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Digital Change Agents for Food + Beverage SMEs

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INTERNET OF THINGS (IoT)

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OBJECTIVES

- Understand the basic concept of IoT
- Discover how IoT is applied in the food and beverage sector
- Explore its advantages and new job opportunities

OUTCOMES

By the end of this module, participants will be able to describe how IoT works and what components it uses, identify practical applications in the food and beverage industry and recognize the impact on jobs and required skills.

01

INTRODUCTION TO IoT

What is IoT?

The Internet of Things (IoT) refers to a **network** of **smart devices**, sensors, appliances, or machines, that are connected to the **internet** and can **collect, share**, and **exchange data** without direct human intervention**.**

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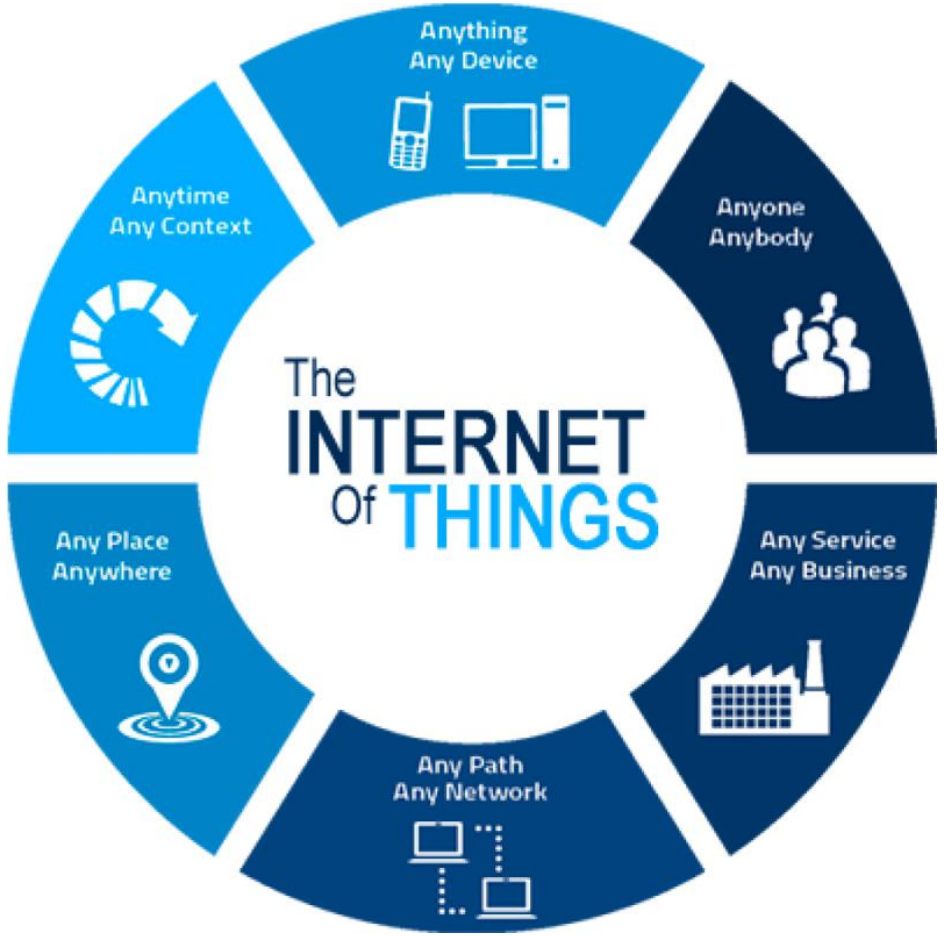
What is IoT?

IoT systems consist of multiple components that work together to **monitor**, **automate**, and **optimize** processes. In sectors like the **food industry**, they are used to:

- **Collect data** from sensors
- **Control equipment** in real-time
- **Improve efficiency, performance, and decision-making**.



