Plant, business and IT–OT

You open the tap and water comes out. You never think about it. But in Palma, behind that tap there are more than 1,100 km of pipes, split into 600 small sectors, and a control centre where people watch pressures and flows on screens all day. In 2025 EMAYA, Palma's water company, said it had cut the water lost in leaks from 25% to 16%, after renewing pipes and installing digital meters. How do you find a leak under a street from a screen?

You find it because the **plant** (the pipes, pumps and meters) is talking to the **business** (the people who plan, pay and decide). This lesson goes down to the plant, names the technologies you find there, and then looks at the most valuable thing in a digital company: the connection between both halves.

What you will learn

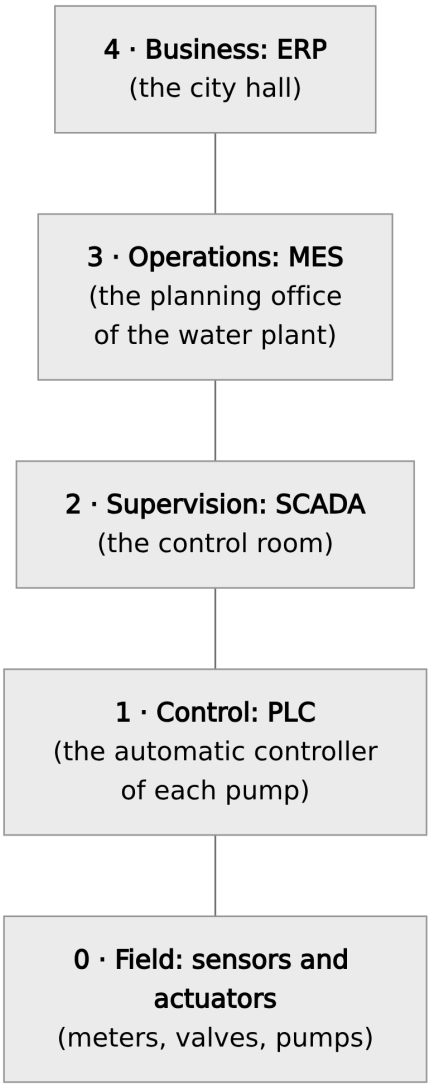
- Place sensors and actuators, **PLC**, **SCADA**, **MES** and **ERP** on the **automation pyramid**
- Recognise those levels in a real plant in Mallorca and on a real SCADA screen
- **Select** the plant and business technologies a specific company needs, and avoid the trap of "the more technology, the better"
- Explain what travels between IT and OT, what the company gains, and what risk it takes
- Describe an **end-to-end** digital company and list its advantages
- Start your **Deliverable 1** with real, cited sources

The automation pyramid

In the city-builder game, the water plant has levels. Down at the bottom, valves open and pumps spin. A bit higher, automatic controllers keep the pressure right. Higher still, an operator watches the whole network on a big screen. At the top, the city hall decides budgets and plans. Companies with a physical operation are organised in the same layers.

> The **automation pyramid** is a model that orders the technologies of a company in levels, from the machines at the bottom to the business at the top.

Level	Technology	What it does
4 · Business	**ERP**	Plans and manages the company: orders, purchasing, finance
3 · Operations	**MES**	*Manufacturing Execution System*: manages production orders, traceability, quality and the performance of the lines
2 · Supervision	**SCADA**	*Supervisory Control And Data Acquisition*: collects data from the controllers, shows them on screens, raises alarms and lets operators give orders from a control room
1 · Control	**PLC**	*Programmable Logic Controller*: an industrial computer that reads sensors and drives actuators in real time, following a program



Level	Technology	What it does
0 · Field	**Sensors** and **actuators**	Sensors measure (temperature, level, pressure, presence); actuators act (motors, valves, relays)

Read it **from the bottom up**: the higher you go, the less real time and the more business view. Levels 0 to 2 are **OT**; level 4 is **IT**; level 3 is the **bridge** between them.

