

Unit V-Ubiquitous Clouds and the Internet of Things

Cloud Trends in Supporting Ubiquitous Computing, Performance of Distributed Systems and the Cloud, Enabling Technologies for the Internet of Things (RFID, Sensor Networks and ZigBee Technology, GPS), Innovative Applications of the Internet of Things (Smart Buildings and Smart Power Grid, Retailing and Supply-Chain Management, Cyber-Physical System), Online Social and Professional Networking.

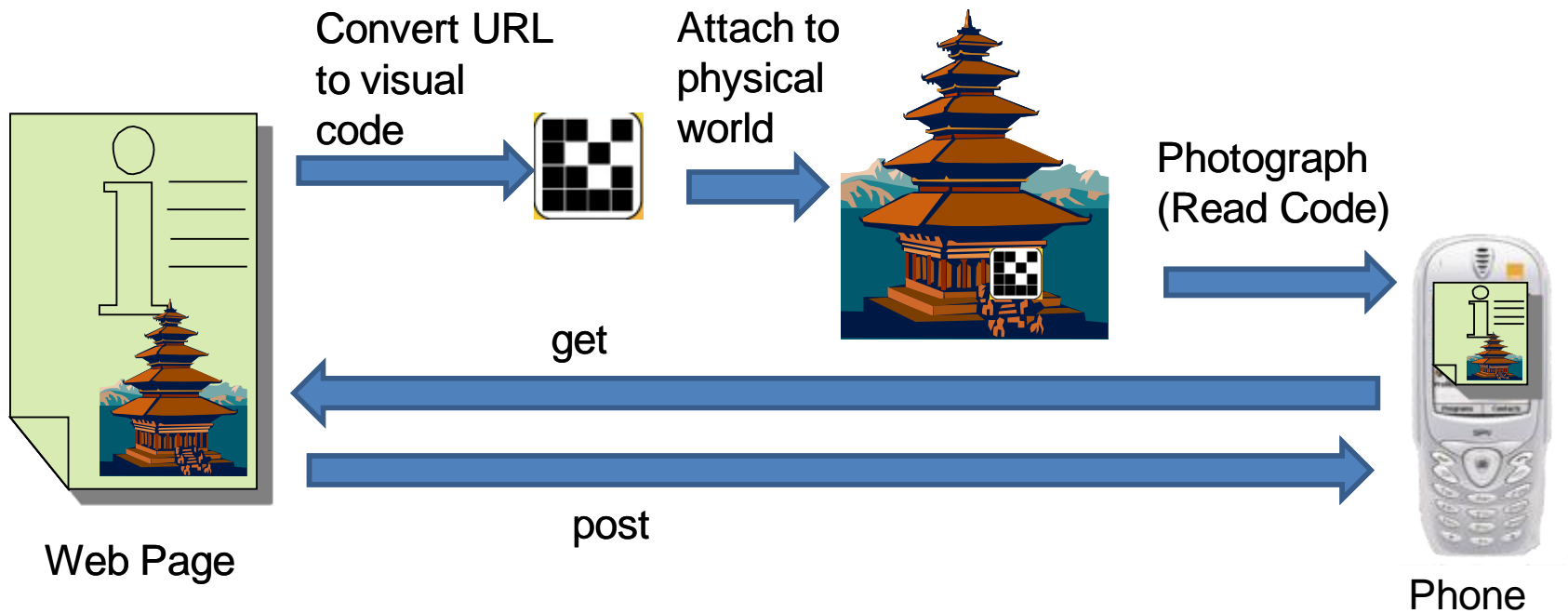
Semacode

- ▶ **Semacode** is a machine-readable **two-dimensional barcode (2D barcode)** designed to store data that can be quickly scanned and interpreted by devices such as mobile phones and RFID readers.
- ▶ It is primarily used for **URL encoding** to enable quick access to web resources without manual typing.
- **QR Code-like Functionality:** Similar to QR codes but specifically optimized for web link encoding.
- **Compact Data Storage:** Uses a **Data Matrix** format to store alphanumeric data efficiently.
- **Fast Scanning & Decoding:** Readable by most modern barcode scanners and smartphones.
- **URL Redirection:** Often used to **embed web links**, enabling instant redirection to online content.

