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IOTEC

IoT in industrial environments to obtain quality data

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Industry’s challenges
Principal requirements of IIoT

IIoT devices built to be	Must work in extreme conditions	Designed to be more scalable	Difficult accessibility and maintenance	Strong security systems	High customization capacity
• Resistant • Reliable • Hardy	• Highest temperatures • Resistant to rust • Protection from electromagnetic interference	• Capacity of increase whenever it is necessary	• Must have great autonomy	• A cyberattack could be fatal and cause large losses	• Adapted according to their function in the manufacturing processes

Industry’s challenges
Reliability in communications

Unlike the preventive systems, industry requires reliability in communications of sensors and actuators

- Real time working
- Must have accurate data
- In environments where communications can be altered by strong electromagnetic interference

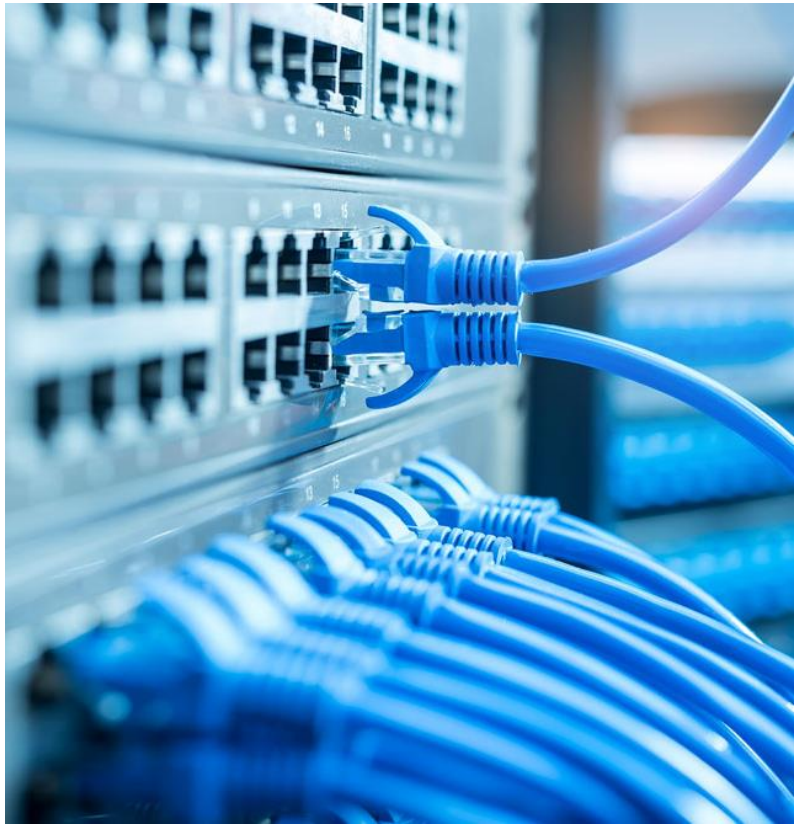
Industry machinery overview
Communication media

Wired communication

- Industrial Ethernet is like Standard Ethernet but more robust
- RS-232, RS-485 serial communication
- HART (Highway Addressable Remote Transducer)
  - Hybrid analog + digital protocol
  - Can share the legacy 4-20mA analog instrumentation current loops

Wireless Communications

- PAN
  - Bluetooth / BLE (Bluetooth Low Energy)
  - ZigBee – Low power, self healing mesh for communication
  - RFID – Readers, Tags, Applications
- LAN – WiFi (IEEE 802.11)
- WAN
  - 3G, 4G and 5G
  - LPWAN (LoRaWAN, SigFox, NB-IoT)
  - Satellite Communications (VSAT)



Industry machinery overview
Sensor and actuator control systems

PLC

Programmable **L**ogic **C**ontroller
In industrial processes, sensor and actuator data are governed by PLCs that work in real time

Fieldbus

Usually, sensors and actuators are connected with PROFIBUS DP, Modbus-RTU, CC-Link, CAN, etc. technologies

Industrial Ethernet

In new installations EtherNet/IP, PROFINET, EtherCAT, Modbus-TCP, POWERLINK, etc. technologies are growing

