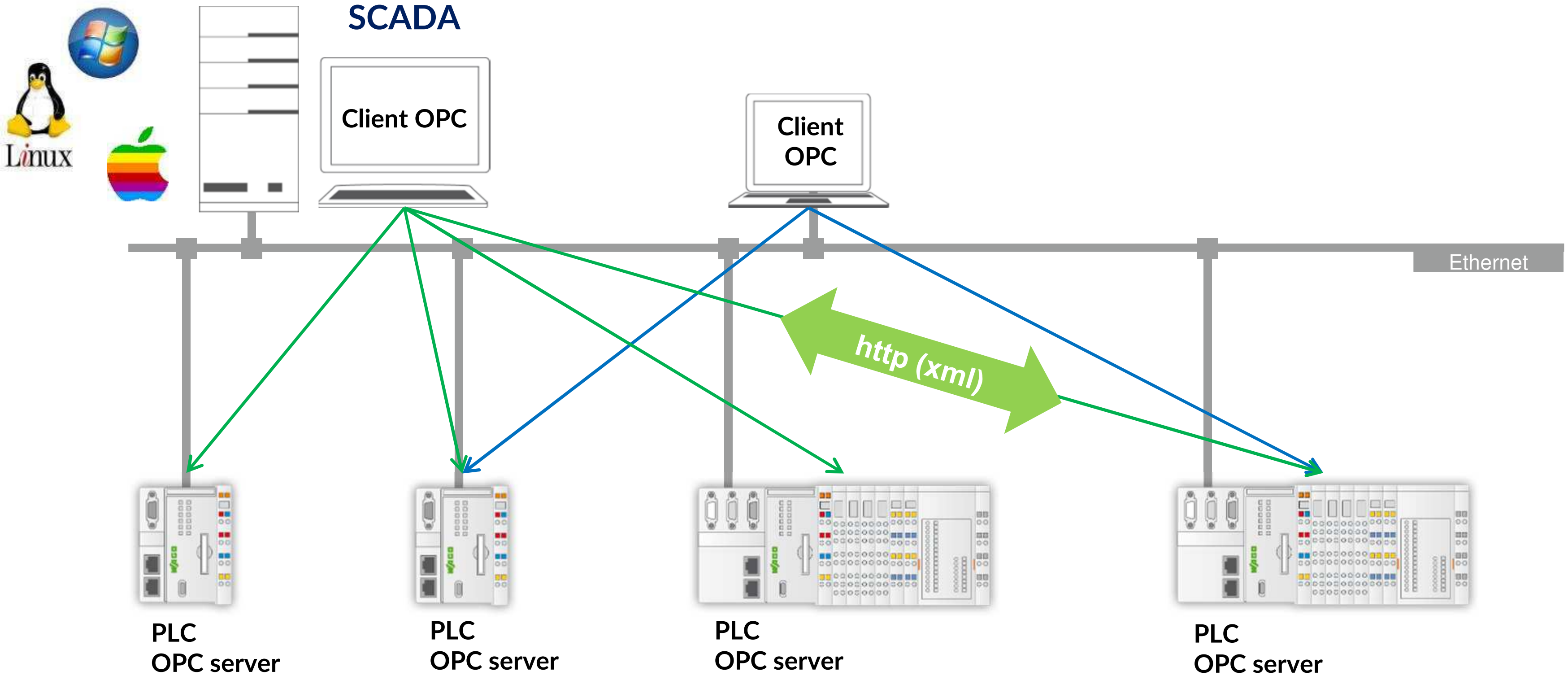
- Open Platform Communications - Unified Architecture : **OPC-UA**

  Objectives :
  - Communication protocol abstraction
  - No more dependence on Microsoft Windows
  - OPC server directly implemented in the PLC equipment