> **Different sources, different numbers**
> This five-level pyramid is the common simplified picture of the **ISA-95** standard (IEC 62264) and the Purdue model. Some sources number the levels slightly differently, or put sensors on level 1. What matters is the order, not the numbers.

A real plant in Mallorca: TIRME at Son Reus

At Son Reus, near Palma, **TIRME** runs the plant that burns Mallorca's household waste and turns the heat into electricity. Its control system was supplied by the Japanese company

Yokogawa, which published the case. According to that case, the plant has four lines, and the two newest ones generate 38 MW, enough electricity for about 53,000 households.

Here is what the published case lets you place on the pyramid:

Level	What the source says about TIRME
4 · Business	Nothing. If you wrote "TIRME uses an ERP", it would be a **hypothesis**, not a fact
3 · Operations	Exaquantum, a plant information system that collects the emissions data for reports
2 · Supervision	A central control room with operator screens, staffed 24 hours a day, and a large screen showing the environmental data
1 · Control	The CENTUM control system, which keeps the combustion above 850 °C, and a separate safety system (ProSafe-RS)
0 · Field	Field instruments connected by an industrial bus (FOUNDATION Fieldbus), feedwater pumps, a steam turbine

Two lessons hide in this table. First, real plants do not always match the textbook: TIRME uses a large control system called a DCS that does the job of the PLCs and the SCADA together, and a plant information system rather than a factory MES. Second, look at level 4: **the source does not say**. In your project, what you find you cite; what you cannot find you label as hypothesis.

What a SCADA screen looks like

Inductive Automation, a company that makes SCADA software, keeps a public demo of a water treatment plant that you can open in the browser, with no account: Ignition Water Treatment Demo.

Open it and look for: the **filters** with their mode and status, the **pumps** in automatic mode switched *On* or *Off*, the **tanks** with their level, the **flows** in and out of the plant, and a **trend** chart of the last few days. Every one of those numbers comes from a sensor (level 0), passes through a controller (level 1) and appears on this screen (level 2). It is the city's info-view overlay, for real.

Business technologies

You met the ERP and the CRM in the previous lesson. Here is the full catalogue of the business side:

Technology	What it is for
ERP and **CRM**	Integrated management of the company and of the relationship with customers
Business intelligence (BI)	Dashboards and reports to decide with data
Website and e-commerce	Selling and serving customers online, at any hour
Cloud collaboration tools	Email, shared documents, video calls, task management
Document management and e-signature	Contracts, invoices and files without paper
Automation of office tasks	Programs that do repetitive work: moving data from one system to another, sending reminders

To **select** technologies means to choose, for one specific company, the ones it needs and the ones it does not. A four-person carpentry workshop does not need a MES; a water company cannot live without a SCADA.

> **Careful: “the more technology, the better”**
> Every technology costs money, training and maintenance, and adds something that can be attacked. A good selection is short and justified: *this company needs this, for this reason*. In Deliverable 1 you will be marked on the reasons, not on the length of the list.

Why connect IT and OT

Remember the hotel in the first lesson: the booking system (IT) switches on the air conditioning (OT) before the guest arrives. Generalise it:

Direction	What travels	What the company gains
OT → IT (plant to business)	Units produced, energy used, temperatures, breakdowns, downtime	Knowing what happens in real time, real costs, **traceability**, maintenance before the machine breaks
IT → OT (business to plant)	Orders, production orders, recipes, plans	The customer’s order reaches the line without anybody typing it again: fewer errors, less time

Without the connection there are **information islands**: someone writes on paper what the machine says, and someone else types it into the computer. A mechanical water meter is an island: a person has to go, read it and write the number down. A digital meter with remote reading sends the number by itself.

How are they connected? Level 3 acts as the bridge, using standards such as **OPC UA** (an industrial standard for machines to share data securely) and **MQTT** (a lightweight messaging protocol for the internet of things), plus APIs and databases. That integration layer is software: work for developers like you.

The price: cybersecurity

Many OT devices are old and were not designed to be connected: few updates, default passwords. Once they share a network with the offices, a problem in IT can reach the plant. That is why the networks are separated, with firewalls between them, and access is controlled.