Industry machinery overview
Monitoring systems

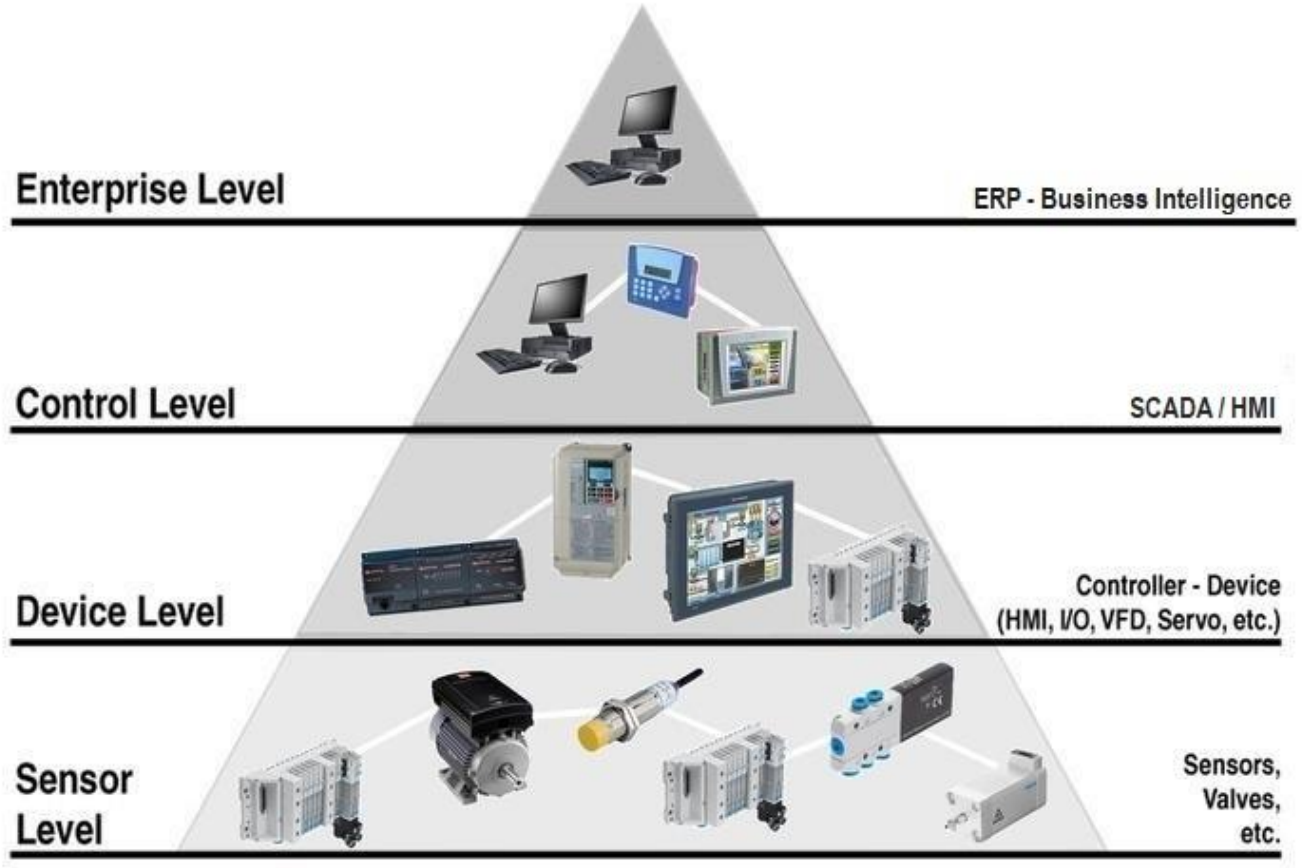
SCADA

Supervisory **C**ontrol **A**nd **D**ata **A**cquisition. Software for computers that allows to distance control and supervise industrial processes

HMI

Human-**M**achine **I**nterface is a control panel designed to interact with the process/machine, transmit orders, graphically visualize the results and obtain a situation of the processes in real time