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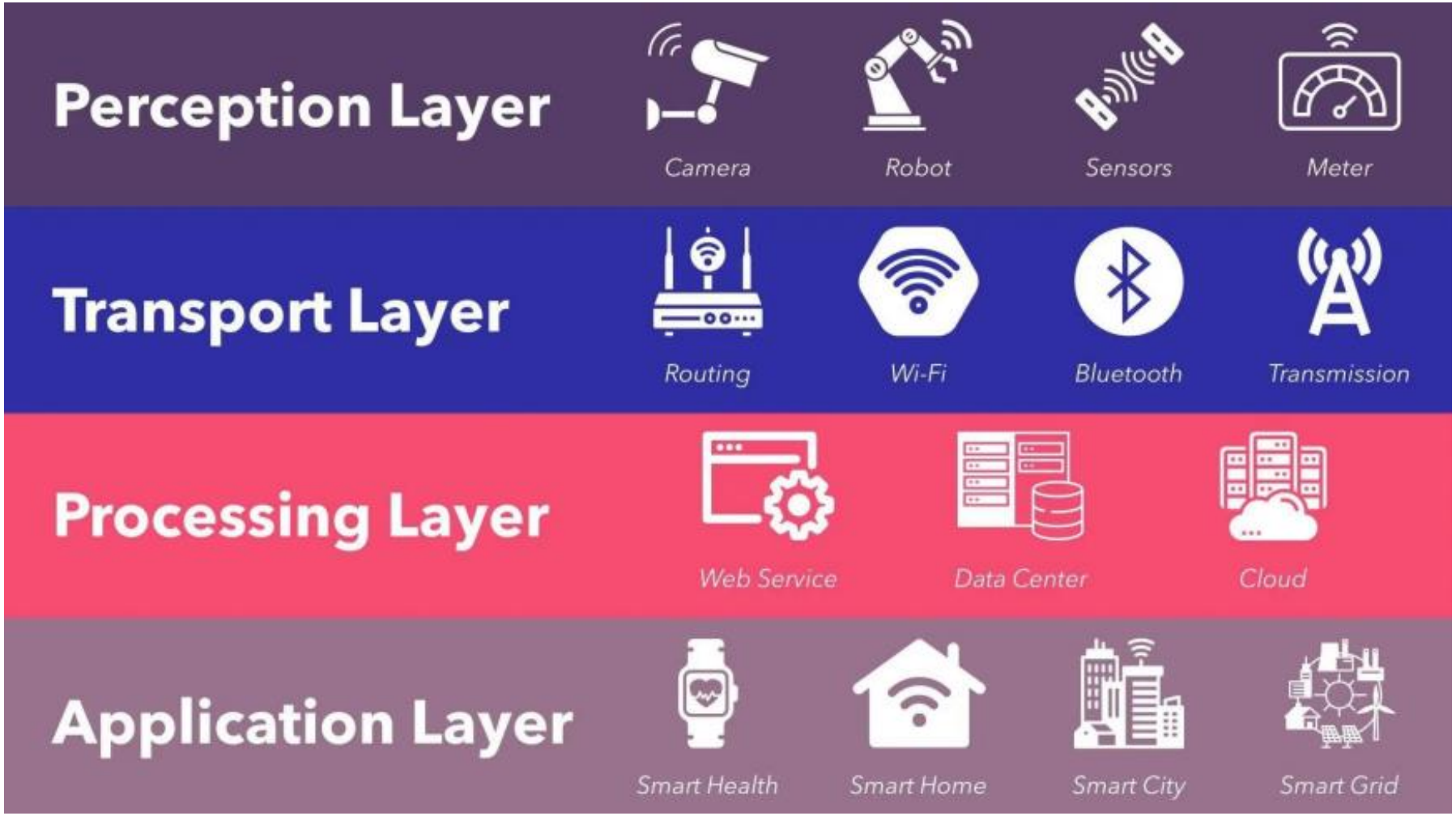
IoT COMPONENTS

Key components



Perception Layer

The **perception layer** of an IoT system architecture, also known as the device layer, consists of **multiple elements** – sensors, cameras, actuators, and similar devices that **gather (exchange) data** and **perform tasks.**

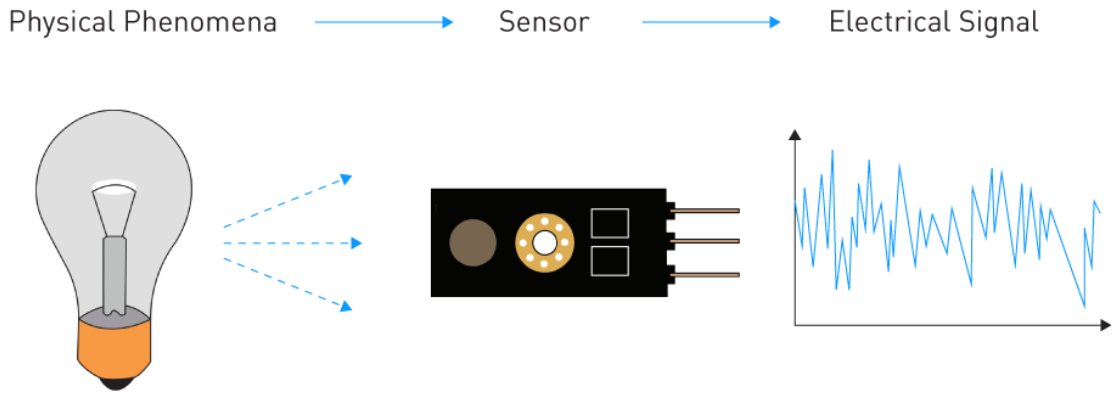
Example: Imagine a smart cold storage room in a food processing facility. Inside, there are temperature and humidity sensors, responsible for checking, whether the temperature rises above safe levels for storing meat or dairy.