6.3 -Message Queuing Telemetry Transport

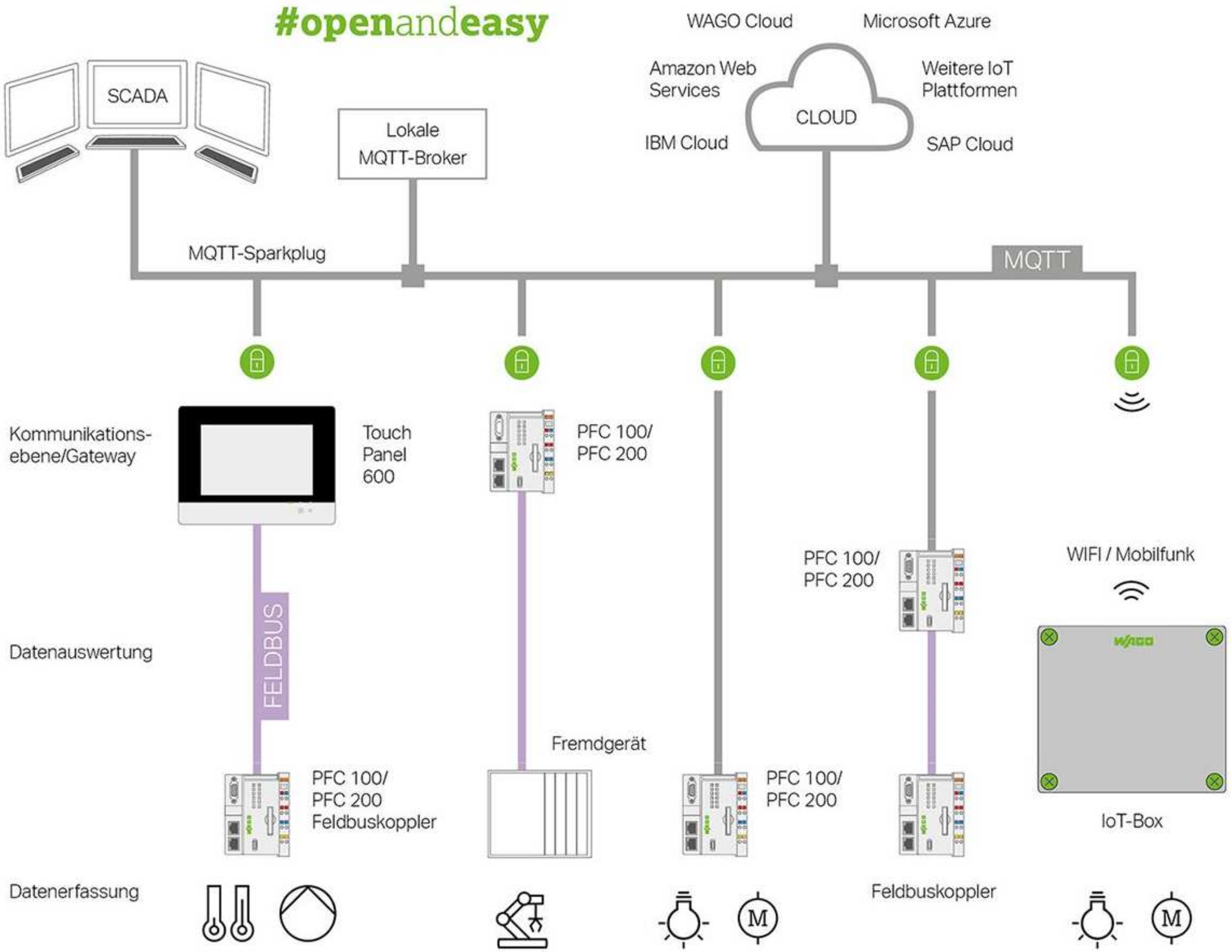
Co-funded by the Erasmus+ Programme of the European Union

Version :
MQTT 1.0 (1999)
…
MQTT 3.1.1 (2019)

Publish-subscribe messaging protocol based on the TCP / IP protocol.

Data virtualization over networks and cloud

Proposed by
IBM
&
Eurotech



Conclusion

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- Industry 4.0
    - Process information's systems
      from the process information (sensors, actuators) « the field »
      to the higher levels of management (SCADA / IA) for optimization
    - Various functionalities: Production, but also Maintenance, Logistics, Transport