Industry machinery overview
Automated systems organization



Enterprise Level

- ERP
- Business Intelligent
- Cloud
- Predictive systems

Control Level

- SCADA
- HMI

Device Level

- PLC

Sensor Level

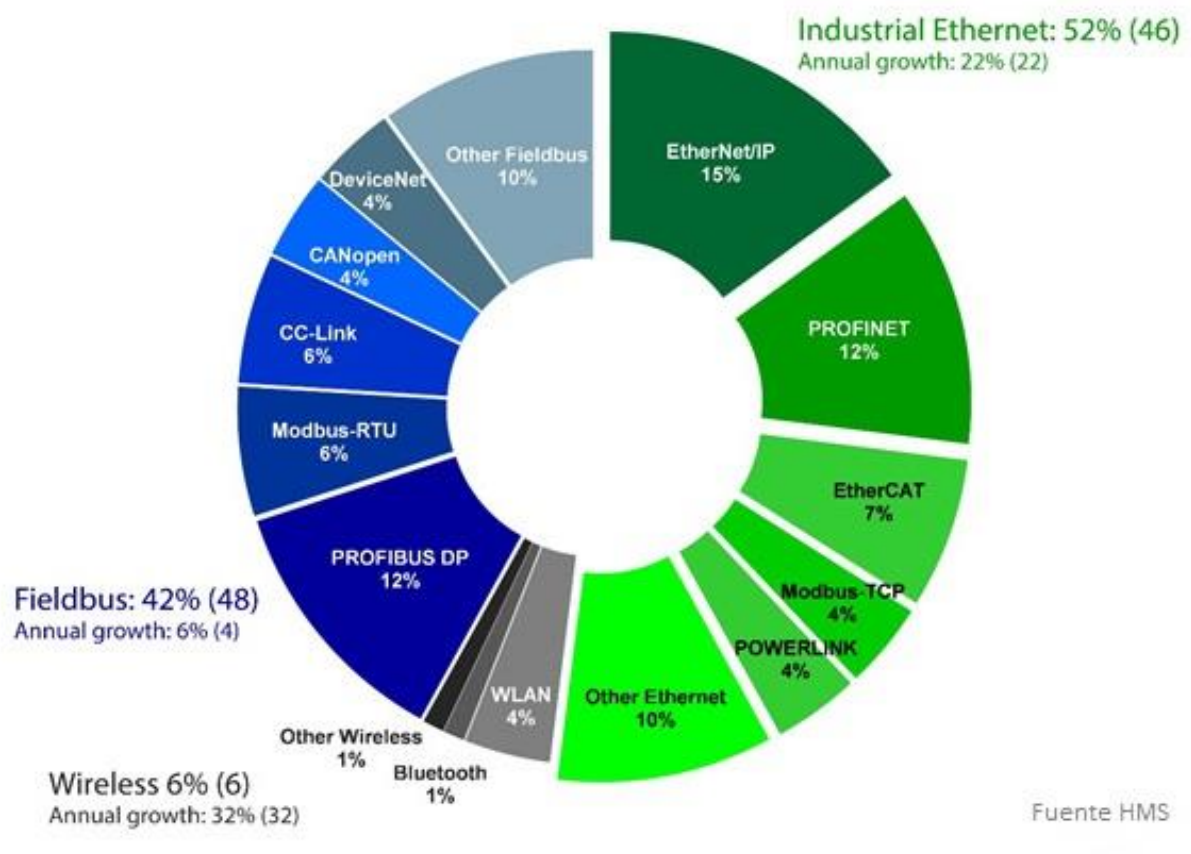
- Electric connection of sensors and actuators

Industry machinery overview
Industrial networks

Industrial Ethernet has been driven by the IIoT representing 52% of the market with a growth of 22%

Fieldbus are widely implemented but with little growth

Wireless technologies begin to have a presence with a growth of 32%



Fuente HMS

Data acquisition
From PLCs

Modbus TCP and RTU

- **Modbus TCP** connect by Ethernet
- **Modbus RTU** connect by COM port using RS-232 or RS485

OPC (**O**pen **P**rotocol **C**ommunication)

- **OPC Classic**, Microsoft Windows early technologies: COM and DCOM
- **OPC UA**, **OPC U**nified **A**rchitecture Modern Publish/Subscriber communication model over TCP/IP