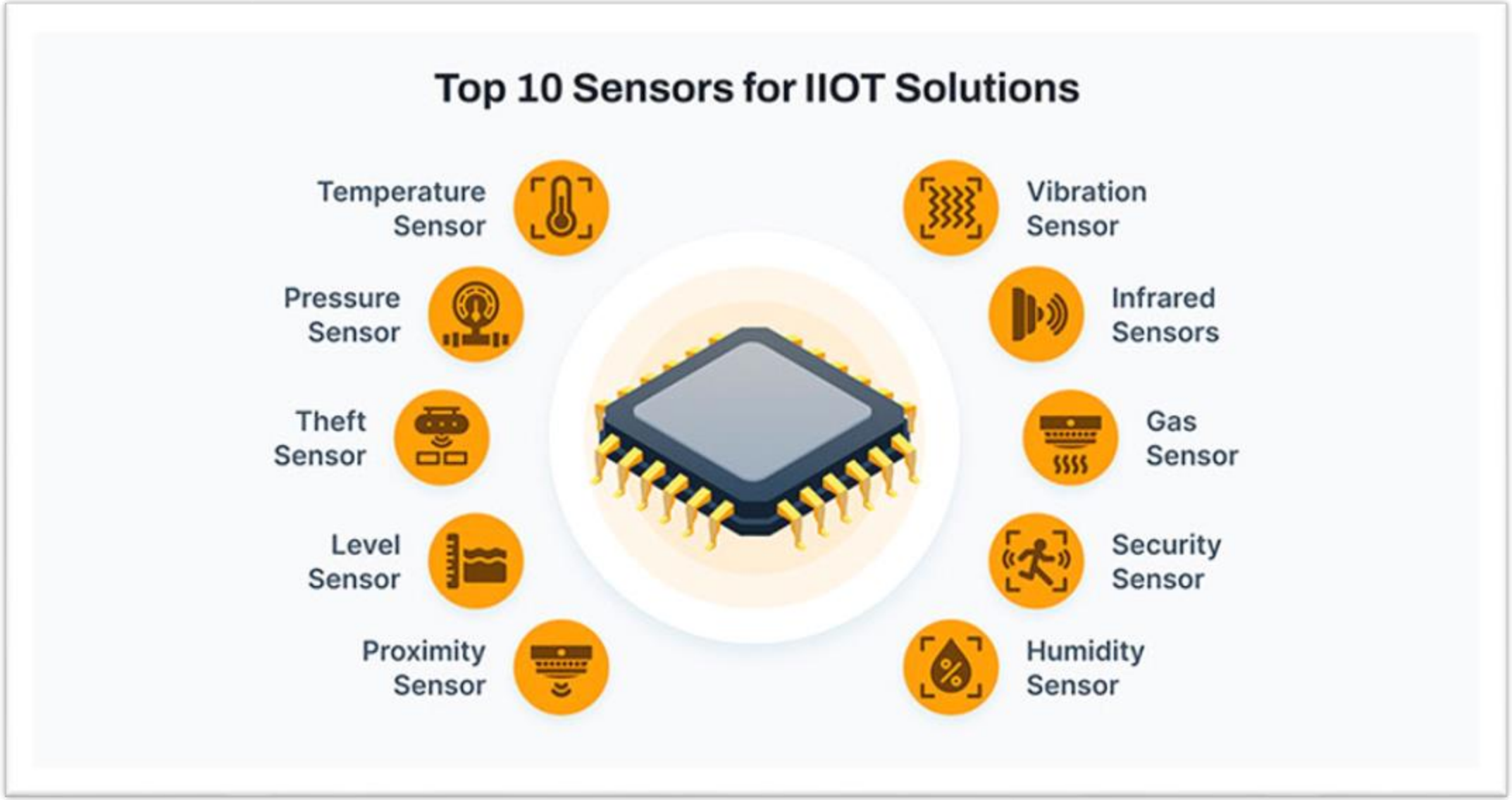
Sensors

Sensors are devices that **detect**, **measure** and **collect** information from the physical changes in the environment and **convert** them into **digital signals** that machines understand and act on.

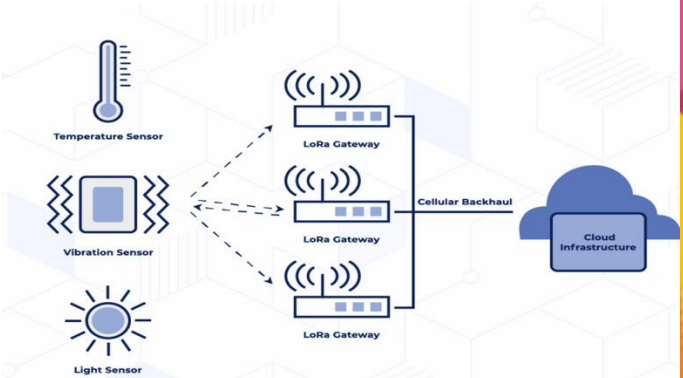
In food and beverage production, sensors are used to control:

- **Temperature and humidity:** monitors food storage areas or trucks
- **Motion and proximity:** detects movement in machinery and how close objects are, for safety and collision avoidance
- **Pressure**: to check if packaging lines are working correctly
- **CO_2:** detect food spoilage




Top 10 Sensors for IIOT Solutions
Temperature Sensor
Pressure Sensor
Theft Sensor
Level Sensor
Proximity Sensor
Vibration Sensor
Infrared Sensors
Gas Sensor
Security Sensor
Humidity Sensor

Transport Layer



The transport layer in an IoT system is responsible for **sending data** from devices (e.g., sensors, cameras) to a computer system either stored **locally** (on-site) or in the **cloud**.

