INTERNET OF THINGS (IoT)

LECTURE 6

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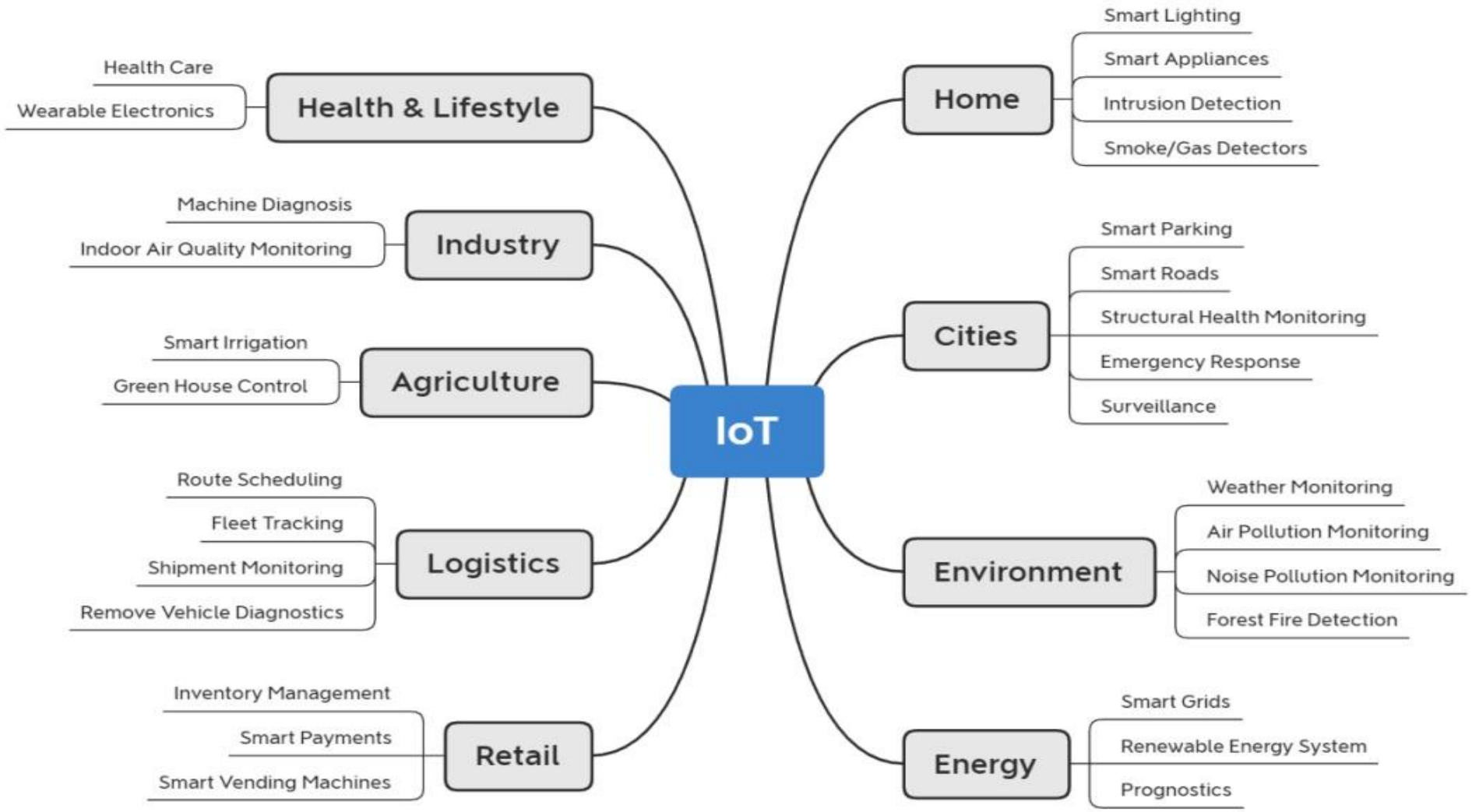
Outline

Domain - Specific IoTs

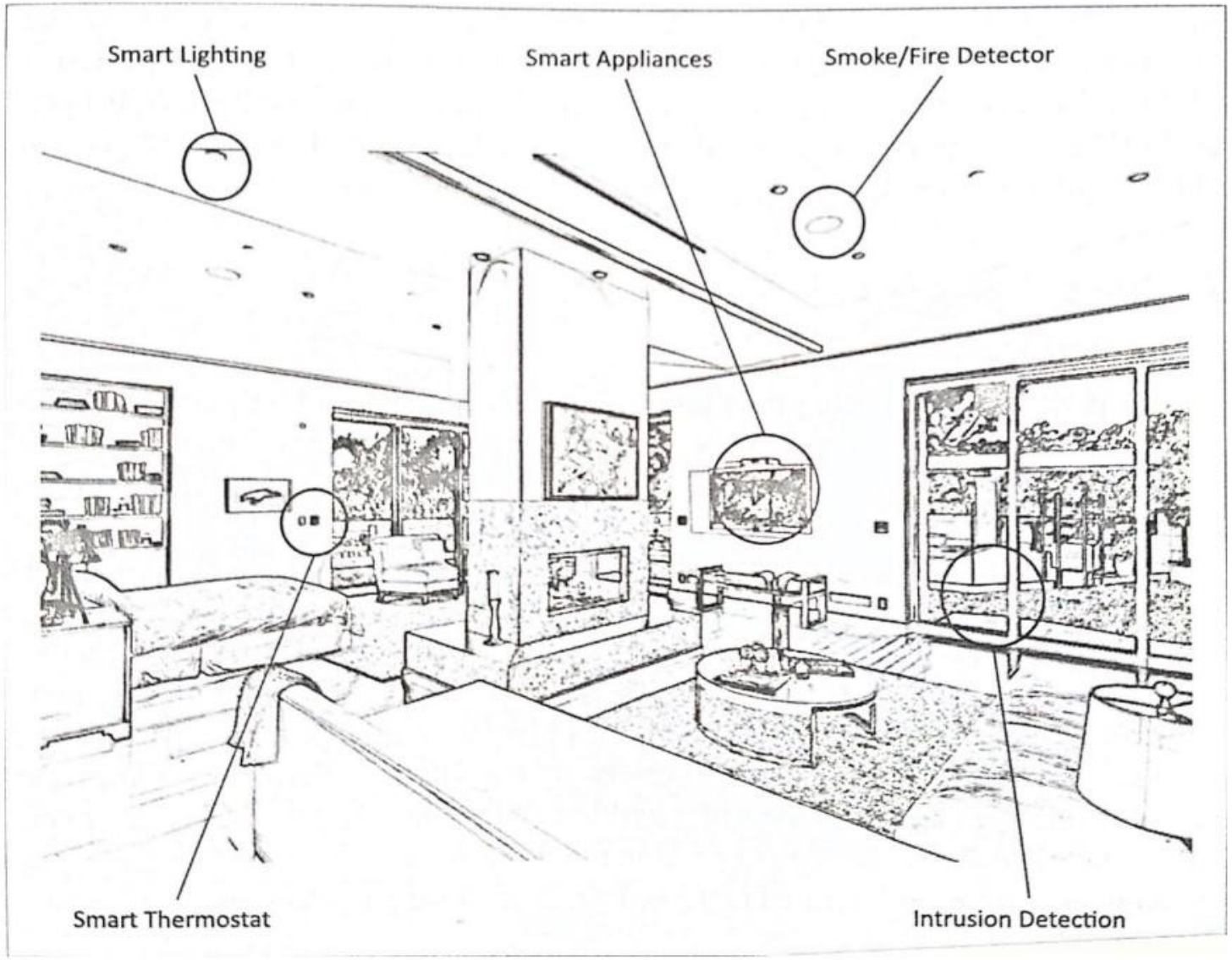
- Introduction
- Home Automation
- Cities
- Environment
- Energy
- Retail
- Logistics
- Agriculture
- Industry
- Health & Lifestyle

Introduction – Applications of IoT



Home Automation

- ❑ Smart Lighting
- ❑ Smart Appliances
- ❑ Intrusion Detection
- ❑ Smoke/Gas Detectors



