Unit I

DOMAIN SPECIFIC IoTs

2.1 Introduction

2.2 Home Automation

2.3 Cities

2.4 Environment

2.5 Energy

2.6 Retail

2.7Logistics

2.8Agriculture

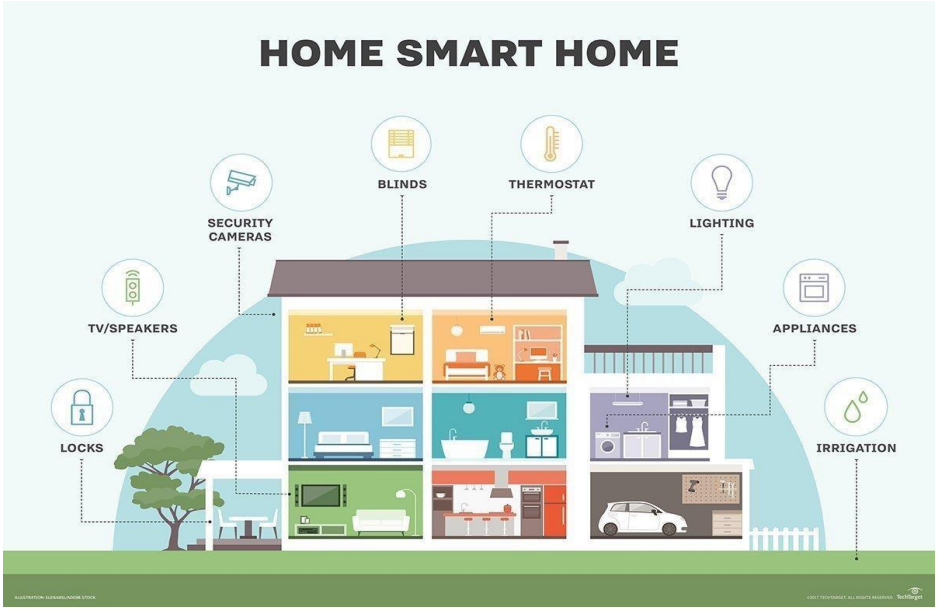
2.9 Industry

2.10 Health & Lifestyle

2.1 Introduction

The Internet of Things (IoT) applications span a wide range of domains Home Automation Cities Environment, Energy, Retail, Logistics, Agriculture, Industry and Health & Lifestyle.

2.1 HOME AUTOMATION



2.1.1 Smart Lighting

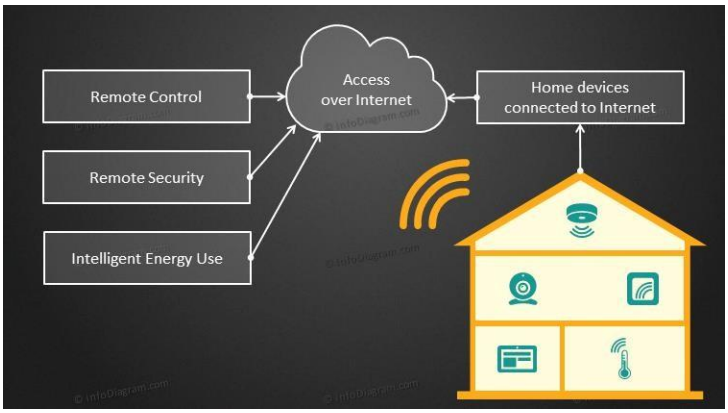
It helps in saving energy by adapting the lighting to the ambient conditions and switching on/off or diming the light when needed. Key enabling technologies for smart lighting include