Data acquisition
From PLCs

Open Source Drivers

- LibNoDave
- Snap7
- Snap7-IoT
  - **ARM** (Raspberry PI, Beaglebone, CubieBoard, PcDuino, Udoo Quad, Mele A2000, ..)
  - **MIPS** (Tested with Arduino Yun)
  - **Quark** (Intel Galileo Gen 2, Siemens SIMATIC IOT2040)
- S7.Net
- DotNetSiemensPLCToolBoxLibrary

Modbus TCP

```
/*
 *  Reading
 */
TcpClient client = new TcpClient("127.0.0.1", 502);
ModbusIpMaster master = ModbusIpMaster.CreateIp(client);

// read five input values
ushort startAddress = 100;
ushort numInputs = 5;
bool[] inputs = master.ReadInputs(startAddress, numInputs);

for (int i = 0; i < numInputs; i++)
    Console.WriteLine("Input {0}={1}", startAddress + i, inputs[i] ? 1 : 0);

/*
 *  Writing
 */
ushort startAddress = 1;
// write three coils
master.WriteMultipleCoils(startAddress, new bool[] { true, false, true });
```

Modbus RTU

```
SerialPort port = new SerialPort("COM1");

// configure serial port
port.BaudRate = 9600;
port.DataBits = 8;
port.Parity = Parity.None;
port.StopBits = StopBits.One;
port.Open();

// create modbus master
IModbusSerialMaster master = ModbusSerialMaster.CreateRtu(port);

byte slaveId = 1;
ushort startAddress = 1;
ushort numRegisters = 5;

// read five registers
ushort[] registers = master.ReadHoldingRegisters(slaveId, startAddress, numRegisters);

for (int i = 0; i < numRegisters; i++)
    Console.WriteLine("Register {0}={1}", startAddress + i, registers[i]);
```

Data acquisition
Directly from machines

Ad-Hoc Applications adapted to productive processes to collect data of machines and register them in the management system (ERP)

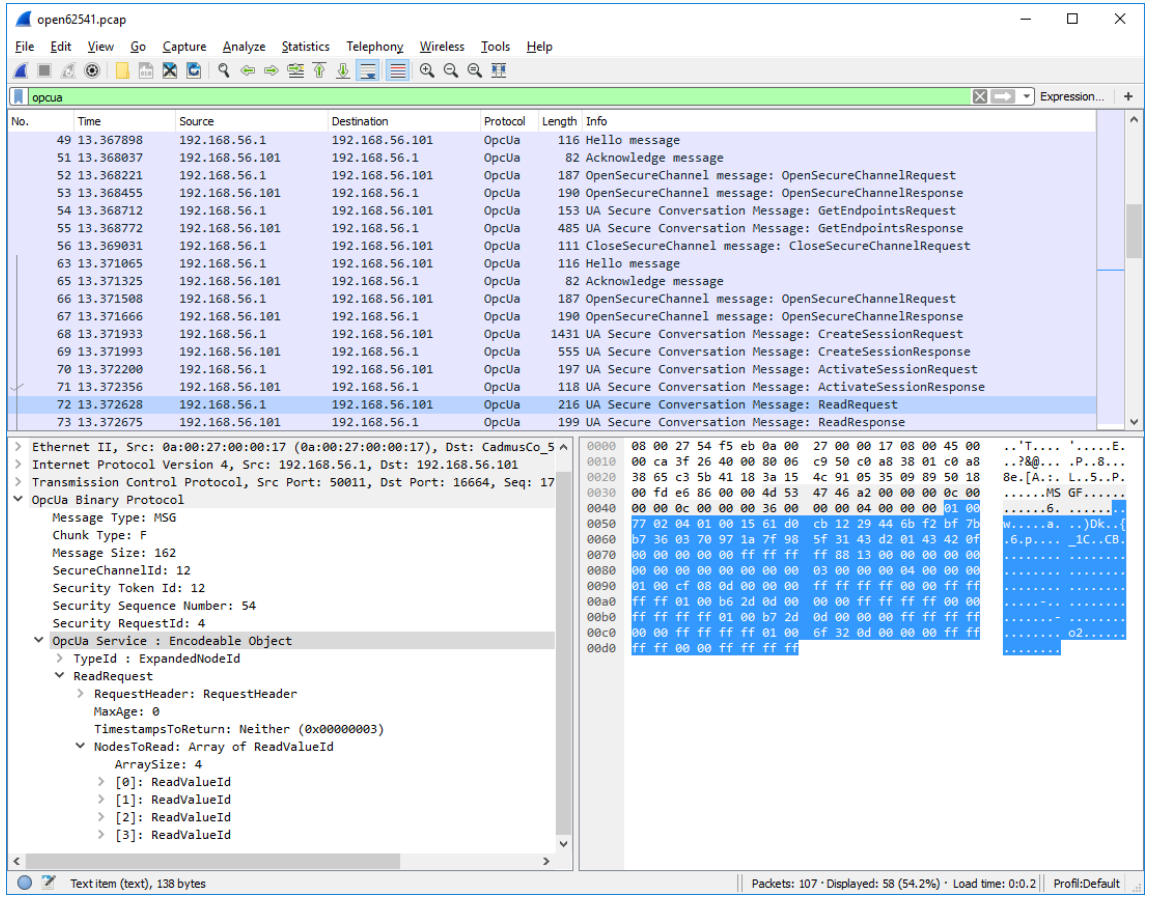
- Ethernet Sockets
- RS-232 Serial Communications
- Converters from RS-485, HART, Current loop, etc. to Ethernet, USB and RS-232 PC connections

