



Internet of Things (IoT)

DAY 1

What IoT is, and the devices that make it work

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Salah Abdeljabar
salah.abdeljabar@kaust.edu.sa

👋 The Teaching Team



Salah Abdeljabar

Course Instructor



Fawaz Al-Ghamdi

Teaching Assistant



To be announced

Teaching Assistant



On Today's Agenda

1. **What is IoT?**: definition & origin
2. **The scale of IoT**: billions of devices, zettabytes of data
3. **Who is building it**: the big names betting on IoT
4. **Sensors & actuators**: the two halves of every device
5. **Microcontrollers (MCUs)**: tiny computers built for one job
6. **Single-board computers (SBCs)**: full computers on a board

What is IoT?

The Internet of Things

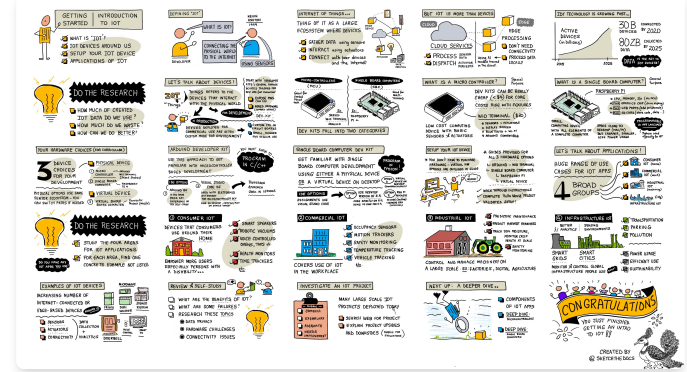
The Origin of IoT

The term **Internet of Things** was coined by **Kevin Ashton** in **1999**, to describe connecting the Internet to the **physical world** through sensors.

Today it means **any device that interacts with the world around it**, by:

-  **Gathering data** with **sensors**: temperature, speed, location
-  **Acting on the world** with **actuators**: switches, lights, sound

The **T** in IoT stands for **Things**: the devices bridging the **digital** and **physical** worlds.



Sketchnote by Nitya Narasimhan

In a nutshell

Everyday **things** + **sensors / actuators** + the **Internet** (and the cloud behind it).

The Scale of IoT



From a handful of devices to **tens of billions**

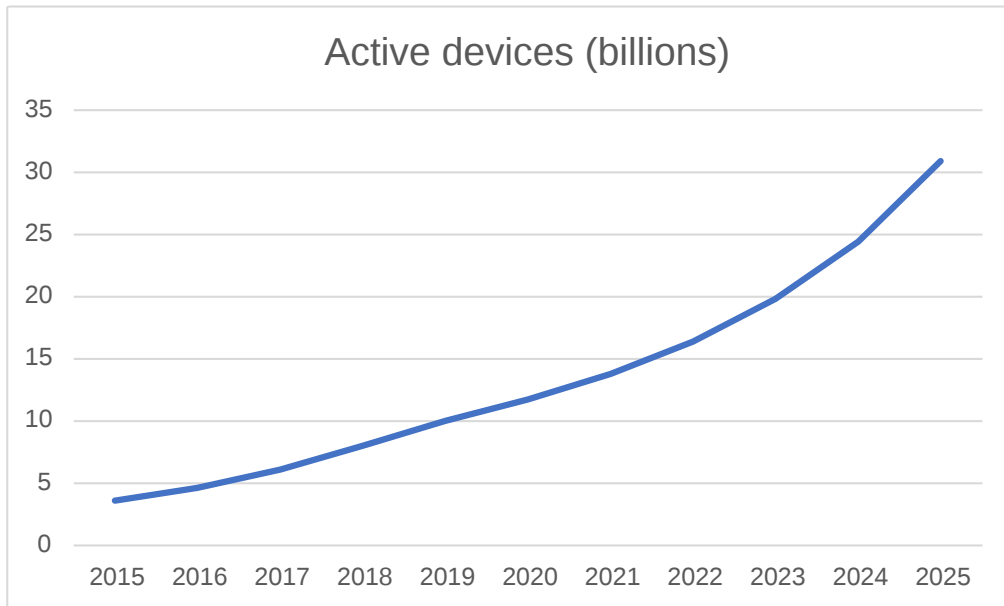
Explosive Device Growth

By the end of **2020**, an estimated **30 billion** IoT devices were connected to the Internet.

- Under **5 billion** in 2015
- Over **30 billion** by 2025
- Growth shows no sign of slowing

💡 Tip

Roughly **4 connected devices for every person** on Earth.



An Ocean of Data

Every one of those devices generates data, and the totals are staggering.