A real case: in May 2021, a ransomware attack (software that encrypts your files and asks for a ransom) hit the IT systems of **Colonial Pipeline**, which carries fuel to the east coast of the United States. There is no evidence that it reached the OT systems, but the company stopped the whole pipeline as a precaution, and it took about five days to restart. You will study cybersecurity properly in Unit 5.

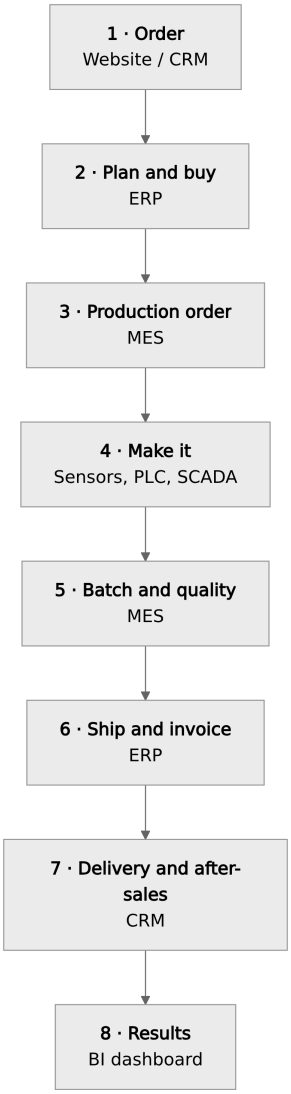
End to end

> A company is digitalised **end to end** when the whole journey, from the customer’s order to delivery and the invoice, runs through connected systems, without typing any piece of data twice.

Follow an order in a biscuit factory:

What does the company gain?

Advantage	What it means
Real-time visibility	Everybody knows where every order is



Advantage	What it means
Fewer errors, less repeated work	Each piece of data is entered once
Traceability	For each packet you know the batch, the line, the day and the raw materials
Faster answers	Shorter delivery times for the customer
Less stock and less waste	You make what was ordered
Maintenance before the breakdown	Machine data warn you before it fails
Energy and material savings	What you measure, you can reduce
Decisions with data	Instead of intuition

It also has a price: investment, training for the staff, and more exposure to cyberattacks. But a company with the whole journey connected can answer in hours what costs another one days.

In class: express X-ray of your company

In this session your group chose its company and each member did a first piece of research for one part. The parts are the four individual sections of Deliverable 1.

Part	Question to answer	Where to look
A · Company and IT systems	What does the company do, which departments does it have, and which **real IT system** does it use (an ERP, a CRM, an app, an online shop)?	The company website (“About us”, “Work with us”), annual report, press. Tip: job offers often say “experience with SAP” or similar
B · Plant and pyramid	What physical operation does it have, and which **real plant technology** is mentioned (sensors, control, control room)? Place it on the pyramid	News about the plant, supplier case studies (like Yokogawa’s for TIRME), the company website. If you find nothing about your company, a real case **from the same sector**, cited
C · IT–OT connection	Open the Ignition SCADA demo, take a screenshot and note **three data** it shows. Which of them, or a similar one in your company, should reach an IT system? What for? What risk?	The Ignition Water Treatment Demo and your company
D · End to end	What is your company’s customer journey (order, service, invoice)? Write the first five steps and the system of each	The company website (how you buy or book), press

For each part, at least: the answer in 3–5 lines, **one source** (title, author or website, link and date you consulted it) and the word **hypothesis** in front of anything you could not find. Your name on your part. The group hands in one document on Classroom; each member is marked on their own part. **No generative AI**: this is an exercise in finding and citing.