Home Automation

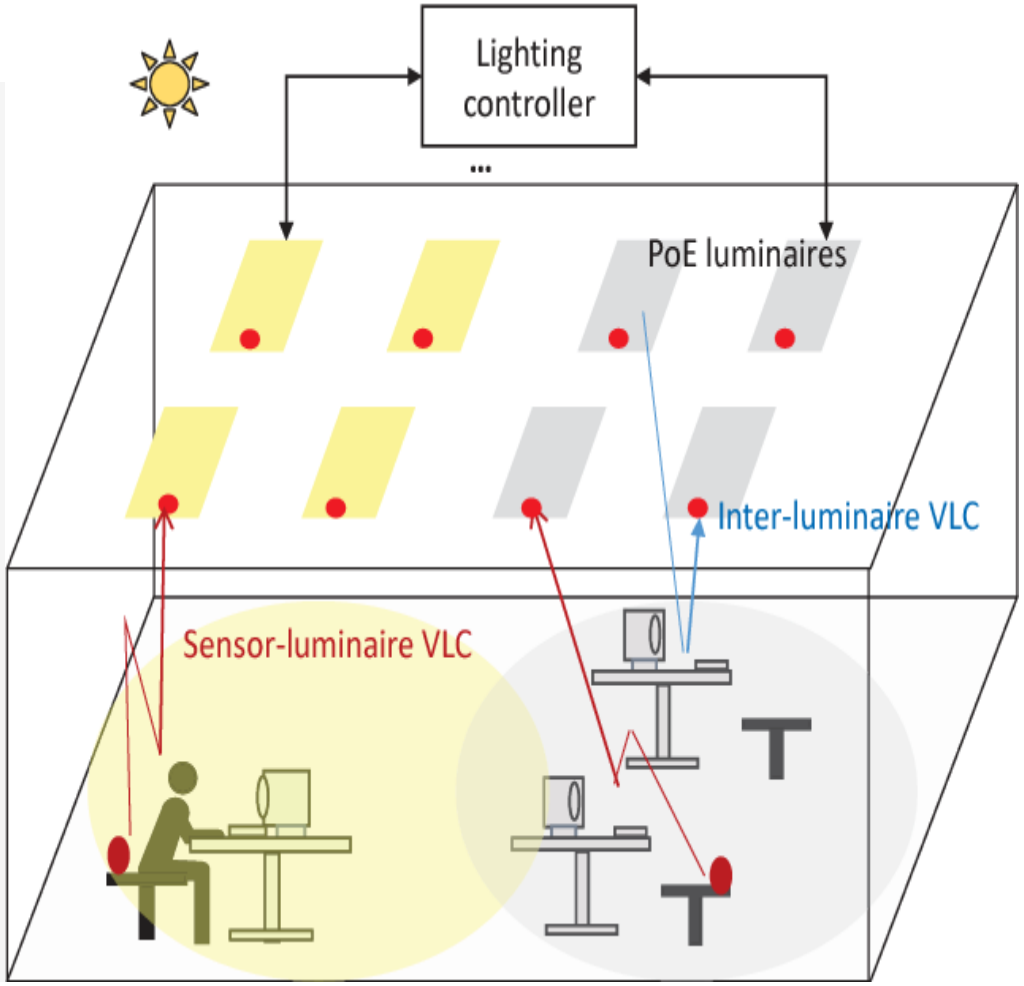
❑ Smart Lighting

- Smart lighting uses IoT-enabled sensors, bulbs, or adapters to allow users to **manage their home or office lighting with their smartphone** or **smart home management platform**. Smart lighting solutions can be controlled through an external device to control lighting **remotely** like smartphone or web applications, set to operate on a schedule, or triggered by sound or motion.

- smart lighting for homes helps in **saving energy** by adapting the lighting to the ambient conditions and switching on/off or dimming the light when needed.

Home Automation

- Smart Lighting



Home Automation

❑ Smart Appliances

- Modern homes have a number of appliances such as TVs, refrigerators, music systems, washers/dryers, etc.
- Managing and controlling these appliances can be difficult, with each appliance having its own controls or remote controls.
- Smart appliances **make management easier and also provide status information to the users remotely**.
- For example, smart washers/dryers that can be controlled remotely and notified when the washing/drying cycle is complete. Smart thermostats allow controlling the temperature remotely and can learn the user preferences.

Home Automation

❑ Smart Appliances

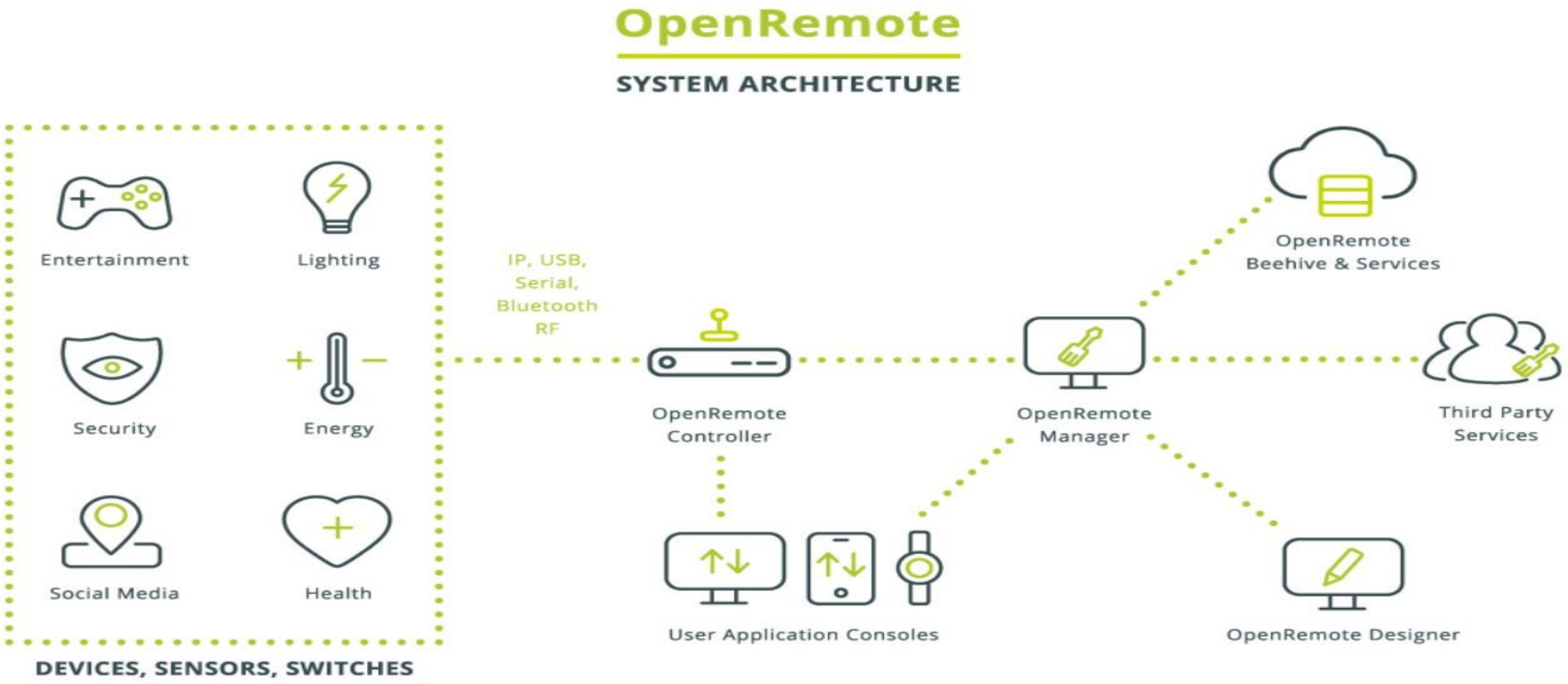
- OpenRemote is an **open-source automation platform** for homes and buildings.
- User with OpenRemot can control various appliances using mobile or web applications.

- OpenRemot comprises three components, **Controller**, **Designer**, and **control panels**.

- **Controller**, manages scheduling and runtime integration between devices.
- **Designer**, allows you to create both configurations for the controller and create user interface designs.
- **Control panels**, allow you to interact with devices and control them.