Data acquisition
A bit of reverse engineering

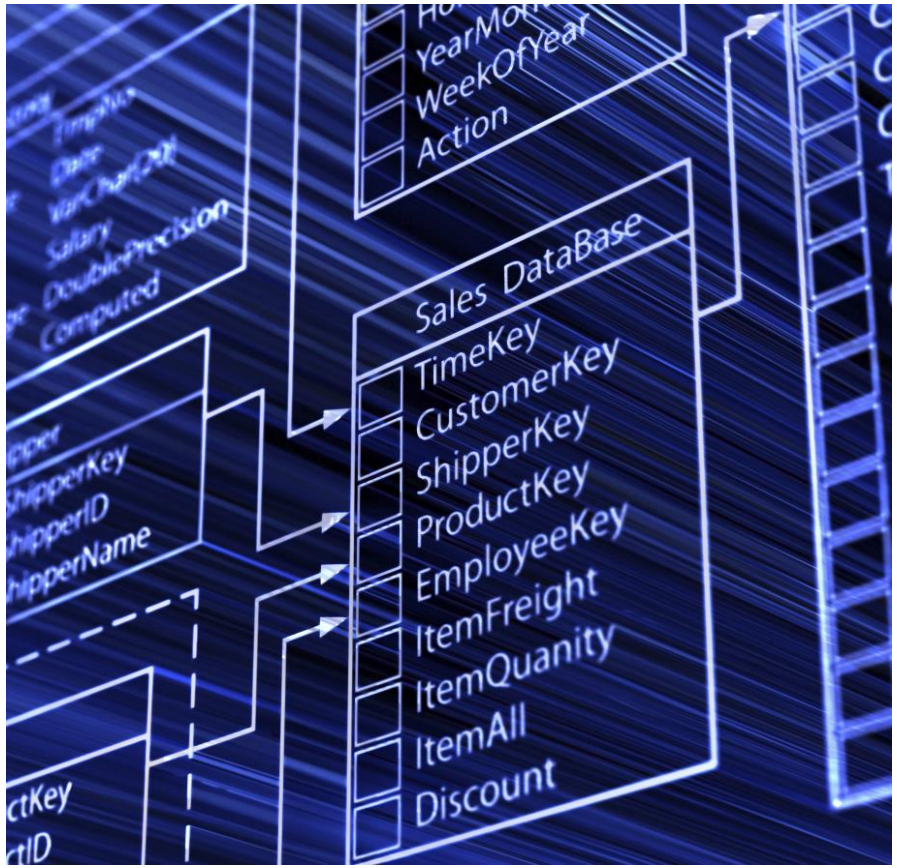
In many cases, the existing machinery has incomplete documentation or lacks it.