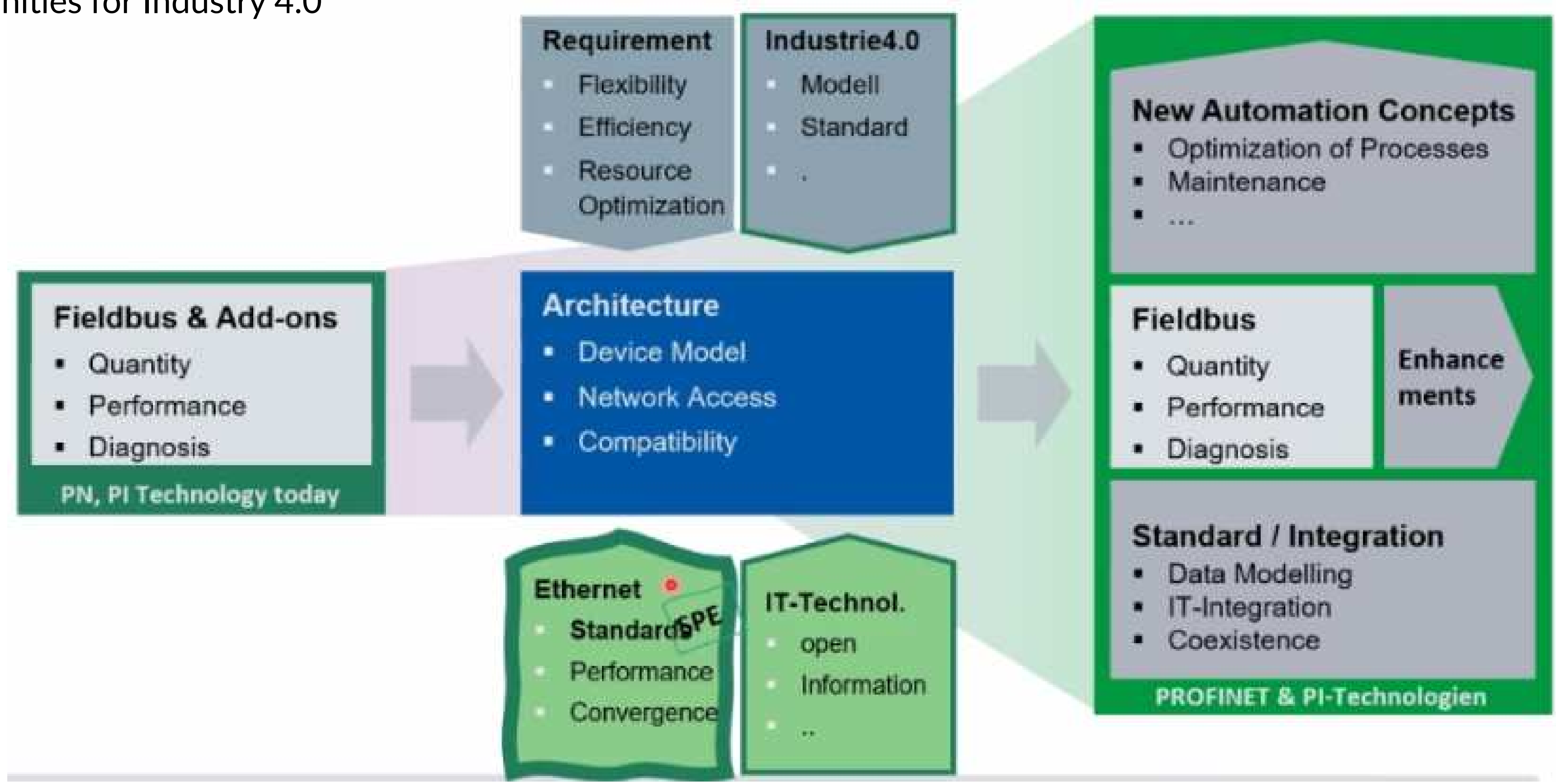
- Based on PLC, Programmable Logic Controller
    - Today dedicated modules ..soon versatile Industrial computer with programs and connectivity
    - Inputs/outputs to be connected to physical processes
    - Communication interface
        - Fieldbus networks, « Industrial networks »,
        - Ethernet networks for supervision
        - Gateways to Cloud devices (virtualization of the control)

- Integration IT (Information Technology) versus ICS (Industrial Control Systems)

- Next course : « Challenges in Dependability/Safety and « Cyber-Security »
  Pr Jean-Marc Thiriet

Conclusion

New opportunities for Industry 4.0



Requirement
- Flexibility
- Efficiency
- Resource Optimization

Industrie4.0
- Modell
- Standard
- .

Fieldbus & Add-ons
- Quantity
- Performance
- Diagnosis

PN, PI Technology today

Architecture
- Device Model
- Network Access
- Compatibility

Ethernet
- Standards SPE
- Performance
- Convergence

IT-Technol.
- open
- Information
- ..