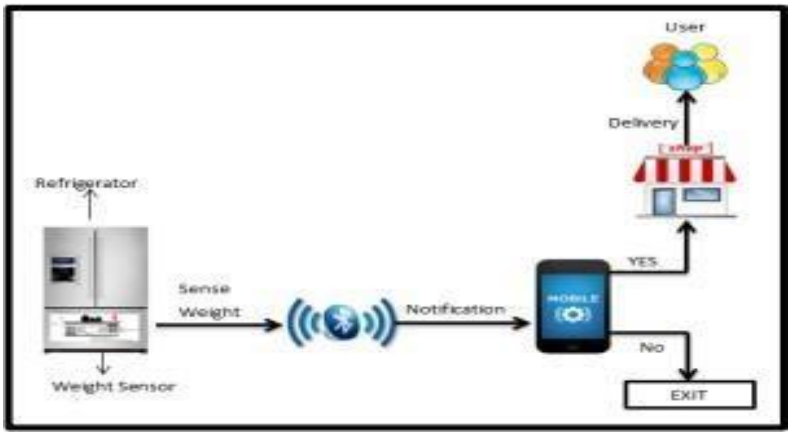
solid state lighting(such as LEDs and IP enabled lights. Smart lightning solutions for home achieve energy savings by sensing the human movements and their environments and controlling the lights accordingly. Wireless enabled and Internet connected lights can be controlled remotely from IoT applications such as mobile or web applications

2.1.2 Smart Appliances

Make the management easier and also provide status information to the users remotely.

- Smart appliances make the management easier and provide status information of appliances to the users remotely. ***E.g:*** smart washer/dryer that can be controlled remotely and notify when the washing/drying cycle is complete.
- ***OpenRemote*** is an open source automation platform for smart home and building that can control various appliances using mobile and web applications.
- It comprises of three components:
  - a Controller → manages scheduling and runtime integration between devices.
  - a Designer → allows to create both configuration for the controller and user interface designs.
  - Control Panel → allows to interact with devices and control them.





2.1.3 Intrusion Detection

It use security cameras and sensors(PIR sensors and door sensors) to detect intrusion and raise alerts. Alerts can be in the form of SMS or email sent to the user.

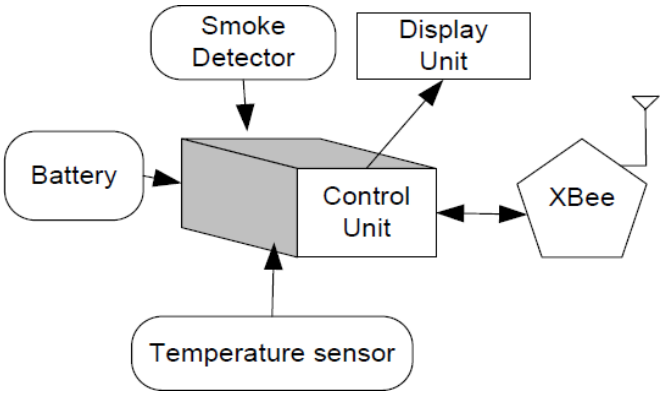
- Home intrusion detection systems use *security cameras* and *sensors* to detect intrusions and raise alerts.
- The form of the alerts can be in form:
  - *SMS*
  - *Email*
  - *Image grab or a short video clip as an email attachment*

Home Network Routers:

All the Internet connected devices in homes these days, the network router continues to be by far the most targeted in attacks . "Most Internet routers that are keystone to our home network are riddled with security issues, which make them easy picking for hackers. Most routers worldwide had default or basic username and password combinations, like "admin" and "password" while others have they user address, birthday or name as password. Because of this, most routers are vulnerable to simple password attacks, which is basically an open invitation to malicious hackers.

2.1.4-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 detector detects the smoke in the home and it sends signal to the control unit that displays the smoke unit in display section and temperature sensor mentioned above gives the temperature of the room and signals are send through IoT to main controller just to control some activities of room



2.2 CITIES

3.2.1 Smart Parking

To make the search for parking space easier and convenient for drivers. Smart parking are powered by IoT systems that detect the no. of empty parking slots and send information over internet to smart application backends. Smart parking management system can be used to find the vacant location for a vehicle at different public places.