For your project

This lesson launches Deliverable 1 · IT/OT X-ray, due **Sunday 8 November 2026 at 23:59**, with individual defences in session 9 (21 December 2026). Today’s four parts are the first draft of its sections:

Today’s part	Becomes	Criterion
A	Section A: company, departments and IT systems	b, d, e (business)
B	Section B: the OT side and the automation pyramid	e (plant)
C	Section C: one IT–OT connection	f
D	Section D: the end-to-end journey and its advantages	g

Key takeaways

- The **automation pyramid**, bottom up: **sensors and actuators**, **PLC**, **SCADA**, **MES**, **ERP**. Levels 0–2 are OT, level 4 is IT, level 3 is the bridge.
- Real plants, like **TIRME** at Son Reus, do not always match the textbook. What a source says you **cite**; what it does not say is a **hypothesis**.
- **Selecting** technologies means choosing and justifying, not listing everything.
- Connecting IT and OT sends **data up** (production, energy, breakdowns) and **orders down**; it removes **information islands** and needs **cybersecurity**.
- **End to end**: the whole journey from order to invoice through connected systems, typing each piece of data once.

Quick check

1 Which order of the automation pyramid, from bottom to top, is correct?

- **A** PLC → sensors → MES → SCADA → ERP
- **B** Sensors and actuators → PLC → SCADA → MES → ERP
- **C** ERP → MES → SCADA → PLC → sensors
- **D** Sensors → SCADA → PLC → ERP → MES

2 Which system lets operators watch alarms, levels and flows of the whole plant from a control room?

- **A** ERP
- **B** CRM
- **C** SCADA
- **D** A sensor

3 Which level of the pyramid acts as the bridge between the plant and the business?

- **A** Level 0, sensors and actuators
- **B** Level 1, PLC
- **C** Level 3, MES
- **D** Level 4, ERP

4 The published case of TIRME's plant says nothing about its ERP. In your deliverable, what should you write?

- **A** "TIRME uses SAP", because most large companies do
- **B** Nothing about the business side at all
- **C** A reasoned guess, clearly labelled as a hypothesis, or a different source that does say it
- **D** That TIRME has no IT

5 Which is a real advantage of connecting IT and OT?

- **A** The plant no longer needs any cybersecurity
- **B** The business decides with real plant data, almost in real time
- **C** The machines no longer need maintenance
- **D** The ERP can control the motors directly

6 Why did the Colonial Pipeline case of 2021 matter for IT–OT?

- **A** Hackers took control of the pipeline's valves
- **B** An attack on the IT systems led the company to stop the physical pipeline as a precaution
- **C** The pipeline broke because its sensors were too old
- **D** It proved that OT never needs to be connected

7 A small bakery with four workers asks you which technologies to install. Which TWO are sensible?

- **A** A simple online ordering page connected to its till
- **B** A full MES with production lines and traceability modules
- **C** A temperature sensor on the oven that sends an alarm to the phone
- **D** A control room with a SCADA staffed 24 hours a day

8 What does “digitalised end to end” mean?

- **A** Every employee has a computer
- **B** The factory has robots at both ends of the line
- **C** The whole journey, from the customer’s order to delivery and the invoice, runs through connected systems without typing data twice
- **D** The company sells only online

You have the whole picture of Unit 1. Now turn it into your group’s first chapter: Deliverable 1 · IT/OT X-ray.

Solutions

1. B · From the machine up to the office: **sensors and actuators** measure and act, the **PLC** controls, the **SCADA** supervises, the **MES** manages operations and the **ERP** runs the business.

2. C · **SCADA** collects the data from the controllers and shows them on screens with alarms and trends. The Ignition demo you opened is a SCADA screen.

3. C · Levels 0–2 are OT and level 4 is IT. The **MES**, at level 3, receives production orders from the ERP and sends back what was actually produced.

4. C · Facts about a company must be **found and cited**. If you cannot find it, you may still reason about it, but you must label it as a **hypothesis**.

5. B · Data going **up** from the plant (production, energy, breakdowns) let the business calculate real costs and react quickly. The connection **adds** cybersecurity risk; it does not remove it.

6. B · The ransomware hit **IT**, and there is no evidence it reached OT, yet the company stopped the whole pipeline for about five days. Once both worlds are connected, a problem in one affects the other.

7. A, C · **Selecting** means fitting technology to the company. A small online shop and one useful sensor solve real problems; a MES and a 24-hour control room are designed for large plants.

8. C · **End to end** is about the whole **journey** being connected: order, planning, production, shipping, invoicing, after-sales and results.