New Automation Concepts
- Optimization of Processes
- Maintenance
- …

Fieldbus
- Quantity
- Performance
- Diagnosis

Enhancements

Standard / Integration
- Data Modelling
- IT-Integration
- Coexistence

PROFINET & PI-Technologien

Future of industry 4.0

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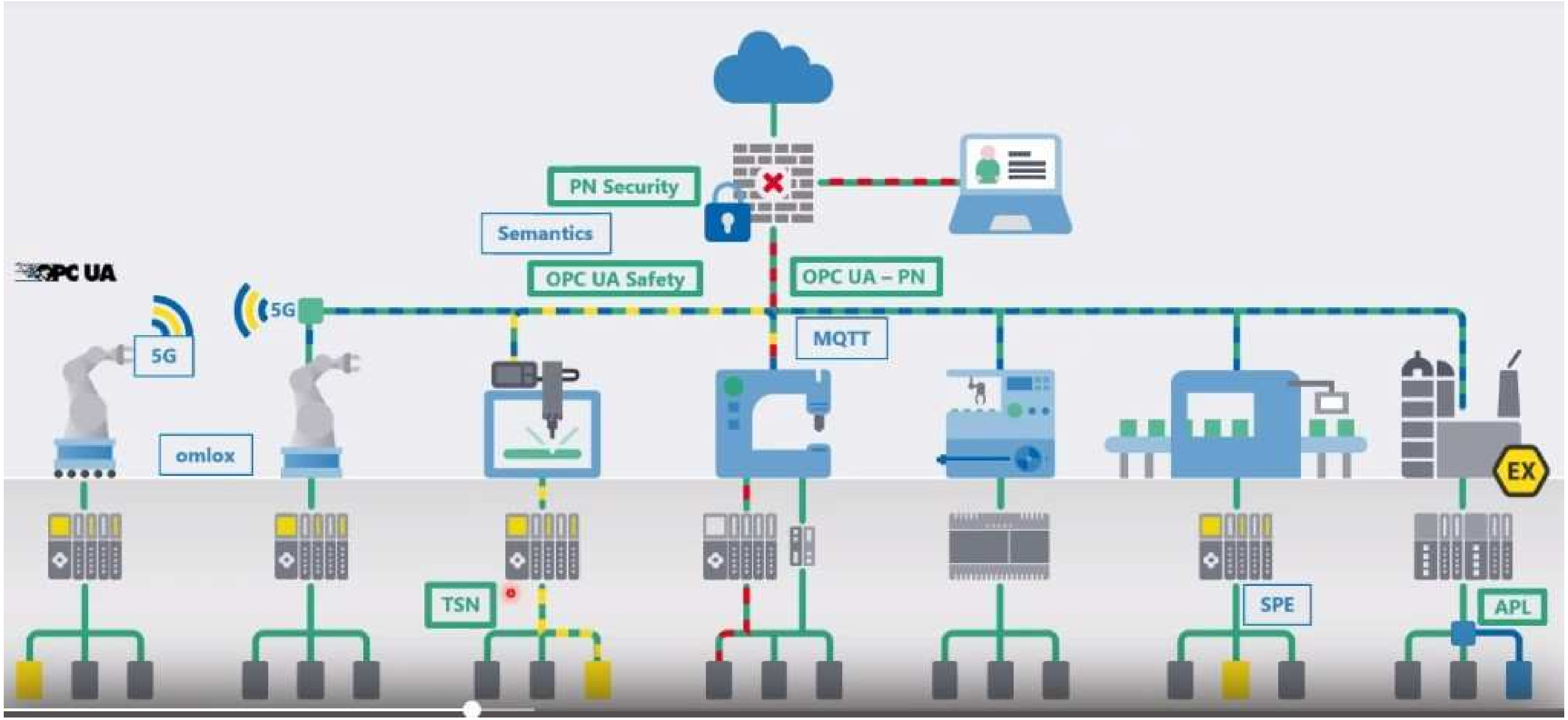

Next PLC architecture network generation will be IP (end to end)

Merci pour votre attention

Merci pour votre attention

Grignan castle

UGA
Université
Grenoble Alpes

Thank you for your attention

Natural bridge over the river

Contact : Denis.genon-catalot@univ-grenoble-alpes.fr