Home Automation

- Smart Appliances



Home Automation

❑ Intrusion Detection

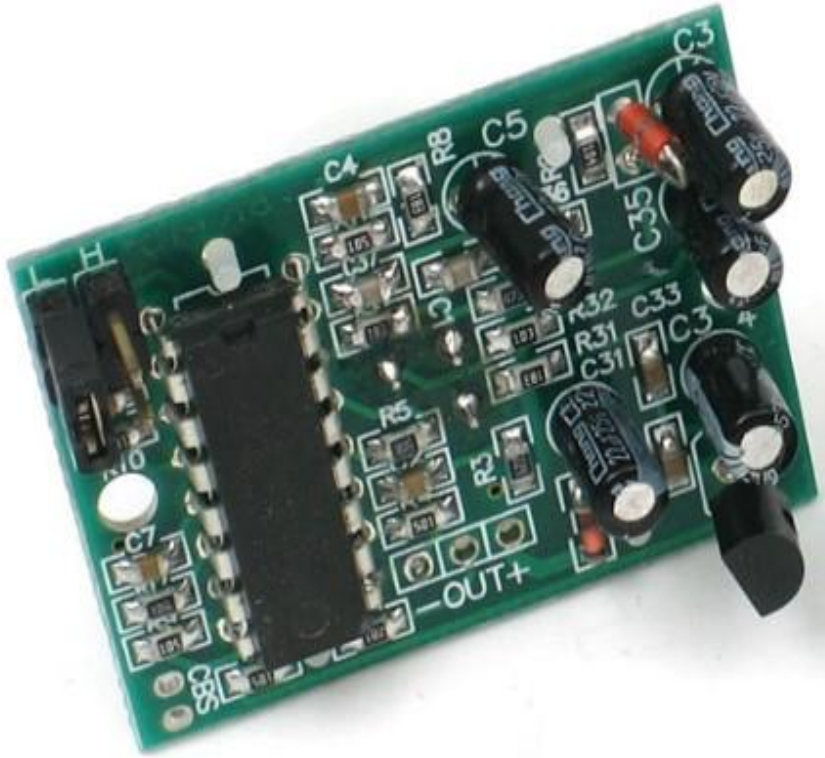
- Home Intrusion Detection systems use security **cameras** and **sensors** such as **passive infrared sensor** (**PIR** sensor) and door sensors to detect intrusion and raise alerts. Alerts can be in the form of SMS or email sent to the user.

- **PIR sensors** allow you to sense motion, almost always used to detect whether a human has moved in or out of the sensors range.
- They are small, ***inexpensive***, ***low-power***, ***easy* to use**. For that reason they are commonly found in appliances and tool used in homes or businesses.

Home Automation

- passive infrared sensor (PIR sensor)

- Advanced system can even send detailed alerts such as **image grab** or a **short video** sent as an **email** attachment.



Home Automation

- door sensors

IoT Based Door Alarm

Home Automation

❑ Smoke/Gas Detectors

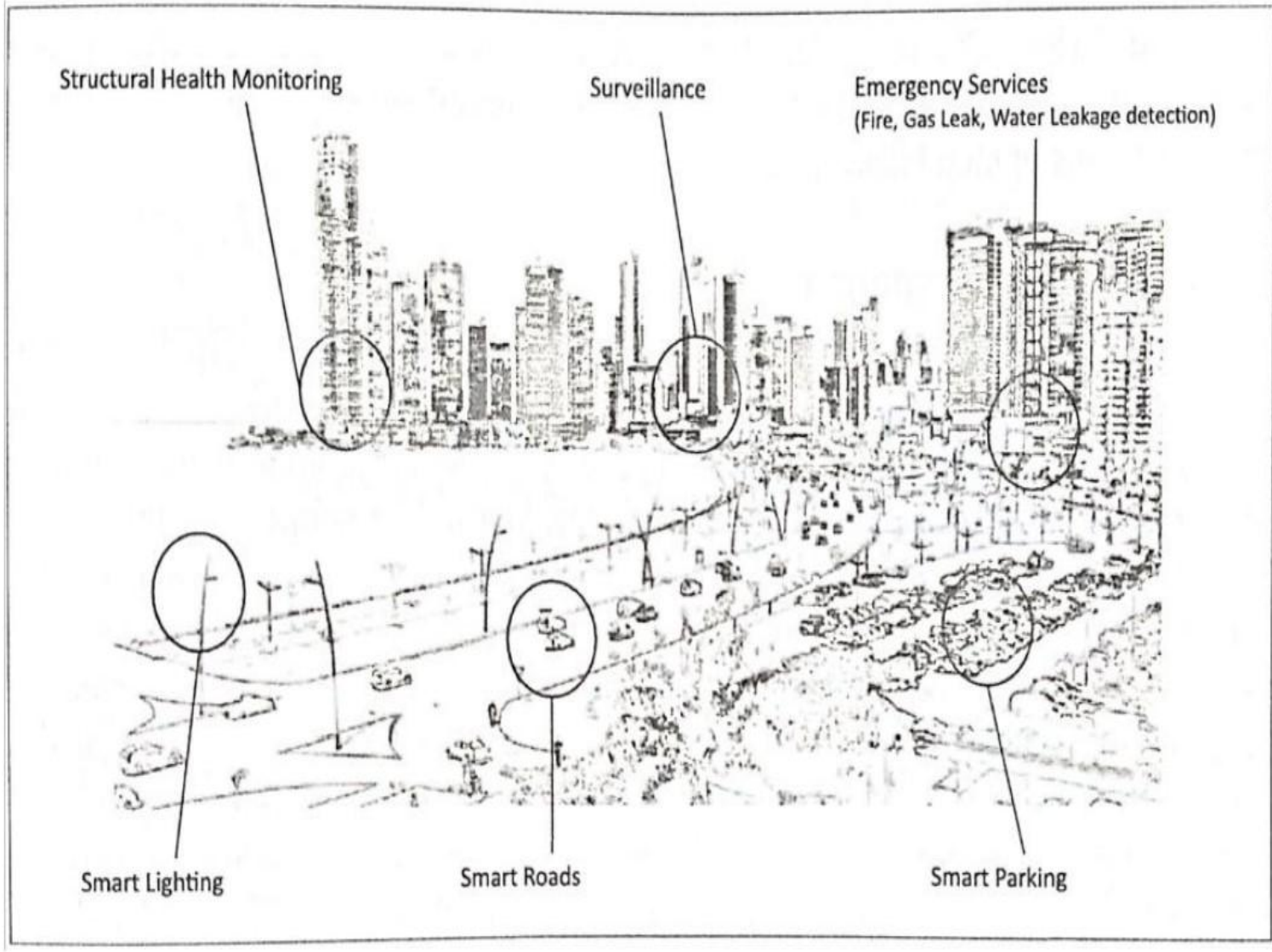
- ***Smoke detectors*** are installed in homes and buildings to detect smoke that is typically an **early sign of fire**. **Alerts** raised by smoke detectors can be in the form of signals to a fire **alarm system**. ***Gas detectors*** can detect the presence of **harmful gases** such as CO, LPG, etc.
- **Smoke detectors** Use **optical detection**, **ionization**, or **air sampling** techniques to detect the smoke.
- **Gas detectors** can detect harmful gases such as Carbon monoxide (CO), Liquid petroleum gas (LPG).
- It can raise alerts in human voice describing where the problem is, send an SMS or email to the user or local fire safety department.

Home Automation

- Smoke/Gas Detectors

Cities

- Smart Parking
- Smart Lighting
- Smart Roads
- Structural Health Monitoring
- Surveillance
- Emergency Response



Cities

❑ Smart Parking

- make the **search for parking space easier** and more convenient for drivers.
- Smart parking is powered by IoT systems that **detect the number of empty parking slots** and send information over the internet to smart applications.
- These applications can be **accessed** by drivers from **smartphones**, **tablets**, and **in-car navigation systems**.

Cities

❑ Smart Parking

- **Sensors** in smart parking are **used for each parking slot**, to detect whether the slot is **empty** or **occupied**.

- The **information** that got from sensors is aggregated by a local **controller** and then **sent** over the internet to the **database**.

Cities

- **Smart Lighting** for roads, parks, and buildings can help in saving energy.
- **Smart Roads** equipped with sensors can **provide information on driving conditions**, **travel time estimates**, and **alerts in case of poor driving conditions**, **traffic conditions**, and **accidents**.
- **Structural Health Monitoring** uses a network of sensors to monitor the **vibration levels** in the **structures** such as **bridges** and **buildings**.
  - The data **collected** from these sensors is analyzed to assess the health of the structures.
  - **Analyzing** the data it is possible to **detect cracks** and **mechanical breakdowns**, locate the damages to a structure and also calculate the remaining life of the structure.
  - Using such a system, advance **warnings** can be given in the case of imminent **failure** of the structure.