Semacode

- ▶ Can be used in
 - Museum or Tourist Information
 - Wi-Fi Auto-Login
 - Event Ticketing & Access Control
 - Advertising & Marketing
- ▶ Data Matrix encoding ,low data capacity,best for URL,can not customized,low cost of implementation

Semacode



UbiComp Components

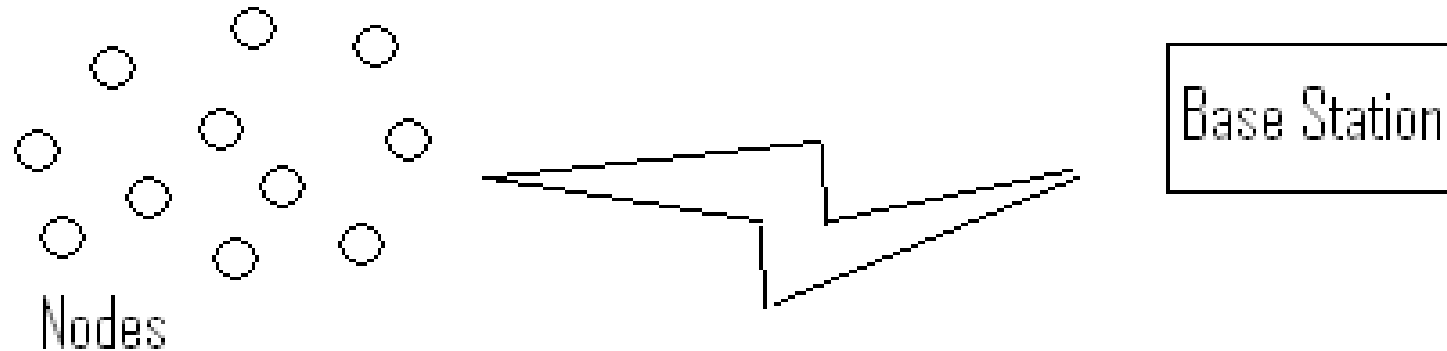
- 1) Hardware Components (Smart Devices & Sensors): Radios
Sensors, Microcontrollers, actuators, edge devices
- 2) Communication & Networking:
 - Wireless Technologies – Wi-Fi, Bluetooth, NFC, Zigbee, LoRaWAN.
 - 5G & IoT Networks – Enables high-speed, low-latency communication.
 - Cloud & Edge Computing – Processes and stores UbiComp data.
- 3) Software & Middleware: Platform Softwares, Application Software
- 4) Human-Computer Interaction (HCI)-
Speech Recognition – Virtual assistants (Siri, Alexa, Google Assistant).
 - Gesture-Based Interfaces – Touchless controls, AR/VR interactions.

Wireless Sensor Networks

- ▶ Wireless sensor networks (WSNs) are usually composed of a large number of sensors, network of spatially **distributed autonomous sensors that collect, process, and transmit data wirelessly.**
- ▶ These networks monitor physical or environmental conditions such as temperature, humidity, pressure, motion, or pollution levels.
- ▶ A MANET is an autonomous system of mobile nodes.
- ▶ self-configuring, decentralized wireless network where mobile devices (nodes) communicate without relying on a fixed infrastructure like routers or base stations.

Wireless Sensor Networks

- ▶ A Wireless Sensor Network (WSN) consists of base stations and a number of wireless sensors (nodes).



Wireless Sensor Networks: Components

▶ Sensor

- A transducer
- converts physical phenomenon e.g. heat, light, motion, vibration, and sound into electrical signals

▶ Sensor node

- basic unit in sensor network
- contains on-board sensors, processor, memory, transceiver, and power supply
- Communicate using Zigbee, Bluetooth, LoRa, Wi-Fi

▶ Sensor network

- consists of a large number of sensor nodes
- nodes deployed either inside or very close to the sensed phenomenon