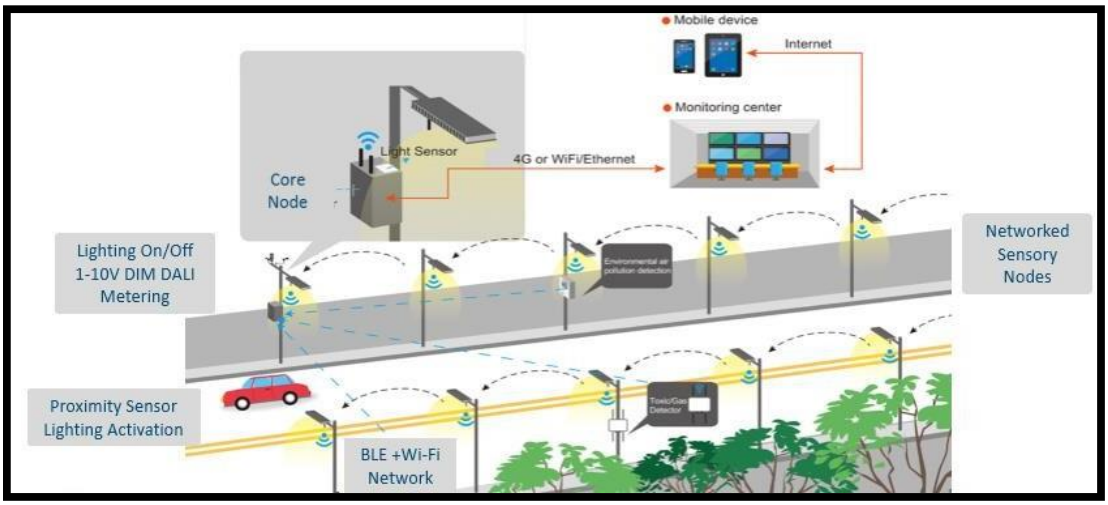
Smart Parking's In-Ground Vehicle Detection Sensors are core technologies, playing a key part in the Smart Parking solution that is revolutionizing how drivers in the malls and city centers can find an available parking space. Wireless sensors are embedded into parking spaces, transmitting data on the timing and duration of the space used via local signal processors into a central parking management application. Smart Parking reduces congestion, decreases vehicle emissions, lowers enforcement costs and cuts driver stress. For effective deployment of smart parking technologies, each device needs to have a reliable connectivity with the cloud servers.

2.2.2 Smart Lighting

It is for roads, parks and buildings can help in saving energy. With smart lighting, city authorities can keep real-time tracking of lighting to ensure optimized illumination and deliver demand-based lighting in different zones. Smart lighting also helps in daylight harvesting and save energy by dimming out sectors with no occupancies For e.g. parking lots can be dimmed during work hours and when a car is entering, it will be detected and appropriate sectors can be illuminated, while others can be kept at diffused setting.

2.2.3 Smart Roads:

Equipped with sensors can provide information on driving condition, travel time estimating and alert in case of poor driving conditions, traffic condition and accidents. Such information can help in making the roads safer and help in reducing traffic jams. Information sensed from the roads can be communicated via Internet to cloud applications and social media and disseminated to the drivers who subscribe to such applications.