Cities

❑ Surveillance

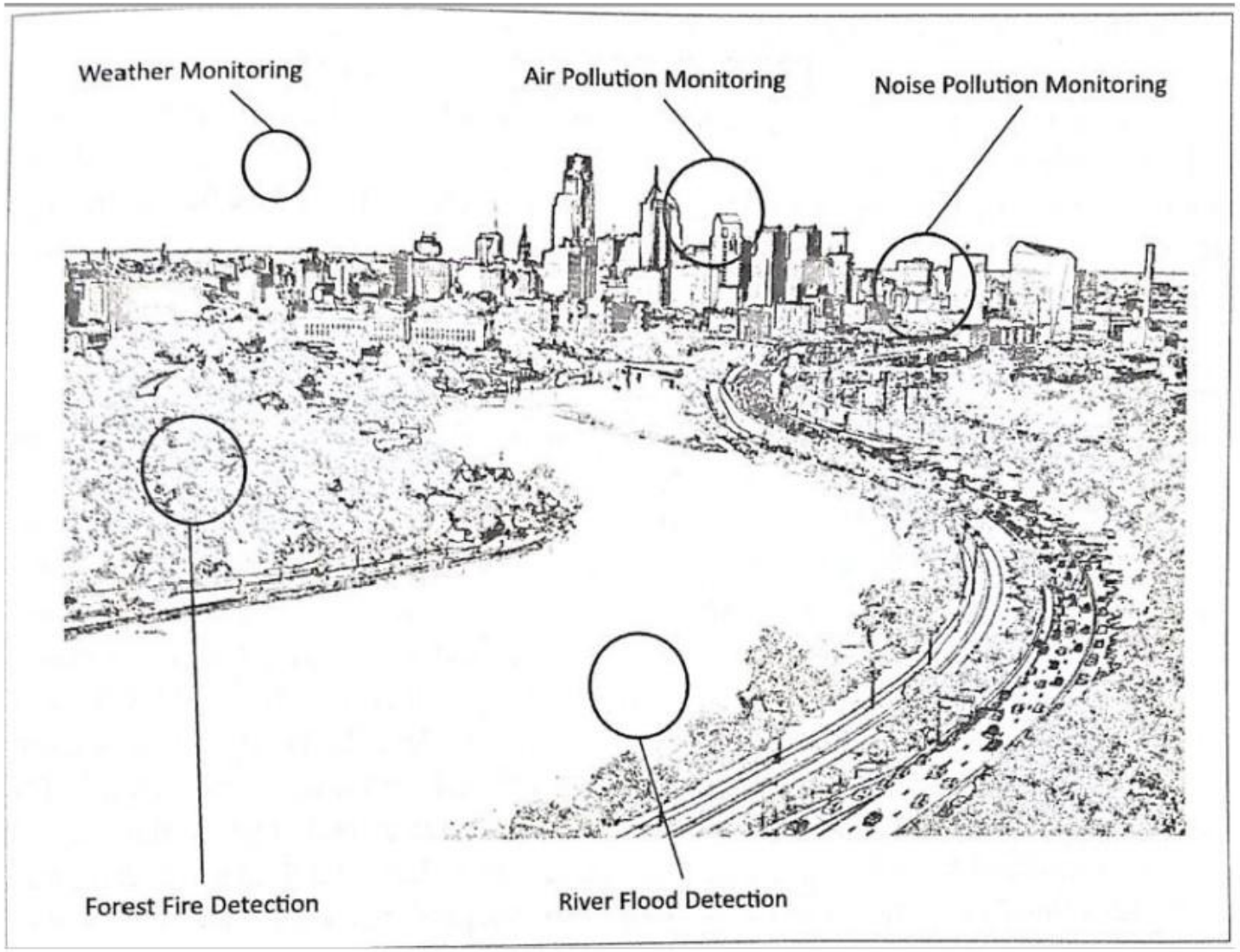
- **Surveillance/monitoring systems** comprise and use a large number of distributed and internet-connected **video surveillance cameras**.
- The **video** feeds from surveillance cameras can be **aggregated** in the **cloud-based scalable storage** solution.
- **Cloud-based video analytics applications** can be developed to search for patterns or specific events from the video feeds.

❑ Emergency Response

IoT systems for **fire** detection, **gas**, and **water leak** detection can help in **generating alerts and minimizing their effects** on critical infrastructures.

Environment

- **Weather** Monitoring
- **Air Pollution** Monitoring
- **Noise Pollution** Monitoring
- **Forest Fire** Detection
- **River Floods** Detection

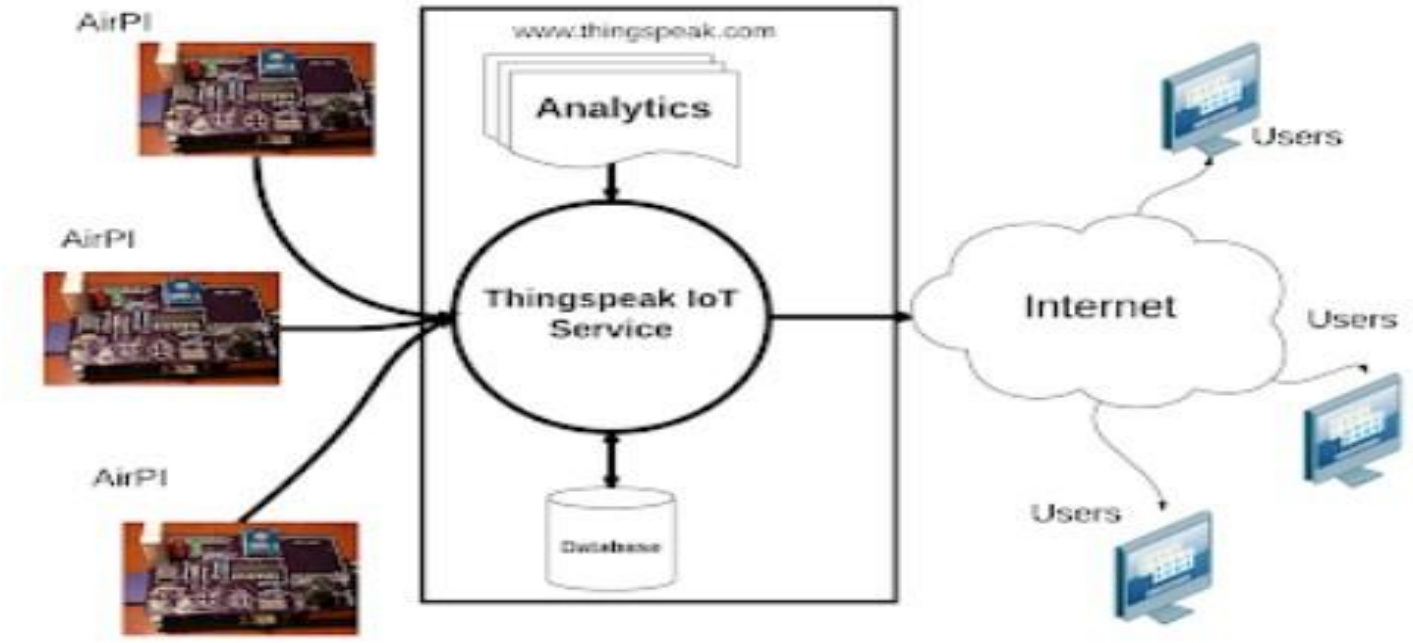


Environment

❑ Weather Monitoring

Systems **collect** data from a number of **sensors** attached (temperature, humidity, pressure, etc.) and **send** the data to **cloud-based applications and storage**. The data collected in the cloud can then be **analyzed** and visualized by **cloud-based applications**.

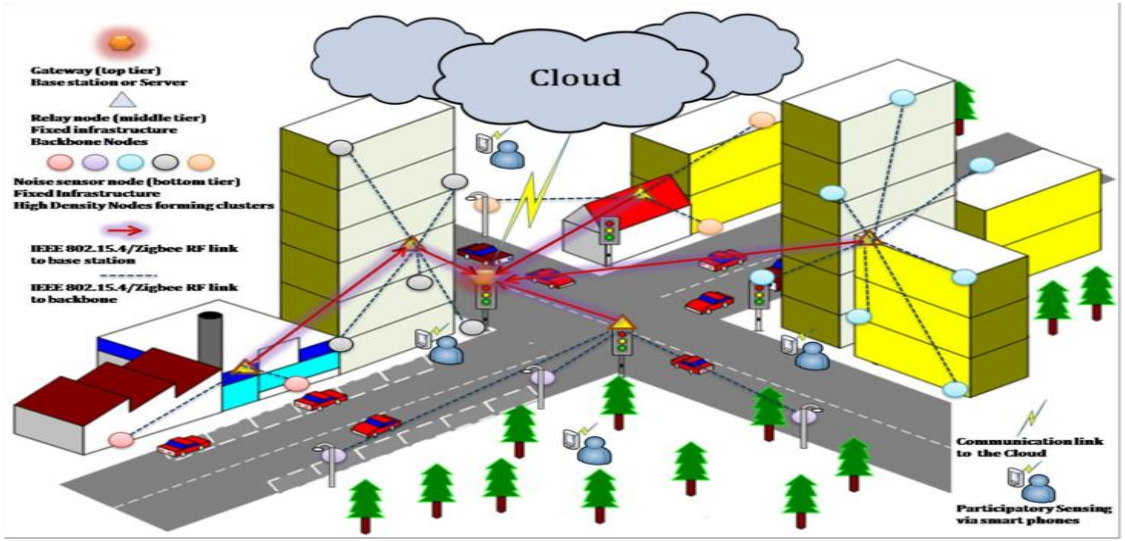
AirPi: is **open-source** weather and pollution **monitoring system**, with the ability to **record** and **stream** data.