An IoT gateway takes the signals from the devices and converts them into digital data (0/1). Then, using the data transfer protocol, sends that data so it can be stored, analyzed, or used to make decisions.

The choice of **data transfer protocol** (e.g MQTT) is based on some factors such as the amount and type of data, speed transmission etc.

Connectivity and cloud platforms

Different **types of connection** are used depending on the location:

- Wi-Fi, Bluetooth or Ethernet inside factories
- RFID tags to follow products through the supply chain
- 5G or LoRa for remote areas or long distances

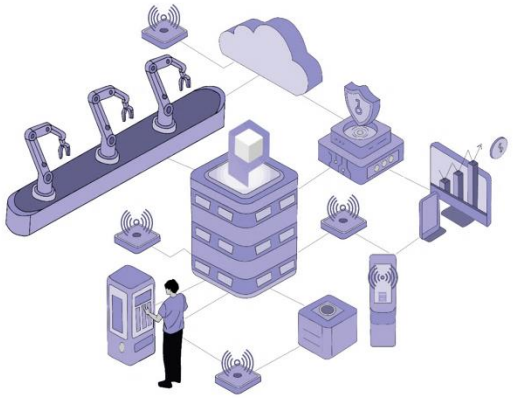
A stable connection ensures the system works in **real time** and devices **send** and **store** data to cloud platforms.

Once the sensors send the information, the system:

- Saves the data in a database
- Provides real-time monitoring and remote access to the data
- Supports automated decision-making

Cloud platforms examples: AWS IoT, Microsoft Azure IoT, Google Cloud IoT

Processing Layer



The processing layer, also called the **middleware layer**, leverages many connected computers simultaneously, in the form of cloud computing, to deliver superior compute, storage, networking, and security performance.

It is responsible for **analyzing input data** to generate new insights, useful predictions, and timely warnings, using a three-stage approach:

- Data accumulation (unstructured, structured)
- Data abstraction (conversion into “readable format”)
- Data analysis (using ML or DL algorithms)

Application Layer

This layer is the “face” of the IoT system, it is what people **see** and **interact** with. This layer includes the **user interface** (UI) which takes the data collected by devices and processed through the system and turns it into something useful.

It includes apps, dashboards, or notifications that warns or helps users understand what is happening.

Good interfaces help staff take action quickly and avoid production loss!

Business layer

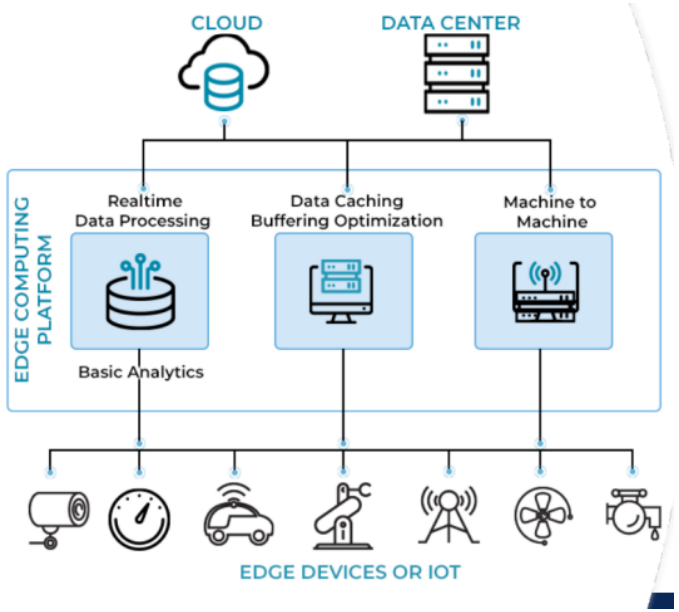
This is behind the scenes, where organizations **analyze data** to make decisions, set rules, and **optimize operations**.

Patterns decoded at the application level are turned into **business insights**, project future trends, and drive operational decisions that improve the efficiency, safety, cost-effectiveness, customer experience, and other important aspects of business functionality.

Edge computing

Edge computing represents a shift in data processing, bringing computation closer to the source of data. There is **localized data processing** near the data source than a central data processing warehouse.

