# Enabling technologies I

You are at the bus stop and the app says: “Line 3, 4 minutes”. How does it know? Nobody is phoning the driver. Somewhere a small box on the bus measures its position, sends it over the mobile network to a server, the server compares it with months of past trips, and a program predicts when the bus will reach your stop. Four different technologies, one sentence on your screen.

Companies on the islands use the same building blocks. In February 2023 EMAYA, Palma’s municipal water company, had already replaced 30,000 mechanical water meters with smart ones, out of about 104,000 planned by 2026. A smart meter reads the consumption every day, hour by hour, without anybody visiting the house, and raises an alarm when it detects a leak. That is not one technology either: it is a sensor, a network, a data platform and an analysis, all working together.

**What you will learn**

- Explain what an **enabling technology** is and why it is called “enabling”
- Describe five of them, **IoT**, **cloud**, **big data**, **artificial intelligence** and **cybersecurity**, with their key characteristics
- Draw the **data chain** that links the five in one solution
- Tell a **characteristic** from an **application area**, the confusion that costs most marks in the report
- Follow a real sensor on a public map and find a real deployment of a technology, with a proper citation

## Unlocking the tech tree

> A **digital enabling technology** is a digital technology that, on its own or combined with others, makes possible processes, products, services or business models that were not viable before. It is not the final product: it is what the product is built on.

In a city-builder game you do not buy “a better city”. You unlock upgrades in the **tech tree**: water sensors, a traffic control room, an automatic advisor. Each upgrade does nothing spectacular by itself; it **enables** the next buildings and policies. Enabling technologies work the same way, and they share three features:

| Feature | What it means | Example |
|---|---|---|
| **Transversal** | The same technology serves very different sectors | Sensors are used in a hotel, a farm and a hospital |
| **Combinable** | Real solutions chain several of them | The bus app needs a sensor, a network, a server and a prediction |
| **Foundation** | Industry 4.0, from Unit 1, is built on them | A smart factory is IoT + cloud + data + AI + security |

There is no single official list. This module works with **eleven**, the ones in its programme. You meet five today and six in the next lesson.

| This lesson | Next lesson |
|---|---|
| Internet of things (IoT) · Cloud · Big data · Artificial intelligence (AI) · Cybersecurity | Blockchain · Robotics · Additive manufacturing · Augmented and virtual reality · 5G · Digital twins |

## Internet of things (IoT)

> The **internet of things (IoT)** is the network of physical objects with **sensors** (which measure) and **actuators** (which act) that are connected to the internet, send data and can receive orders.

| Characteristic | In plain words |
|---|---|
| Sensor + connectivity + platform | Something measures, something carries the data, something stores and shows it |
| Many small, cheap devices | Thousands of meters, not one big machine |
| Two directions | The thermostat sends the temperature and receives “switch off” |
| Industrial version | In factories it is called **IIoT** (industrial IoT) |

EMAYA’s smart water meters are IoT: the meter is the sensor, the radio network carries the reading, and a platform shows it to the company and to the customer.

## Cloud

> The **cloud** is computing (servers, storage, applications) that you use over the internet, on demand, instead of buying and running your own machines.

In the city-builder, the cloud is renting water and electricity from a utility instead of building your own power station. The US standards body NIST lists five characteristics, and they are the ones to remember:

| Characteristic | In plain words |
|---|---|
| On-demand self-service | You switch it on yourself, without phoning anybody |
| Broad network access | It works from anywhere with internet |
| Resource pooling | Many customers share the same big data centres |
| Rapid elasticity | It grows and shrinks with the demand: more servers in August, fewer in January |
| Measured service | You pay for what you use, like the electricity bill |

You will study the cloud properly in Unit 3. Today you only need to know what it is and what it is good for.

## Big data

> **Big data** means data sets so large, so fast or so varied that ordinary tools (a spreadsheet, one database server) can no longer handle them.

The classic way to recognise it is the **three Vs**:

| V | Question | EMAYA example |
|---|---|---|
| **Volume** | How much? | About 104,000 meters reporting every day |
| **Velocity** | How fast does it arrive? | A reading every hour, all day |
| **Variety** | How many kinds? | Meter readings, alarms, customer records, the weather |

> **Careful: big data is not "a lot of data"**
> Volume is only one V. A huge file that arrives once a year in one format is just a big file. Velocity and variety are what force new tools.

## Artificial intelligence (AI)

> **Artificial intelligence (AI)** is software that does tasks we associate with human intelligence: recognising, predicting, generating content or making decisions. Today it almost always **learns from data** instead of following rules written by a programmer.