By 2025

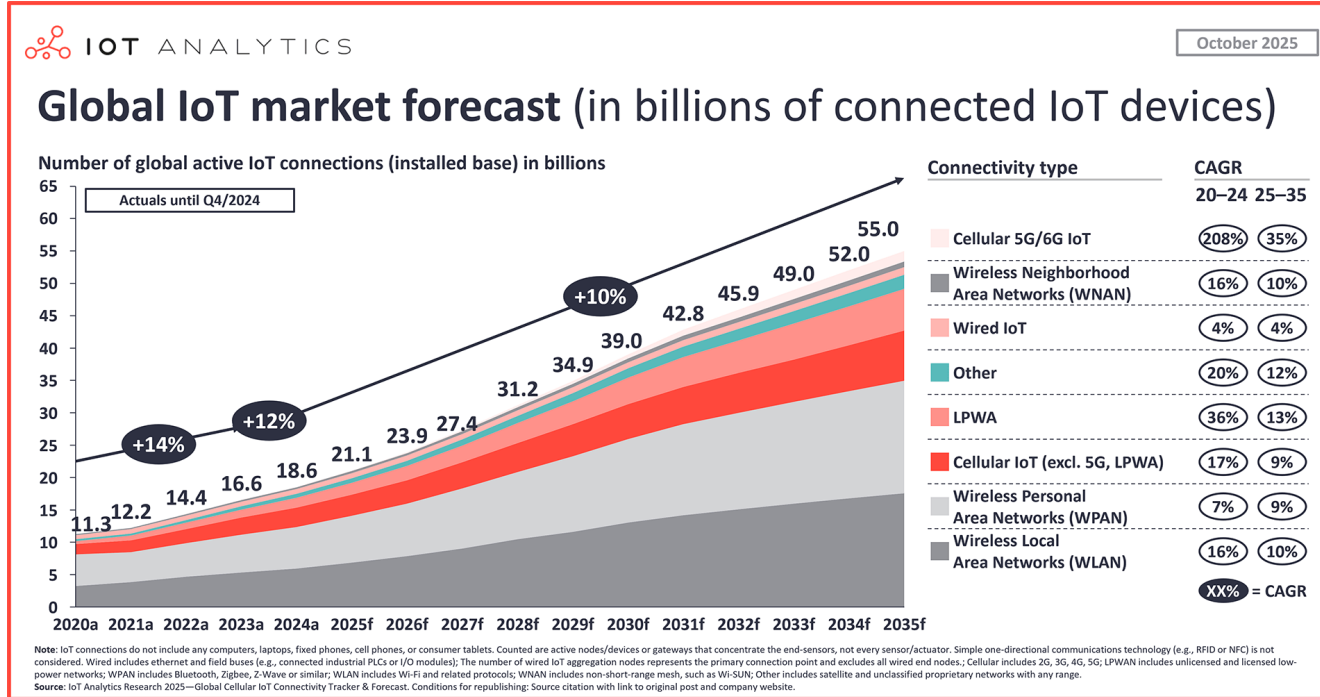
IoT devices will gather almost **80 zettabytes** of data: that's **80 trillion gigabytes**.

Why it matters

This data is the **key to IoT's success**: the value comes from understanding it and acting on it.

Successful IoT means knowing what data to gather, how to gather it, and how to make decisions from it.

The Curve, Counted Carefully



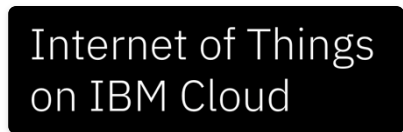
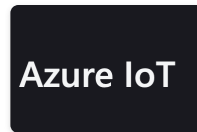
21.1 billion active connections in 2024

55 billion forecast by 2035

Growing at roughly **10% a year**

Everyone Is Betting on IoT 🏢

Every major technology company is **active in this space**, from the silicon up to the cloud.



Note

Chip makers, network vendors, cloud providers, and telecom operators are all investing here: a sign that IoT is **infrastructure**, not a niche.

Sensors & Actuators

How IoT devices **feel** and **act on** the physical world

Two Halves of Every IoT Device



Sensors: *input*

Gather information **from** the physical world by converting what they measure into an electrical signal.

- Temperature, speed, location
- Light, sound, movement
- Pressure, humidity



Actuators: *output*

Convert an electrical signal **into** a real-world interaction.

- Turn on a switch or light
- Make a sound
- Move a motor

The Core Idea

Note

Sensors **read** the world and turn it into an **electrical signal**. Actuators take an electrical signal and use it to **change** the world. Many devices use both.

Everyday example

A **smart thermostat**: a temperature **sensor** reads the room, an **actuator** switches the heater on or off.

Microcontrollers (MCUs)

Tiny computers-on-a-chip built for **one job**

What is a Microcontroller?

A microcontroller (**MCU**) is a small, low-power computer on a single chip:



Runs your program, one or more cores

Program storage + RAM, on the chip

Pins to talk to sensors & actuators

- **Low cost**: often **US\$0.03–0.50**, dev kits from ~US\$4
- **Low power**: can run **months or years** on a battery
- Programmed in **C/C++** to do a few very specific tasks



Tip

Searching for "**MCU**"? Add "microcontroller", or you'll get the Marvel Cinematic Universe!

The ESP32: Our Workshop MCU

This workshop uses the **ESP32**, a popular and capable microcontroller.

- **Dual-core** processor
- **Wi-Fi + Bluetooth** built in
- Dozens of **GPIO** pins
- Cheap and widely supported

① How we program it

The **Arduino framework** in C/C++: `setup()` runs once, `loop()` runs forever.

```
void setup() {  
  Serial.begin(115200);  
  Serial.println("Hello, IoT!");  
}  
  
void loop() {  
  // runs forever  
}
```

Single-Board Computers (SBCs)



A **full computer** on a single board

MCU or SBC?



Single-Board Computer

A complete computer on one board, running a **full operating system**.

- Runs **Linux**, coded in **Python**
- More power, memory & complexity
- Connect monitors, keyboards, USB
- e.g. **Raspberry Pi**



Microcontroller

A chip built to do **one specific task**.

- Runs **C/C++**, no full OS
- Tiny power draw, low cost
- Real-time, single-purpose
- e.g. **ESP32**

When to Choose Which?

📌 Pick an MCU when...

You need **battery life**, **low cost**, **real-time** response, and a single dedicated job.

📌 Pick an SBC when...

You need **complex logic**, **multiple peripherals**, a **rich UI**, or to run **AI models**.

Rule of thumb

Simple & battery-powered → **MCU**. Powerful & flexible → **SBC**.