- **Reduces latency** and improves response times
- **Minimizes amount of data** needed to be sent over the network, reducing bandwidth
- **Improve performance** applications, leading to faster insights and actions



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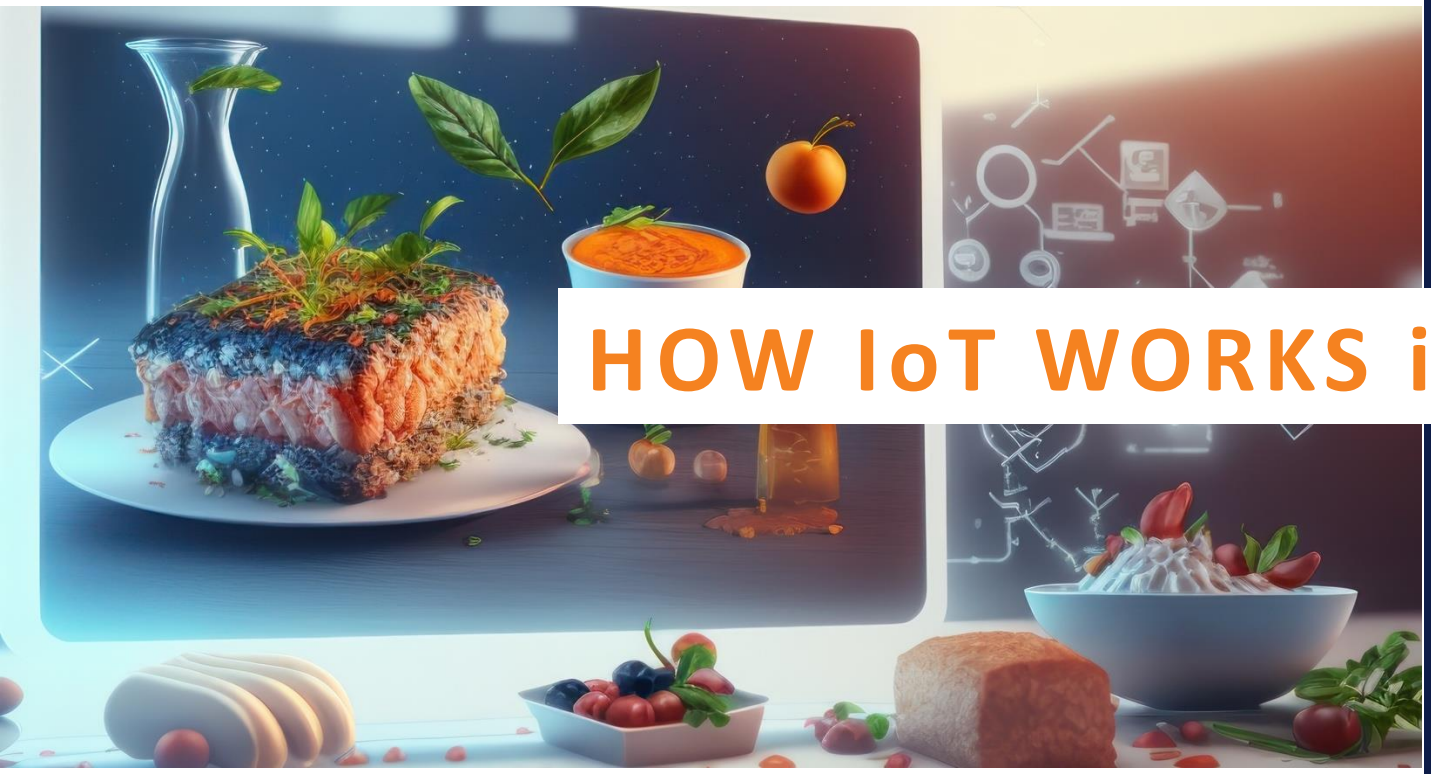


HOW IoT WORKS in F&B industry

IoT System Structure and real-time communication

An IoT system in the food and beverage sector follows a structured flow that allows for continuous monitoring and control. This flow involves:

- **Data collection (input):** Sensors installed on production lines, warehouses, fridges, or vehicles measure variables such as temperature, humidity, or movement.
- **Data transmission:** Connectivity technologies like Wi-Fi, Bluetooth, RFID or 5G send data to the cloud or local servers. This transmission happens instantly and continuously.
- **Data processing and analysis:** Cloud or edge computing platforms process the incoming data. They can detect anomalies (e.g., a fridge too warm), predict failures, or optimize production timing.
- **Real-time response (output):** The system sends alerts, adjusts machinery, or informs operators. Real-time dashboards or mobile apps show what's happening at every moment.
- **Feedback loop:** Data is stored and analyzed to improve decision-making over time.

Data flow in IoT Systems

Understanding how data moves within an IoT system is essential. Once data is collected and transmitted, it follows a continuous cycle of processing and feedback.

This data flow includes:

- **Edge processing:** In some cases, data is processed directly on devices (e.g., a sensor or smart controller) without sending it to the cloud. This reduces latency and enables quick reactions.
- **Cloud analysis:** Large volumes of data are sent to cloud platforms for deep analysis, using AI algorithms or machine learning models to detect trends, forecast issues, or generate recommendations.
- **Data storage:** Relevant information is stored for traceability and auditing purposes. This includes temperature logs, delivery times, or production errors.
- **Operator access**: Dashboards and control panels visualize real-time data, enabling human workers to take informed decisions quickly and accurately.