Sometimes, the only possibility is to sniff the data of existing machinery

- Ethernet Sniffer (Wireshark, …)
- COM Analyzer
- Others



Data registry
In database management systems



Knowledge of multiple database access drivers

- SQL Server
- Oracle
- MySQL
- PostgreSQL
- MariaDB
- MongoDB

Analysis of data models in existing systems

- Analysis of data tables
- Analysis of the contents of the fields of the tables
- Search for relationships between tables
- Analysis of ERP data and processes
- Maintain the integrity of the data
- Analysis of ERP transactions by tracing queries with tools such as SQL Profiler

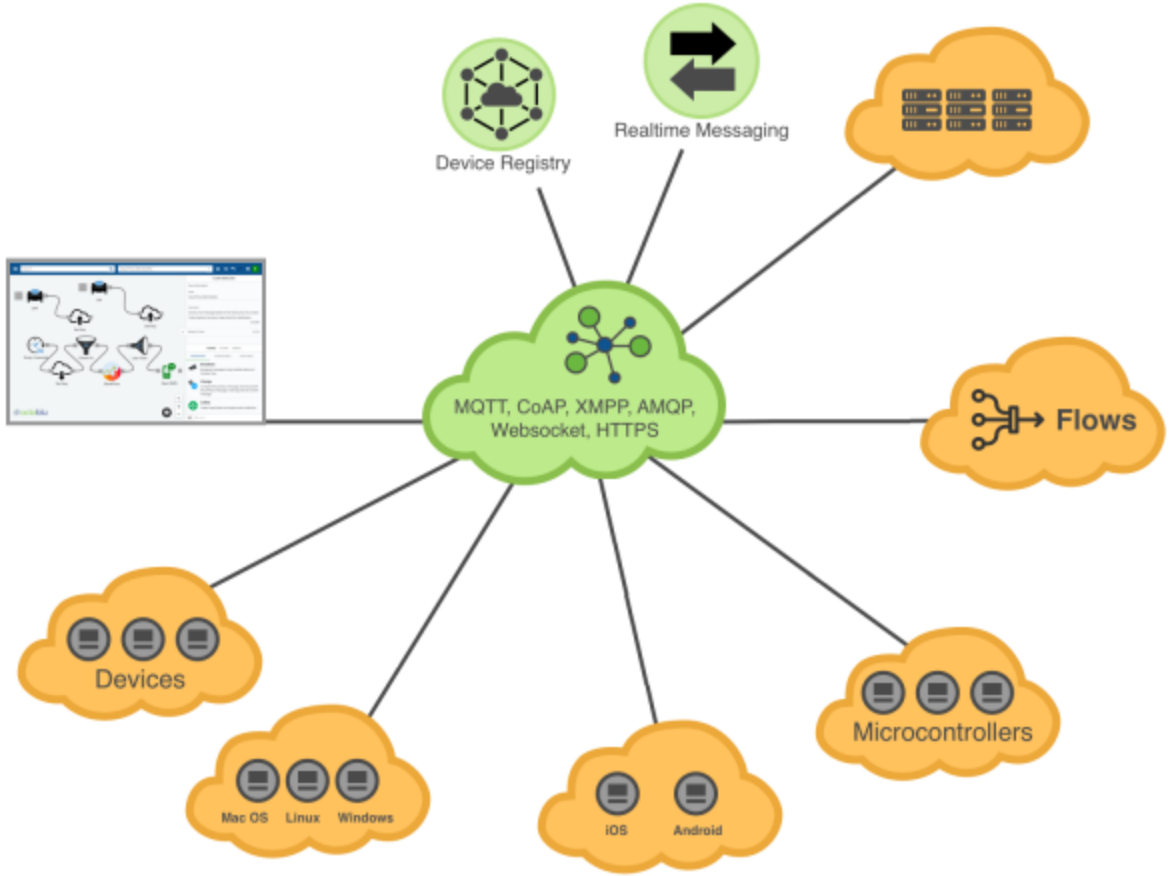
Data registry
In the cloud

From applications (Webservices)

- SOAP
- REST
- HTTP

From devices (M2M)

- MQTT
- AMQP
- WAMP
- CoAP
- STOMP
- XMPP
- WMQ



Conclusions

During the last half decade, the Enterprise Resource Planning (ERP), Manufacturing Execution Systems (MES), and SCADA have tried complementing each other in industries, but haven’t been able to gain the expected success levels.

This has left the gap wide open for IoT, analytics, and cloud based technologies to fill in the gap between ERP, MES, and SCADA.

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