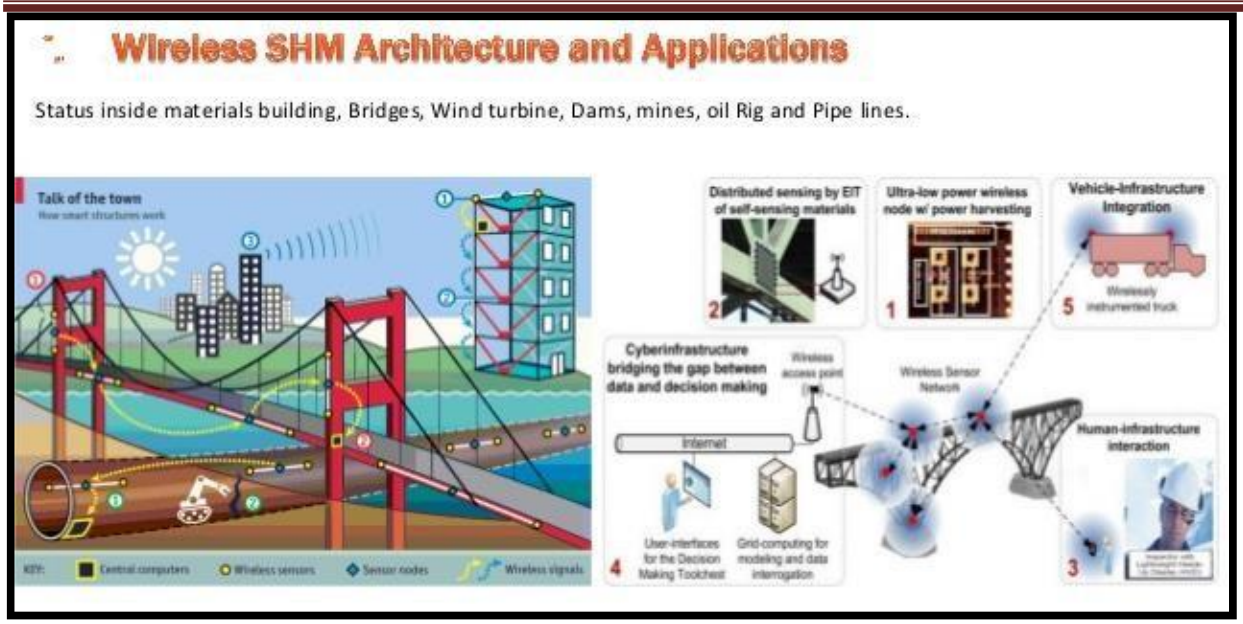


2.2.4 Structural Health Monitoring:

It 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.

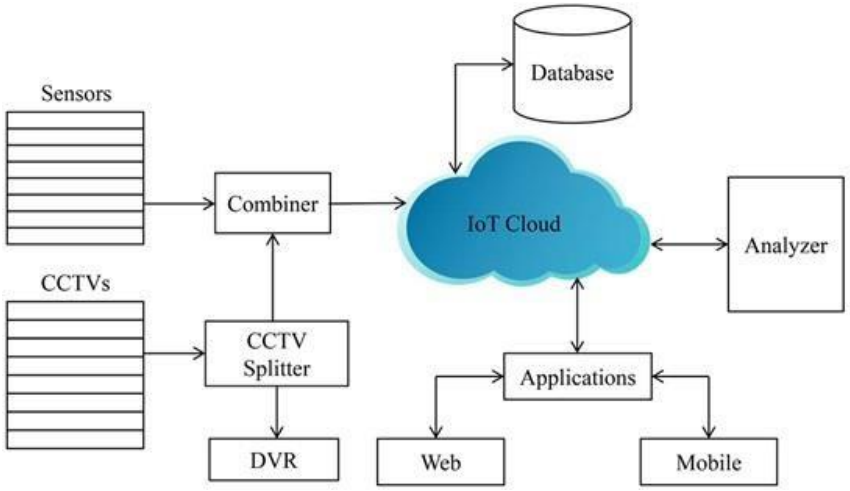
• By analyzing the data it is possible to detect cracks and mechanical breakdowns, locate the damages to a structure and also calculate the remaining life of the structure.

• Using such systems, advance warnings can be given in the case of imminent failure of the structure.



2.2.5 Surveillance

The video feeds from surveillance cameras can be aggregated in cloud based scalable storage solution. The video feeds from surveillance cameras can be aggregated in cloud-based scalable storage solutions.



• Cloud-based video analytics applications can be developed to search for patterns of specific events from the video feeds.

2.2.6 Emergency Response:

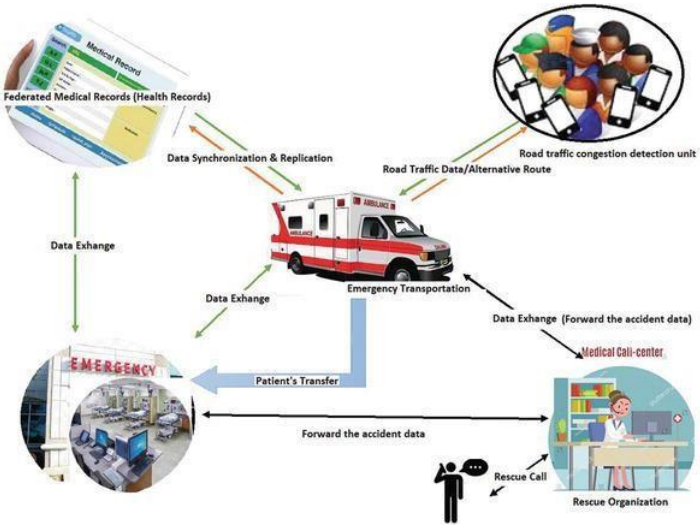
IoT systems for fire detection, gas and water leakage detection can help in generating alerts and minimizing their effects on the critical infrastructures. IoT systems can be used for monitoring the critical infrastructure cities such as buildings, gas, and water pipelines, public transport and power substations.