Digital Twin

A **Digital Twin** is a virtual replica of a physical process, system, or product that enables real-time monitoring, simulation and analysis. Manufacturers can gain insights, predict outcomes and optimize operations digitally.

Example in the F&B sector:

- Imagine a digital twin of a bottling line in a beverage factory.
- Sensors on the equipment track temperature, pressure, fill levels, and speed.
- This live data feeds into the digital twin, which simulates production in real time.
- If the system predicts a slowdown or fault (like a cap misalignment), it can alert technicians before it happens, avoiding downtime.
- Engineers can also test changes (e.g., faster speed, new bottle design) on the virtual twin before making adjustments in the real factory.

04

APPLICATIONS IN FOOD AND BEVERAGE

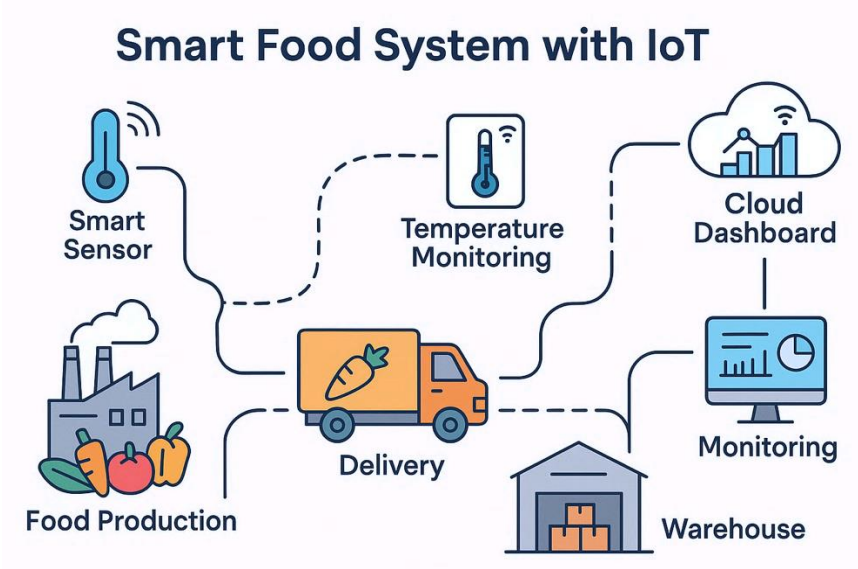
Application of IoT in the Food and Beverage Sector

Agriculture: smart irrigation systems adjust water use automatically. During processing, sensors detect machine failures, monitor hygiene, and ensure temperature and pressure are within safe limits.

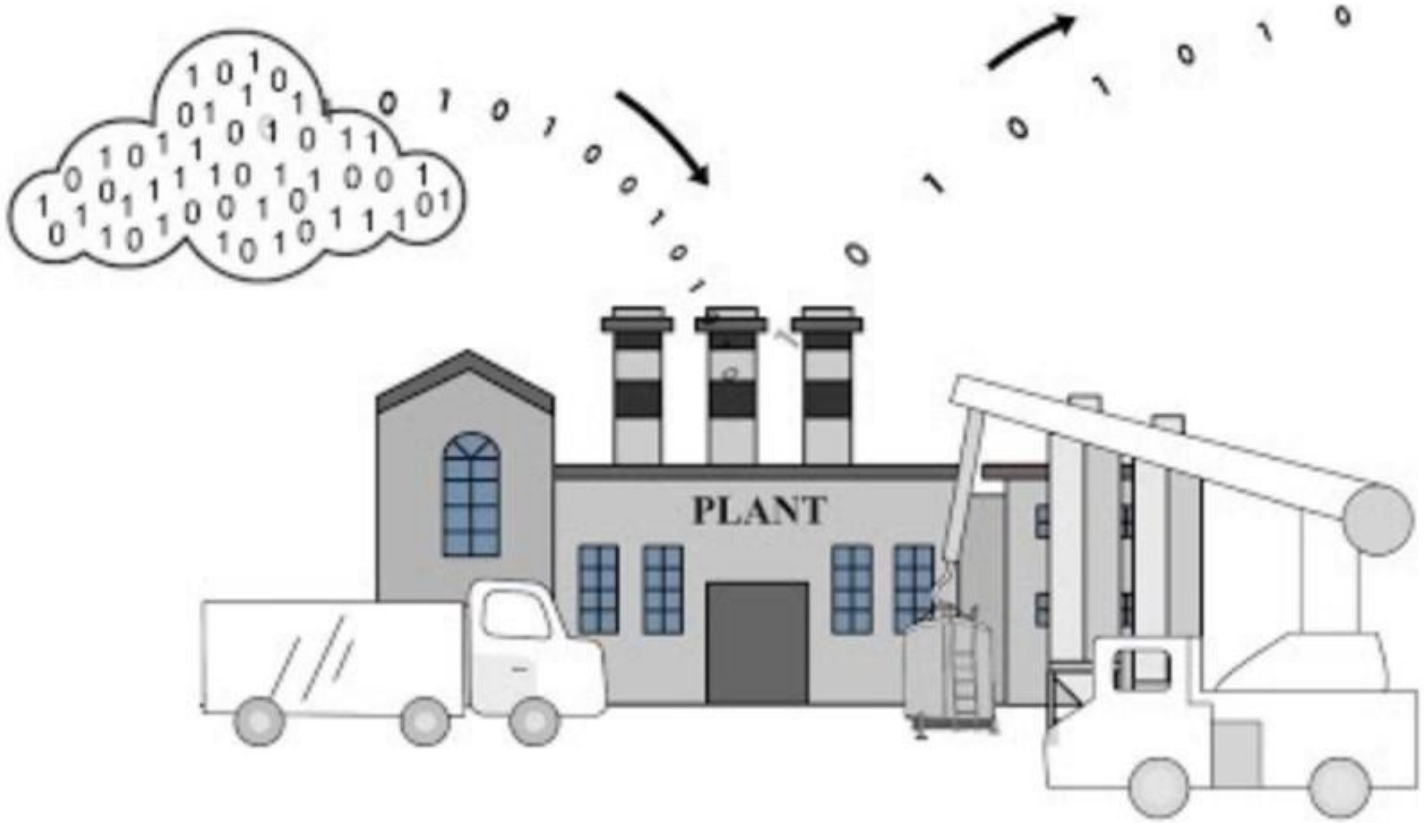
Storage: cold chain monitoring helps preserve freshness by keeping conditions optimal.