The EU AI Act (Regulation (EU) 2024/1689) defines an AI system as a machine-based system that **infers** from the input it receives how to generate outputs such as predictions, content, recommendations or decisions. In the city-builder, AI is the automatic advisor that tunes the traffic lights.

| Characteristic | Consequence |
|---|---|
| Learns from data | Without good data, it learns nothing useful |
| Gives probable answers | It can be wrong, and it does not warn you |
| Needs computing power | It usually runs in the cloud |

Unit 4 is all about AI. Remember the course rule: **generative AI is not allowed** in assessed work unless the teacher authorises it for a specific activity.

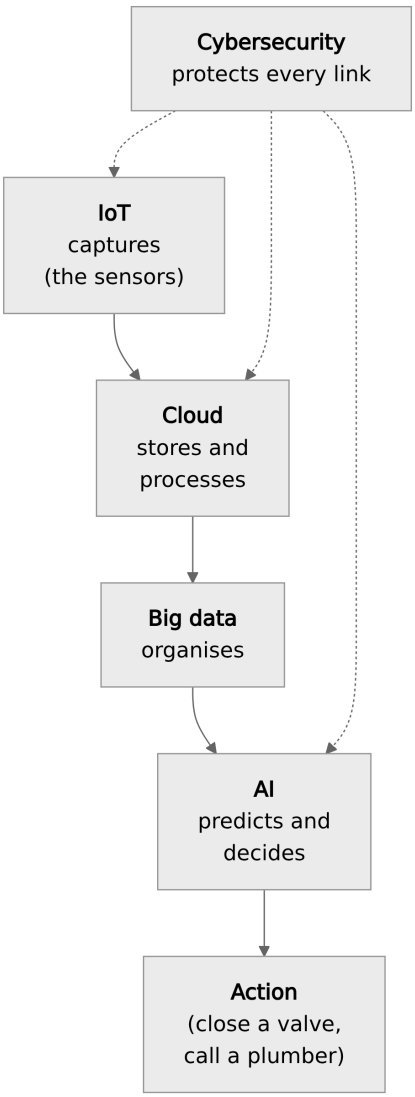
## Cybersecurity

> **Cybersecurity** is the set of technical and organisational measures that protect systems, networks and data.

It protects three properties, the **CIA triad**:

| Property | Question | If it fails |
|---|---|---|
| **Confidentiality** | Can only the right people read it? | Customer data leaked |
| **Integrity** | Is it correct and unaltered? | A meter reading changed |
| **Availability** | Is it there when you need it? | Nobody can work |

A real case, very close: on **13 January 2024** the Ajuntament de Calvià suffered a **ransomware** attack (a program that encrypts the files and asks for money to unlock them) by the LockBit 3.0 group. The attackers demanded 10 million euros; the council refused to pay and spent months restoring its systems. Availability failed for a whole town hall.




Every sensor you connect is one more door somebody can try to open. That is why cybersecurity is not “one more technology” at the end: it is a condition for all the others. Unit 5 goes deeper.

## The data chain

The five technologies of today are rarely used alone. Most real solutions chain them like this:

A sensor with nobody analysing its data is junk; an AI with no data learns nothing. When you propose a technology for your company, always ask: what comes before it in the chain, and what comes after?

## Characteristic or application area?

This is the distinction the report lives on, so learn it now.

> A **characteristic** says what the technology **is like**. An **application area** says **where and for what** it is used in a company.

| Technology | Characteristic | Application area |
|---|---|---|
| IoT | Many cheap connected sensors | Water network: detect leaks at night |
| Cloud | Rapid elasticity | Booking system: absorb the August peak |
| AI | Learns from data | Sales: forecast next month's demand |
| Cybersecurity | Protects availability | IT department: backups and recovery plan |

Test: if your sentence names a department, a process or a place in the company, it is an application area. If it would be true in any company, it is a characteristic.

## In class: follow a real sensor

Two short tasks, done in the browser, handed in as one document on Classroom (class activity, individual). **No AI tools.**

**Part 1 — A real IoT device.** Sensor.Community is a citizen-science network of home-made air-quality sensors that publish their readings openly.

| Step | Do this | You should see |
|---|---|---|
| **1** | Open `maps.sensor.community` and zoom into Mallorca | Hexagons coloured by air quality |
| **2** | Click a hexagon near Palma or your town | The sensors inside it, with their ID and their latest readings |
| **3** | Write down the sensor ID, the PM2.5 and PM10 values and the time of the reading | Numbers in µg/m³ and a time-stamp a few minutes old |
| **4** | Draw the data chain of that sensor: what captures, what carries, where it is stored, who could analyse it, what could go wrong | One line per link of the chain |

**Part 2 — Deployment hunt.** Find **one real deployment** of one of today's five technologies, the one that belongs to your section of Deliverable 2 (if your section has none of today's five, take any). Prefer the Balearic Islands or your company's sector.