Environment

- **Air Pollution Monitoring:** IoT-based air Pollution Monitoring Systems can **monitor the emission of harmful gases**(CO2, CO, NO, NO2, etc.,) by **factories** and **automobiles** using gaseous and meteorological sensors. The collected data can be analyzed to make informed decisions on pollutions control approaches.

- **Noise Pollution Monitoring:** Due to **growing urban** development, **noise levels** in cities have **increased** and even become alarmingly high in some cities. IoT-based noise pollution monitoring systems use a number of noise monitoring systems that are deployed at different places in a city. The **data** on noise levels from the station is **collected** on **servers** or in the **cloud**. The **collected data** is then **aggregated** to **generate** noise **maps**.



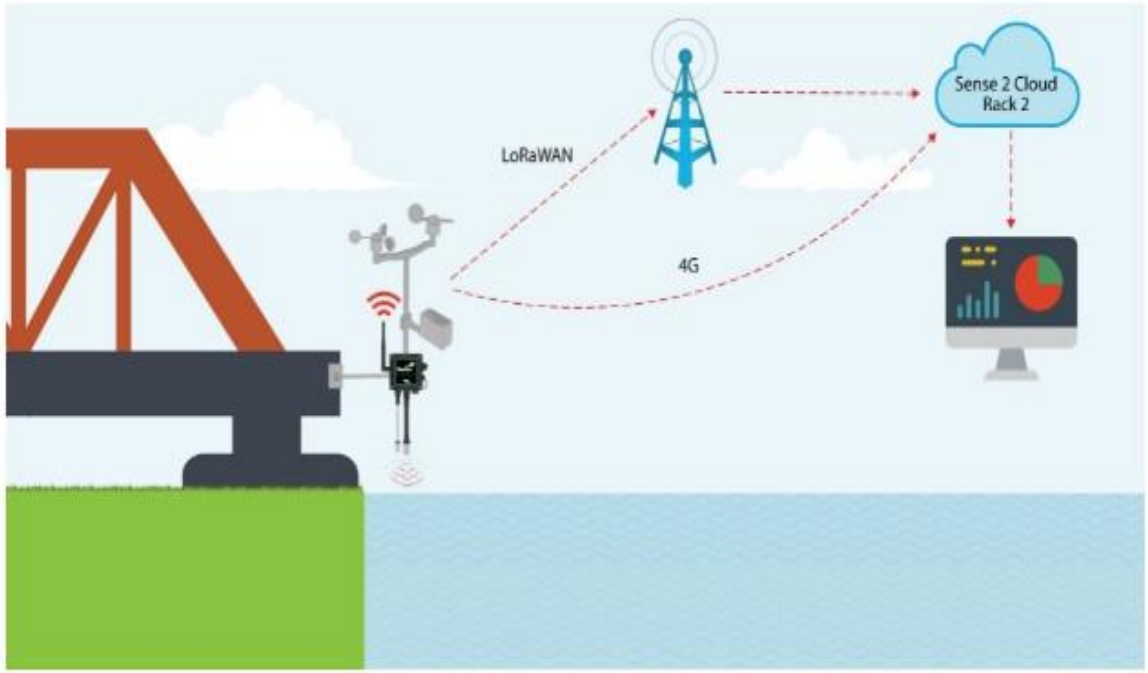
Environment

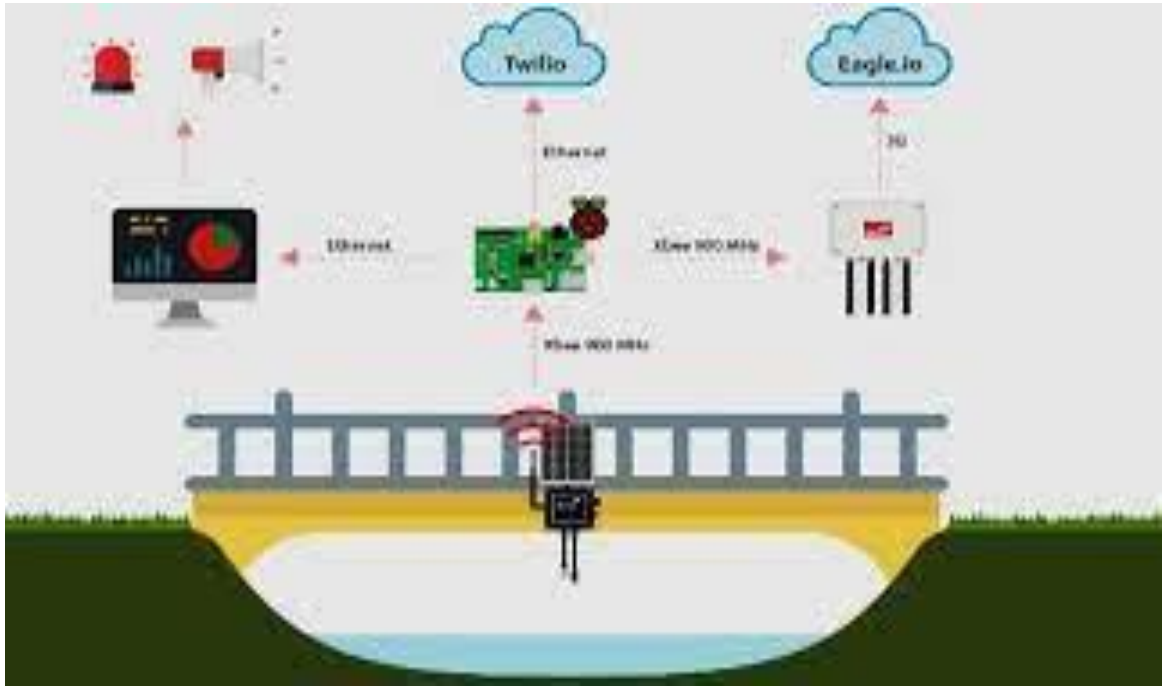
- **Forest Fire Detection:** A forest fire can **cause damage** to natural resources, property, and human life. Early detection of a forest fire can help in **minimizing damage**.

- IoT-based forest fire detection system uses a number of monitoring nodes deployed at different locations in a forest.
- Each monitoring node **collects measurements** on surroundings conditions including temperature, humidity, light level, etc.
- the system uses **multi-criteria detection** which is implemented by **the artificial neural network(ANN).**
- The (**ANN**) integrate sensing data corresponding to **multiple attributes** of a forest fire (such as temperature, humidity, infrared and visible light) to **detect forest fires**.

Environment

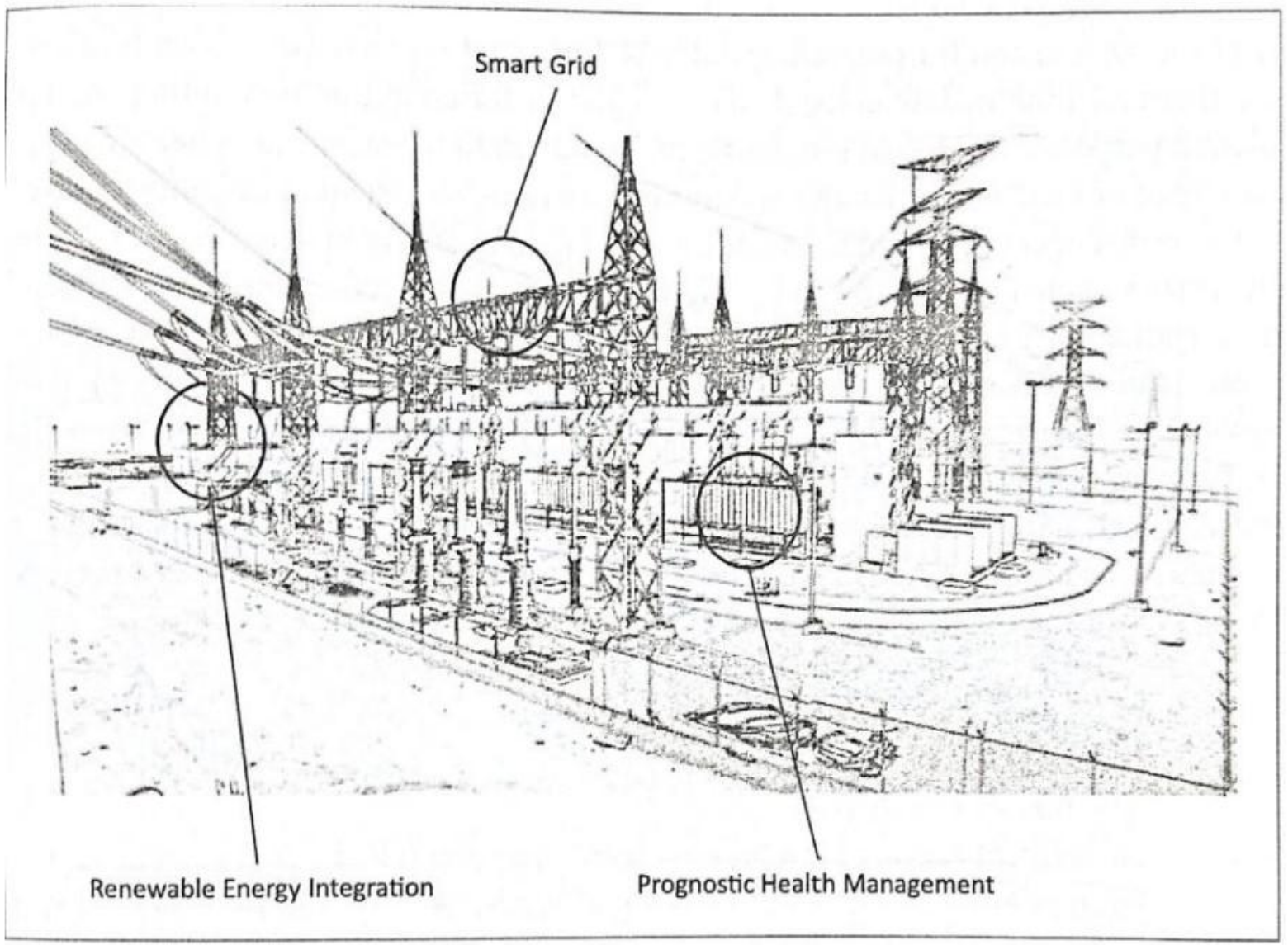
- **River Floods Detection:** River floods can cause damage to natural and human resources and human life. Early warnings of floods can be given by monitoring **the water level and flow rate**. IoT-based river flood monitoring system uses a number of sensor nodes that **monitor the water level** and **flow rate sensors**.