• IoT systems for critical infrastructure monitoring enable aggregation and sharing of information collected from lager number of sensors.

Using cloud-based architectures, multi-modal information such as sensor data, audio, video feeds can be analyzed in near real-time to detect adverse events.

• The alert can be in the form :

- Alerts sent to the public
- Re-rerouting of traffic
- Evacuations of the affected areas



2.3 ENVIRONMENT:

2.3.1 Weather Monitoring:

Systems collect data from a no. of sensors attached and send the data to cloud based applications and storage back ends. The data collected in cloud can then be analyzed and visualized by cloud based applications.

Weather alert can be sent to the subscribed users from such applications.

• AirPi is a weather and air quality monitoring kit capable of recording and uploading information about temperature, humidity, air pressure, light levels, UV levels, carbon monoxide, nitrogen dioxide and smoke

level to the Internet.

2.3.2 Air Pollution Monitoring:

System can monitor 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.

2.3.3 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 no. 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. It uses a number of noise monitoring stations that are deployed at different places in a city.• The data on noise levels from the stations is collected on servers or in the cloud and then the collected data is aggregate to generate noise maps.

2.3.4 Forest Fire Detection:

Forest fire can cause damage to natural resources, property and human life. Early detection of forest fire can help in minimizing damage. IoT based forest fire detection system use a number of monitoring nodes deployed at different location in a forest.

• Each monitoring node collects measurements on ambient condition including temperature, humidity, light levels, etc.• Early detection of forest fires can help in minimizing the damage.

2.3.5 River Flood 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 no. of sensor nodes that monitor the water level and flow rate

sensors. IoT based river flood monitoring system uses a number of sensor nodes that monitor the water level using ultrasonic sensors and flow rate using velocity sensors.

• Data from these sensors is aggregated in a server or in the cloud, monitoring applications raise alerts when rapid increase in water level and flow rate is detected.

2.4 ENERGY:

2.4.1 Smart Grids:

It is a data communication network integrated with the electrical grids that collects 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 integrity of the grid can be evaluated.

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• Smart grid collect the data regarding:

- Electricity generation
- Electricity consumption
- Storage
- Distribution and equipment health data

• By analyzing the data on power generation, transmission and consumption of smart grids can improve efficiency throughout the electric system.

• Storage collection and analysis of smarts grids data in the cloud can help in dynamic optimization of system operations, maintenance, and planning.

• Cloud-based monitoring of smart grids data can improve energy usage usage levels via energy feedback to users coupled with real-time pricing information.

• Condition monitoring data collected from power generation and transmission systems can help in detecting faults and predicting outages.

2.4.2Renewable 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 point of interconnection which coordinate wind turbine outputs and provides power support. Due to the variability in the output from renewable energy sources (such as solar and wind), integrating them into the grid can cause grid stability and reliability problems.

• IoT based systems integrated with the transformer at the point of interconnection measure the electrical variables and how much power is fed into the grid

• To ensure the grid stability, one solution is to simply cut off the overproductions

2.4.3 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 informationreceived from PMUs must be monitored in real-time for estimating the state of the system andfor predicting failures. IoT based prognostic real-time health management systems can predictperformance of machines of energy systems by analyzing the extent of deviation of a system from its normal operating profiles.

• In the system such as power grids, real time information is collected using specialized electrical sensors called Phasor Measurement Units (PMU)

• Analyzing massive amounts of maintenance data collected from sensors in energy systems and equipment can provide predictions for impending failures.

• OpenPDC is a set of applications for processing of streaming time-series data collected from Phasor Measurements Units (PMUs) in real-time.

2.5 RETAIL

2.5.1Inventory Management:

IoT systems enable remote monitoring of inventory using data collected by RFID readers. IoT system using Radio Frequency Identification (RFID) tags can help inventory management and maintaining the right inventory levels.

• RFID tags attached to the products allow them to be tracked in the real-time so that the inventory levels can be determined accurately and products which are low on stock can be replenished.

• Tracking can be done using RFID readers attached to the retail store shelves or in the warehouse.

