# Chapter 2: IoT Architecture and Ecosystem

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## 📘 Description

This chapter dives into the structure of an IoT system. You'll explore the four-layer architecture that defines how IoT devices sense, communicate, process, and deliver data, and get introduced to the broader ecosystem of platforms and technologies that support IoT development.

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## 🎯 Learning Objectives

By the end of this chapter, you will be able to:

- Explain the layered architecture of IoT systems.
- Understand the role of each architectural layer.
- Identify key technologies and platforms in the IoT ecosystem.
- Differentiate between edge, fog, and cloud computing.

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## 🏗️ Section 1: Four-Layer IoT Architecture

| Layer | Description |
|---|---|
| **Perception Layer** | The physical layer—sensors, actuators, and devices that gather data. |
| **Network Layer** | Transfers the data via communication protocols (Wi-Fi, Bluetooth, etc.). |
| **Middleware Layer** | Processes, stores, and analyzes the data—can be cloud-based or local. |

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| **Application Layer** | Interfaces with users—dashboards, mobile apps, automation tools. |

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## 🌍 Section 2: IoT Ecosystem Overview

The IoT ecosystem includes:

- **Hardware**: Sensors, microcontrollers, communication modules
- **Software**: Operating systems, firmware, device drivers
- **Connectivity**: Wi-Fi, LoRa, Zigbee, NB-IoT, etc.
- **Cloud Platforms**: AWS IoT, Google Cloud IoT, Azure IoT Hub
- **Security Tools**: Encryption, identity verification, access control
- **User Applications**: Mobile/web apps, AI/ML interfaces

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## 🌫️ Section 3: Edge, Fog, and Cloud Computing in IoT

| Type | Description | Use Case |
|---|---|---|
| **Edge Computing** | Data processing close to the device (e.g., on the microcontroller) | Real-time decisions in smart vehicles |
| **Fog Computing** | Intermediate layer between edge and cloud, reducing latency | Smart traffic control |
| **Cloud Computing** | Centralized processing and storage of large-scale data | Data analysis from smart cities and factories |

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## 📦 Section 4: Examples of IoT Architectures

- **Smart Home System**
  Perception: Door sensors, motion detectors
  Network: Wi-Fi
  Middleware: Home Assistant (on Raspberry Pi)

Application: Mobile app to control and monitor

- **Smart Agriculture System**
  Perception: Soil moisture and temperature sensors
  Network: LoRa for long-range communication
  Middleware: Cloud server for data analysis
  Application: Web dashboard for irrigation control

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## ✅ Chapter Summary

- IoT systems follow a four-layer architecture: Perception, Network, Middleware, and Application.
- Each layer has a specific role in sensing, transmitting, analyzing, and visualizing data.
- The ecosystem includes hardware, software, platforms, and connectivity technologies.
- Edge and fog computing offer alternatives to centralized cloud processing for faster and local responses.