| Write | Example (do not copy it) |
|---|---|
| What, who, where, when | EMAYA replaces mechanical water meters with smart ones in Palma, 2023–2026 |
| Which characteristic it shows | Many cheap connected sensors; hourly readings (velocity) |
| Business or plant? | Plant (the water network), and business (billing, customer website) |
| The source, cited | Mallorcadiario. (2023, February 15). *Emaya apuesta por los contadores inteligentes*. https://www.mallorcadiario.com/emaya-apuesta-por-los-contadores-inteligentes |

A company website, a public body, a newspaper or a specialised medium is fine. A forum post or an AI answer is not a source.

## For your project

Today your group splits Deliverable 2: each member takes one **section** (a set of two or three technologies) and writes it down in the group log. The deployment you found today is field 2 of your first technology sheet, and the definition and characteristics are field 1. Keep the citation exactly as you wrote it: in the report every fact about a real company needs one.

## Key takeaways

- An **enabling technology** makes new processes, products and services possible; it is an upgrade in the tech tree, not the final building.
- **IoT** captures data from the physical world with **sensors** and acts with **actuators**.
- The **cloud** is computing on demand over the internet: self-service, network access, pooling, elasticity, pay per use.
- **Big data** is defined by the **three Vs**: volume, velocity and variety, not by size alone.
- **AI** learns from data to predict, generate or decide, and it can be wrong. **Cybersecurity** protects confidentiality, integrity and availability, and it protects all the others.
- A **characteristic** says what a technology is like; an **application area** says where and for what the company uses it.

## Quick check

**1** Why is a technology called “enabling”?

**A** Because it is the newest technology on the market
**B** Because it makes possible processes, products or services that were not viable before
**C** Because it replaces the workers of a department
**D** Because the government subsidises it

**2** EMAYA’s smart water meters send a reading every hour. Which technology captures that reading?

**A** The internet of things (IoT)
**B** Artificial intelligence
**C** Cybersecurity
**D** Big data

**3** A data set of a single huge file that arrives once a year in one format. Is it big data?

**A** Yes: anything large is big data
**B** Probably not: big data also needs velocity and variety, not only volume
**C** Yes, as long as it is stored in the cloud
**D** No, because big data only exists in social networks

**4** Which one is a characteristic of the cloud, and not an application area?

**A** Hosting the hotel’s booking system
**B** Storing the backups of the accounting department
**C** Rapid elasticity: resources grow and shrink with demand
**D** Running the warehouse’s stock control

**5** In the Calvià attack of January 2024, the files were encrypted and nobody could work. Which property of the CIA triad failed most visibly?

**A** Confidentiality
**B** Integrity
**C** Availability
**D** Elasticity

**6** In the typical data chain, what is the right order?

- **A** AI → IoT → cloud → big data
- **B** IoT captures → cloud stores → big data organises → AI predicts, with cybersecurity protecting everything
- **C** Cybersecurity → AI → IoT → cloud
- **D** Big data → IoT → AI → cloud

**7** A bakery with three shops wants to know each morning how many loaves to bake in each shop. Pick the two technologies that are most directly needed.

- **A** Big data: put together past sales, the day of the week, the weather and local festivities
- **B** AI: learn from that history to predict tomorrow's demand per shop
- **C** Robotics: a robot arm that kneads the dough
- **D** Blockchain: a shared ledger among the three shops

Five technologies are about data. The next six touch the physical world, the network and trust. Next: Enabling technologies II.

## Solutions

**1. B** · An **enabling technology** is a foundation, like an upgrade in a tech tree: it is valuable for what it lets you build on top of it, not by itself.

**2. A** · The meter is a **sensor** connected to a network: that is **IoT**. Big data and AI may come later in the chain, when the readings are stored and analysed.

**3. B** · Big data is defined by the **three Vs**. Volume alone makes a big file; **velocity** and **variety** are what make ordinary tools fail.

**4. C** · **Elasticity** describes what the cloud is like, in any company. The other three name a department or a process: they are **application areas**.

**5. C** · **Availability** means the system is there when you need it. Ransomware attacks it directly. (Elasticity is a characteristic of the cloud, not part of the triad.)

**6. B** · Data are born in the physical world (**IoT**), travel to where they are stored and processed (**cloud**), are organised (**big data**) and turned into a prediction or decision (**AI**). **Cybersecurity** is not a step; it covers every link.

**7. A, B** · The problem is a **prediction**, so you need organised data (**big data**) and something that learns from it (**AI**). A robot would change how bread is made, not how many loaves; a blockchain only makes sense with several parties that do not trust each other.