2.5.2Smart Payments:

Solutions such as contact-less payments powered by technologies such as Near Field Communication(NFC) and Bluetooth.

• Smart payments solutions such as contact-less payments powered technologies such as Near field communication (NFC) and Bluetooth.

• NFC is a set of standards for smart-phones and other devices to communicate with each other by bringing them into proximity or by touching them

• Customer can store the credit card information in their NFC-enabled smart-phones and make payments by bringing the smart-phone near the point of sale terminals.

• NFC maybe used in combination with Bluetooth, where NFC initiates initial pairing of devices to establish a Bluetooth connection while the actual data transfer takes place over Bluetooth.

2.5.3Smart Vending Machines:

Sensors in a smart vending machines monitors its operations and send the data to cloud which can be used for predictive maintenance.

Smart vending machines connected to the Internet allow remote monitoring of inventory levels, elastic pricing of products, promotions, and contact-less payments using NFC.

• Smart-phone applications that communicate with smart vending machines allow user preferences to be remembered and learned with time. E.g: when a user moves from one vending machine to the other and

pair the smart-phone, the user preference and favorite product will be saved and then that datais used for predictive maintenance.

• Smart vending machines can have communicated each other, so if a product out of stock in amachine, the user can be routed to nearest machine

• For perishable items, the smart vending machines can reduce the price as the expiry date nears.

2.6 LOGISTICS

2.6.1Route generation & scheduling:

IoT based system backed by cloud can provide first response to the route generation queries and can be scaled upto serve a large transportation network. Route generation and scheduling systems can generate end to end routes using combination of route patterns and transportation modes and feasible schedules based on the availability of vehicles IoT based system backed by cloud can provide first response to the route generation queries and can be scaled upto serve a large transportation network

2.6.2 Fleet Tracking:

Use GPS to track locations of vehicles inreal-time.

Vehicle fleet tracking systems use GPS technology to track the locations of the vehicles in the real- time.

• Cloud-based fleet tracking systems can be scaled up on demand to handle large number of vehicles,

• The vehicle locations and routers data can be aggregated and analyzed for detecting bottlenecks in the supply chain such as traffic congestions on routes, assignments and generation of alternative routes, and supply chain optimization

GPS to track locations of vehicles in real-time. Some of the main features that the modern Fleet Manager in the fleet tracking system are: route optimization, increased productivity, driver & vehicle safety and time management

3 types of fleet tracking systems.

i) Cellular
ii) wireless passive
iii) satellite.

2.6.3 Shipment Monitoring:

IoT based shipment monitoring systems use sensors such as temp, humidity, to monitor the conditions and send data to cloud, where it can be analyzed to detect food spoilage. Shipment monitoring solutions for transportation systems allow monitoring the conditions inside containers.

• E.g : Containers carrying fresh food produce can be monitored to prevent spoilage of food. IoT based shipment monitoring systems use sensors such as temperature, pressure, humidity, for

instance, to monitor the conditions inside the containers and send the data to the cloud, where it can be analyzed to detect food spoilage.

2.6.4 Remote Vehicle Diagnostics:

Systems use on-board IoT devices for collecting data on Vehicle operaions(speed, RPMetc.,) and status of various vehicle subsystems. It can detect faults in the vehicles or warn of impending faults.

• These diagnostic systems use on-board IoT devices for collecting data on vehicle operation such as speed, engine RPM, coolent temperature, fault code number and status of various vehicle sub- system.

• Modern commercial vehicles support on-board diagnostic (OBD) standard such as OBD-II

• OBD systems provide real-time data on the status of vehicle sub-systems and diagnostic trouble codes which allow rapidly identifying the faults in the vehicle.

• IoT based vehicle diagnostic systems can send the vehicle data to centralized servers or the cloud where it can be analyzed to generate alerts and suggest remedial actions.