Energy

- Smart Grids
- Renewable Energy Systems
- Prognostics



Energy

❑ Smart Grids

data communication network integrated with the **electrical grids** that collect and analyze data captured in near-real-time about **power transmission**, **distribution**, and **consumption**. **Smart grid technology** *provides* **predictive information** and **recommendations** to utilities, their suppliers, and their customers on **how best to manage power**. By using IoT-based sensing and measurement technologies, the health of equipment and the integrity of the grid can be evaluated.

❑ Renewable Energy Systems

IoT-based systems integrated with the **transformers** at the point of interconnection **measure the electrical variables and how much power is fed into the grid**. For wind energy systems, closed-loop controls can be used to regulate the voltage at the point of interconnection which **coordinates wind turbine outputs and provides power support**.

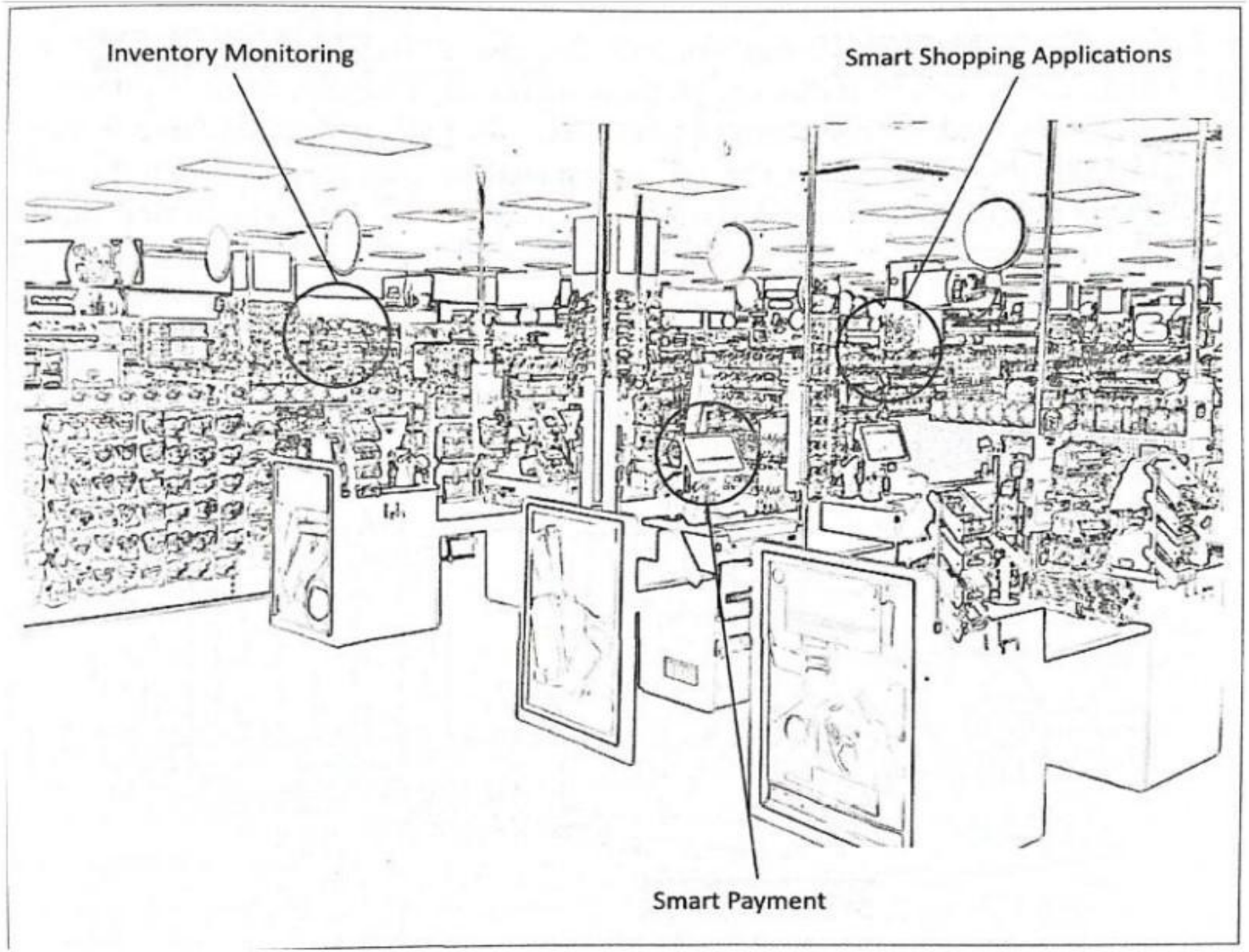
Energy

❑ Prognostics

In systems such as power grids, real-time information is collected using specialized electrical **sensors** called **Phasor Measurement Units (PMUs)** at the substations. The information received from PMUs must be monitored in real-time **for estimating the state of the system and for predicting failures**.

Retail

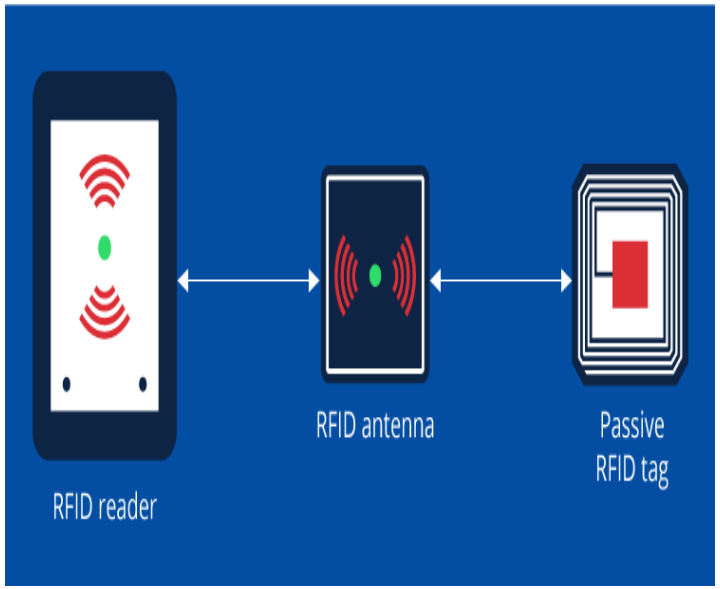
- **Inventory** Management
- Smart **Payments**
- Smart **Vending Machines**