Transportation: GPS and environmental sensors track product location and status.

Retail: smart shelves monitor stock levels and expiration dates.



Industrial IoT, and Digital Twins in F&B Production



https://www.youtube.com/watch?v=kGb6utklQwk

05

BENEFITS FOR THE SECTOR

Benefits of IoT for Food and Beverage Companies

IoT improves efficiency, hygiene, and food safety across the **entire supply chain.** It allows companies to:

- Monitor and control processes in real time
- Reduce energy and water consumption
- Minimize human errors
- Improve predictive maintenance and reduce downtime
- Optimize inventory and logistics

Powered by modern tech:

- IoT devices
- Low-cost computing
- Cloud storage
- Big data & AI

These improvements result in **cost savings**, **better product quality**, and **increased customer satisfaction.**

IoT for sustainability in the F&B sector

IoT technologies help drive sustainable and efficient practices by combining smart sensors with real-time monitoring. This reduces environmental impact and improves operational control.

Key benefits:

- Precise control of temperature, and other environmental factors, to lower energy consumption
- Monitoring of CO_2 emissions and optimization of energy use in production and transportation
- Better resource management to avoid overproduction and food waste
- Implementation of circular economy strategies through detailed data analysis
- Compliance with environmental regulations and food safety standards

Linked Sustainable Development Goals (SDGs):

- **Goal 9:** Industry, Innovation and Infrastructure
- **Goal 12:** Responsible Consumption and Production