2.7AGRICULTURE

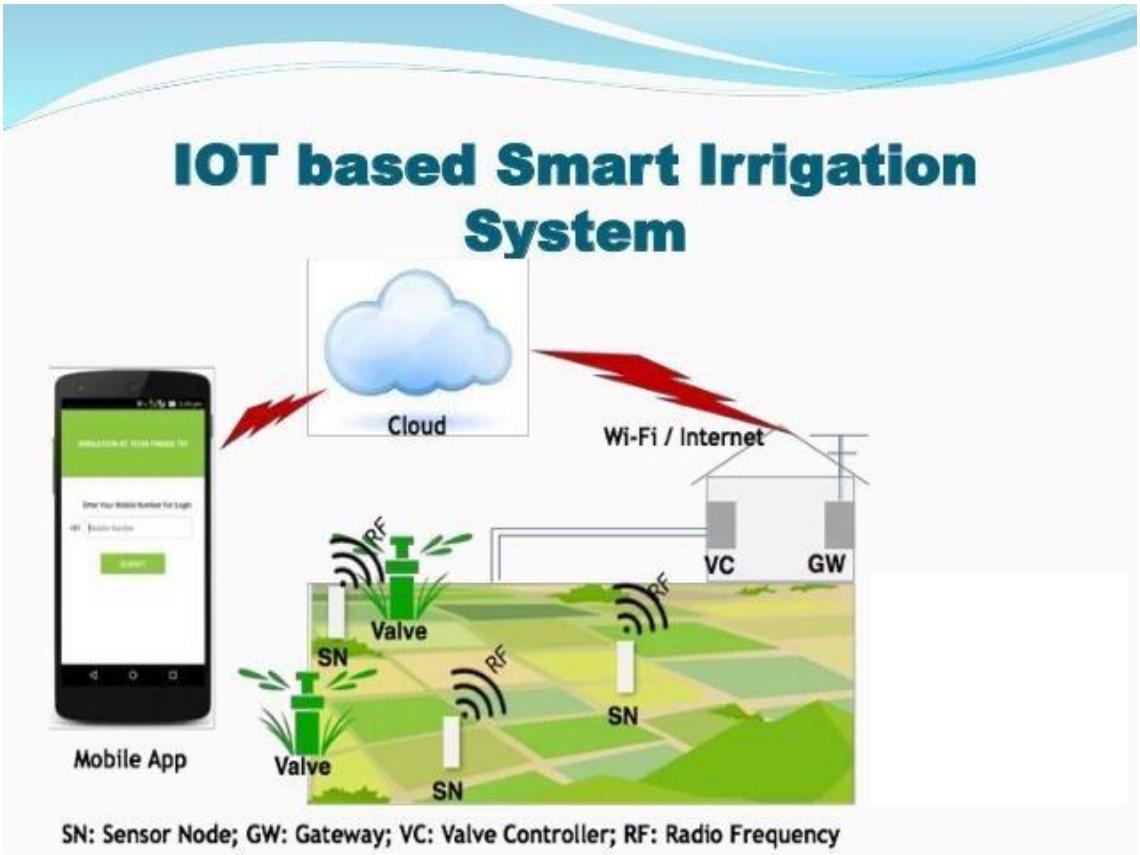
2.7.1 Smart Irrigation

Smart irrigation system can improve crop yields while saving water.

• Smart irrigation systems use IoT devices with soil moisture sensors to determined the amount of moisture on the soil and release the flow of the water through the irrigation pipes only when the moisture levels go below a predefined threshold.

• It also collect moisture level measurements on the server on in the cloud where the collected data can be analyzed to plan watering schedules.

• Cultivar's Rain Could is a device for smart irrigation that uses water valves, soil sensors, and a WiFi enabled programmable computer. To determine moisture amount in soil.



Cultivar's Rain cloud is a device for smart irrigation that uses water valves, soil sensors and a WiFi enabled programmable computer

2.7.2 Green House Control: to improve productivity.

- Green Houses are structure with glass or plastic roofs that provide conducive environment for growth of plants.
- The climatological conditions inside a Green House can be monitored and controlled to provide the best conditions for growth of plants.
- The temperature, humidity, soil moisture, lighten, Carbon-di Oxide levels are monitored using sensors.

• It controls temperature, humidity, soil, moisture, light, and carbon dioxide level that are monitored by sensors and climatological conditions that are controlled automatically using actuation devices.

• IoT systems play an importance role in green house control and help in improving productivity.

• The data collected from various sensors is stored on centralized servers or in the cloud where analysis is performed to optimize the control strategies and also correlate the productivity with different control strategies.