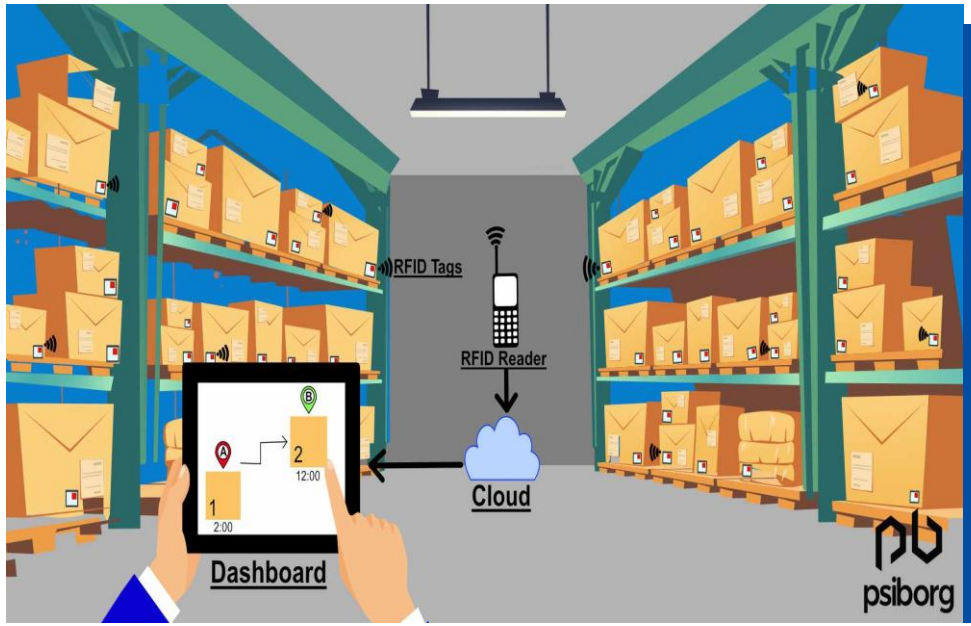


Retail

❑ Inventory Management

IoT systems enable **remote monitoring** of inventory using **data collected** by Radio Frequency Identification (**RFID**) readers. **RFID tags** attached to the **products** allow them to be **tracked** in real-time so that **the inventory levels can be determined accurately and products that are low on stock can be filled up again**.





Retail

❑ Smart Payments

Solutions such as contactless payments powered by technologies such as **Near Field Communication(NFC)** and **Bluetooth**. NFC is a set of standards for smartphones and other devices to communicate with each other by bringing them into proximity or by touching them.

Retail

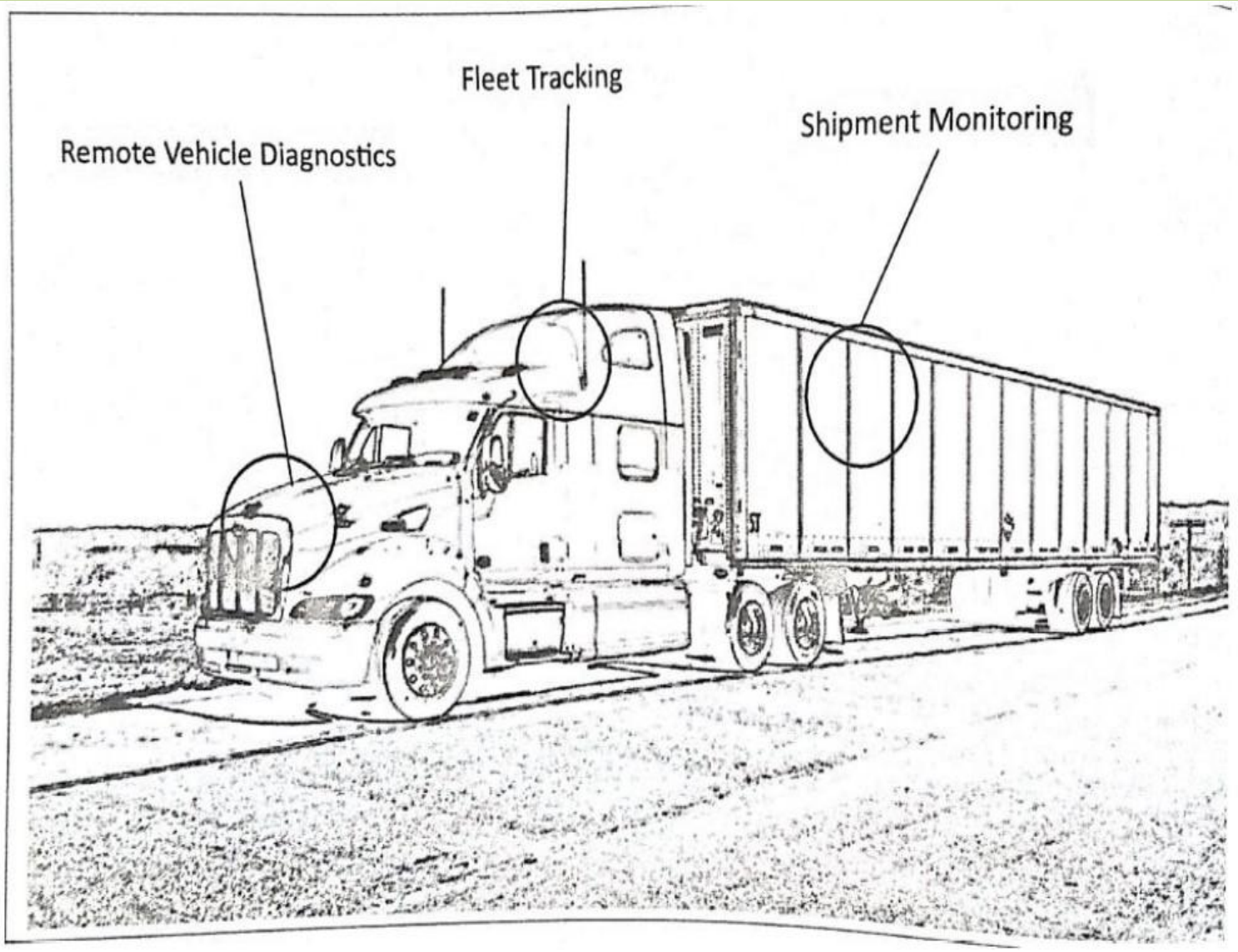
❑ Smart Vending Machines

Sensors in smart vending machines **monitor their operations** and **send** the **data** to the **cloud** which can be used for **predictive maintenance**.

- Allow **remote monitoring** of **inventory** levels
- Flexible **pricing** of products.
- Contact-less payment using **NFC**
- The information of **inventory** levels
- The information of the **nearest machine** in case a product goes out of **stock** in a machine

Logistics

- Route generation & Scheduling
- Fleet Tracking
- Shipment Monitoring
- Remote Vehicle Diagnostics



Logistics

- **Route generation & scheduling**
  - IoT-based system backed by the cloud can provide the **first response** to the **route generation queries** and can be **scaled up** to serve a **large transportation network**.
  - Generate **end-to-end routes** using a combination of **route patterns**

- **Fleet Tracking**
  - Use **GPS** to track the locations of vehicles in real time.
  - Track the locations of the vehicles in real-time
  - **Generate alerts** for deviations (changing) in planned routes

Logistics

❑ Shipment Monitoring

IoT-based shipment monitoring systems use sensors such as temp, humidity, to monitor the conditions and send data to the cloud, where it can be analyzed to **detect food damage**.

- Monitoring the conditions **inside** containers
- Using sensors (temperature, pressure, humidity)
- Detecting food damage.