06

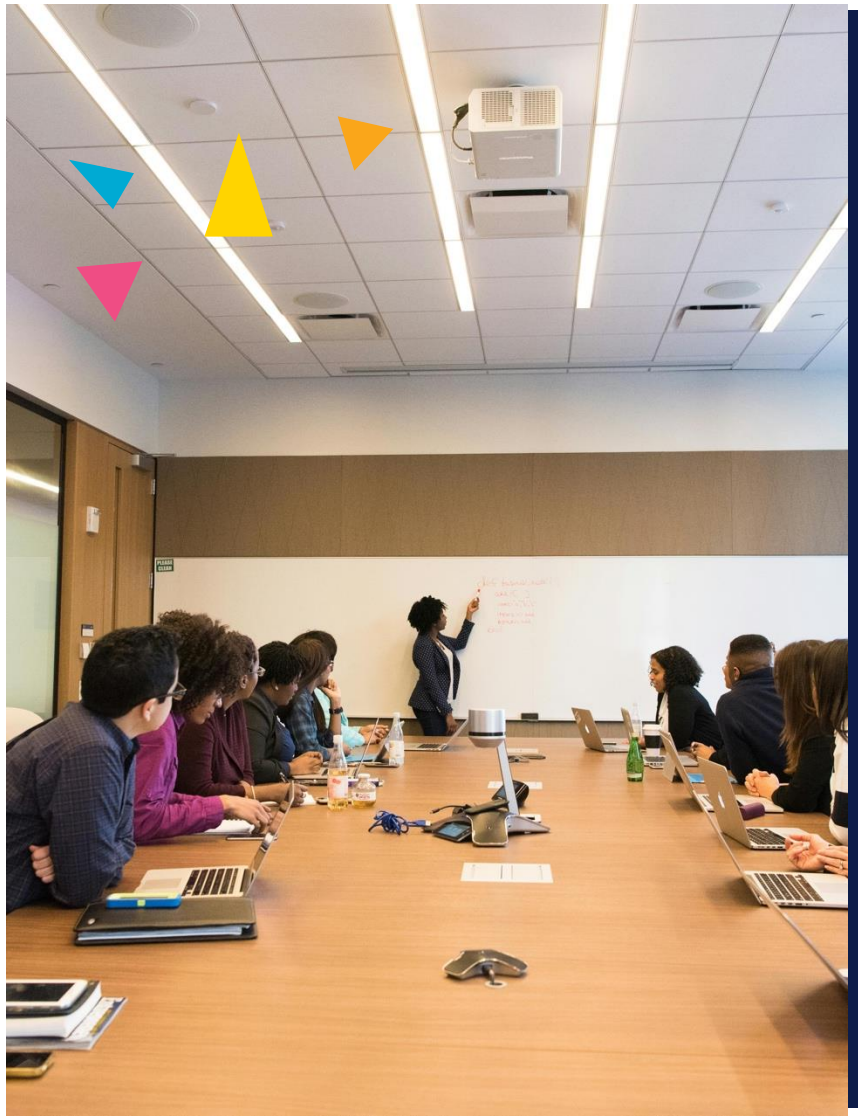
NEW JOBS AND SKILLS

New Jobs

- IoT technicians and sensor specialists
- IoT security and network engineers
- Data analysts for production monitoring
- Maintenance staff for connected systems
- Supervisors for smart production lines
- Operators of automated machinery
- Food safety digital inspectors

New Skills

- Ability to manage IoT platforms and connected devices
- Understanding of data visualization tools and dashboards
- Basic knowledge of sensors, connectivity, and automation
- Problem-solving and troubleshooting in digital systems
- Teamwork and communication in smart environments
- Adaptability to changing digital tools and protocols



Continuous learning and training

As IoT improves systems, digital tools and smart environments reshape the F&B sector, professionals must continuously updated their skills meet the new industry demands.

These learning opportunities play a critical role in preparing workers for **automation, data-driven processes,** and **smart production systems:**

- Vocational Education
- Short Courses
- Workplace Training Programs

07

Conclusions

Successful integration

The integration of IoT technologies is **changing** how the **food and beverage industry operates**.

From production to logistics and retail, connected systems help monitor, control, and improve every step of the supply chain. These technologies **enable** smarter decisions, better hygiene, improved traceability, and reduced waste.

IoT is not just about machines, it also creates **new job opportunities** and **demands new skills**. Workers must adapt to digital tools and continuous learning becomes essential.

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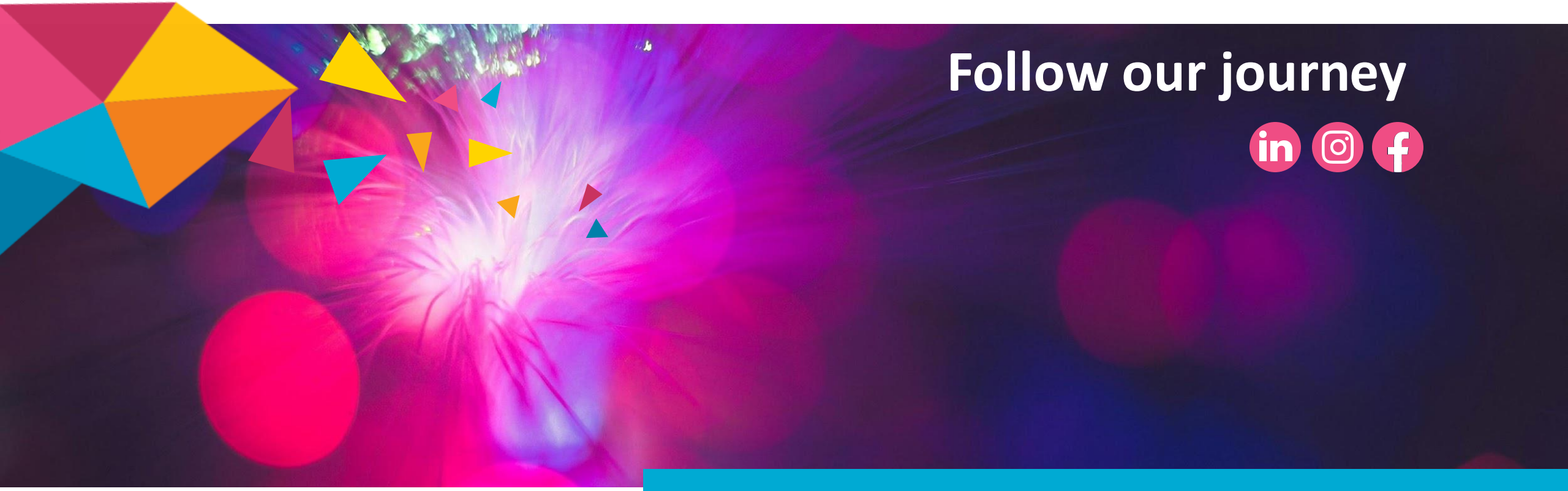

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