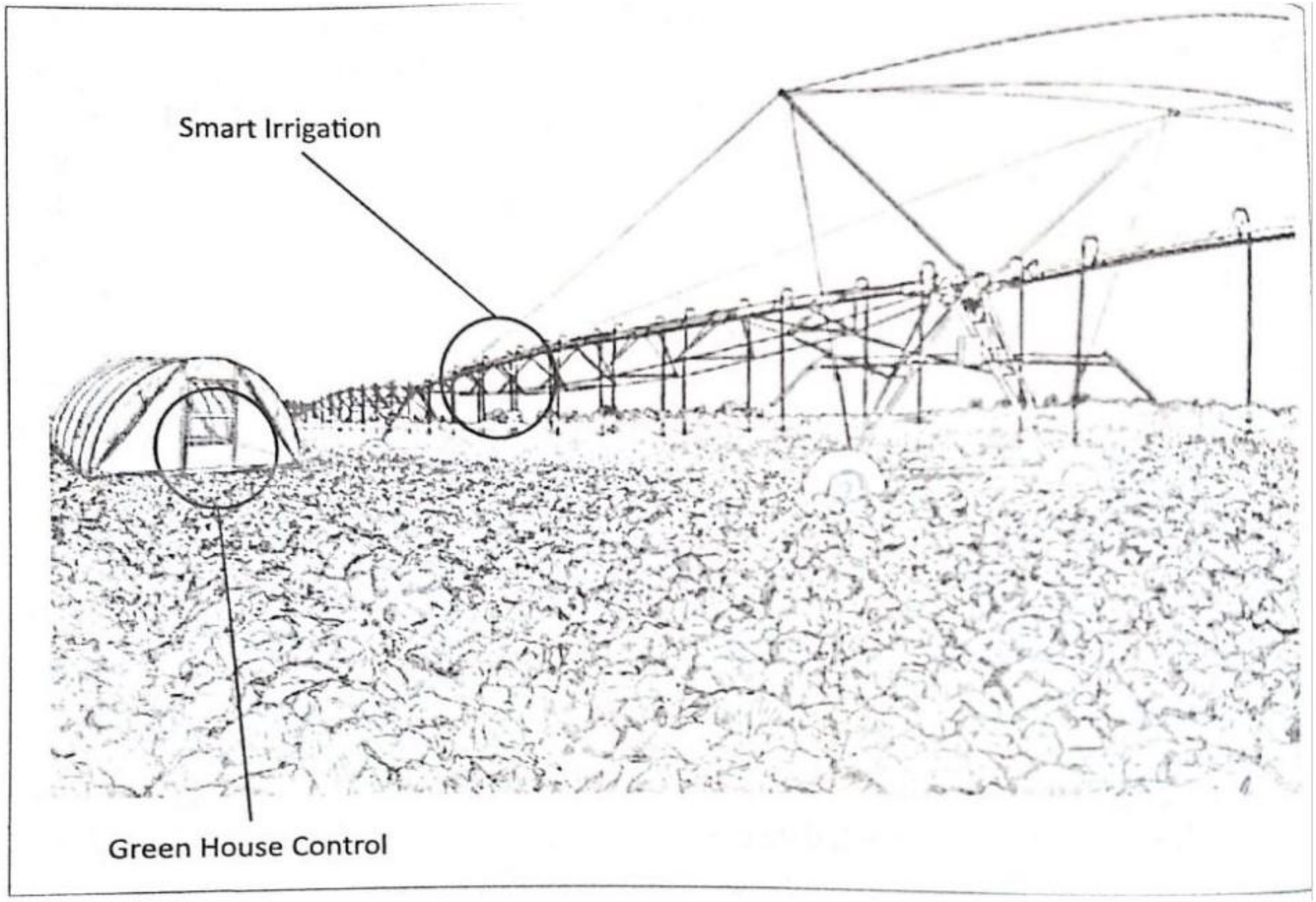
❑ Remote Vehicle Diagnostics

Systems use onboard IoT devices for collecting data on Vehicle operations and the status of various vehicle subsystems.

- **Detect problems** in the vehicle
- **Warn** of impending problems
- IoT **collects the data** on vehicle (speed, engine revolutions per minute (RPM), coolant temperature).
- **Generate alerts** and suggest repairer.

Agriculture

- **Smart Irrigation**
- **Green House Control**



Agriculture

❑ Smart Irrigation

• Use sensors to **determine the amount of humidity** in the soil and release the flow of water through the irrigation pipes only when the moisture levels go below a predefined threshold.

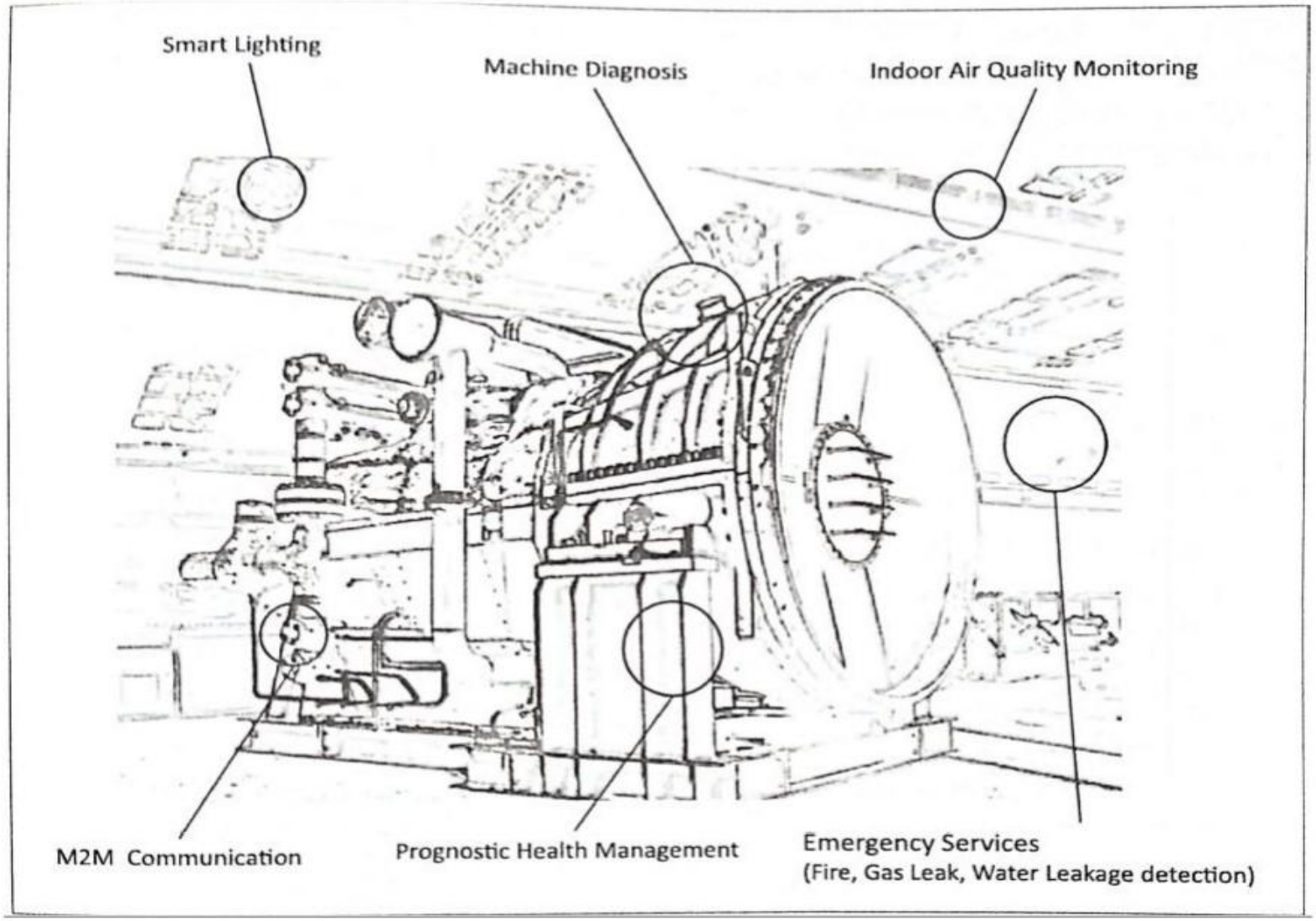
- Water Scheduling

❑ Green House Control

- Automatically **control the climatologic conditions** inside a greenhouse
  - Using several sensors to monitor (temperature, humidity, soil moisture)
  - Using actuation devices to control such as (Valves for releasing water and switches for controlling fans)
- Maintenance of agricultural production to improve productivity.

Industry

- **Machine diagnosis and prognosis**
- **Indoor Air Quality Monitoring**



Industry

❑ Machine diagnosis and prognosis

- Sensors in machine **monitor the operating conditions**
  - For example: temperature & vibration levels
- Collecting and analyzing massive scale machine sensor data
  - For reliability analysis and problem prediction in machines

❑ Indoor Air Quality Monitoring

- Use various gas sensors
  - To monitor the harmful and toxic gases *(CO, NO, NO_2,* etc.)
- Measure the environmental parameters to determine the indoor air quality
  - Temperature, humidity, gaseous pollutants, aerosol

Health & Lifestyle

- **Health & Fitness Monitoring**
- **Wearable electronic**

Health & Lifestyle

❑ Health & Fitness Monitoring

- **Collect the healthcare data**

  Using some sensors: body temperature, heart rate, movement (with accelerometers), etc.

- Various forms: belts and wrist-bands

Health & Lifestyle

❑ Wearable electronic

- Assists the daily activities
  - Smartwatch
  - Smart shoes
  - Smart wristbands

Acknowledgment

- **These lecture slides are based on:**

1) **Chapter 2 (P 54 -73)** from the book “Internet of Things A Hands-On Approach” by Arshdeep Bahga, Vijay Madisetti (z-lib.org)

INTERNET OF THINGS (IoT)

END OF LECTURE 6

Keep connected with the classroom

qzc4you

THANK YOU FOR YOUR ATTENTION