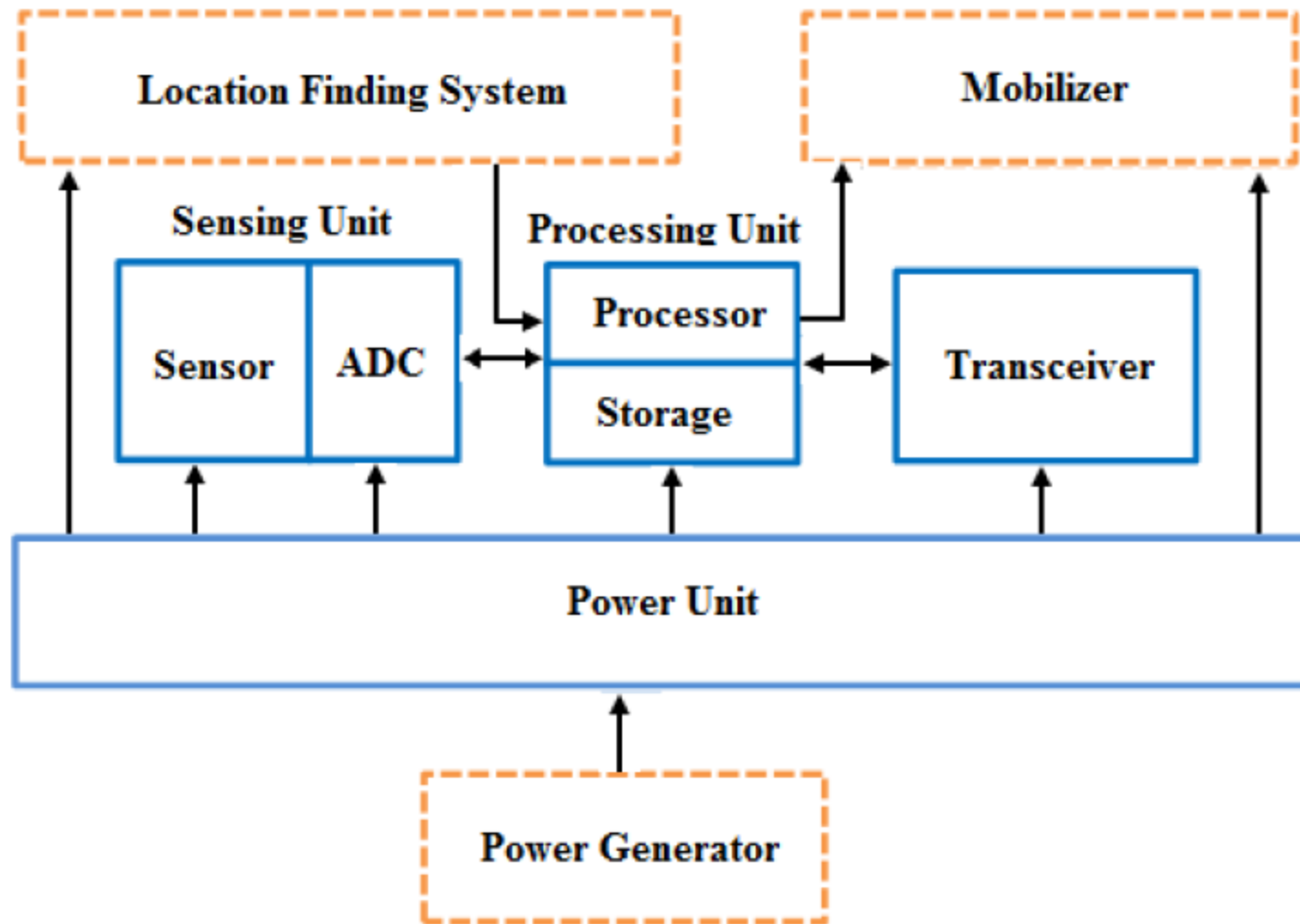
Wireless Sensor Networks: Components

- Base Station (Sink Node/Gateway)
 - Acts as a central hub that gathers data from multiple sensor nodes.
 - Forwards collected data to cloud servers, edge computing devices, or control centers.
 - Often has higher processing power and a stable power source.
- Communication Network
 - Sensor nodes communicate to the base station.
 - Wireless technologies used: Zigbee, LoRaWAN, Wi-Fi, 5G, Bluetooth Low Energy (BLE).

How WSN works?

- ▶ Wireless Sensor Networks is a class of special wireless ad hoc networks.
- ▶ A wireless ad hoc network is a collection of wireless nodes, that communicate directly over a common wireless channel.
- ▶ There is no additional infrastructure needed for ad hoc networks. Therefore, every node is equipped with a wireless transceiver and has to be able to act as a router, to process packets to their destinations.

Components of a typical Sensor Node



Components of a typical Sensor Node

- ▶ **1. Sensing Unit** :The sensing unit is responsible for detecting environmental parameters and converting them into electrical signals.
- ▶ It consists of
 - ▶ Sensors – Measure physical conditions like temperature, humidity, motion, light, gas, pressure, vibration, etc.
 - ▶ Analog-to-Digital Converter (ADC) – Converts analog sensor signals into digital data for processing.
- **DHT11** – Temperature & Humidity Sensor
- **MPU6050** – Accelerometer & Gyroscope Sensor
- **MQ-135** – Air Quality Sensor

Components of a typical Sensor Node

2. Processing Unit: Handles data computation, storage, and communication.

It includes:

- Microcontroller (MCU) or Microprocessor – The "brain" of the node, responsible for processing sensor data and managing network communication.
- Memory (RAM, Flash, EEPROM) – Stores program code, temporary data, and sensor readings.

Components of a typical Sensor Node

3) **Communication Unit**: Enables wireless transmission of data to other sensor nodes or a base station.

It consists of:

- **Wireless Transceiver (Radio Module)** – Sends and receives data over the network.
- **Communication Protocols:**
 - **Zigbee (IEEE 802.15.4)** – Low power, short-range
 - **LoRaWAN** – Long-range, low-power IoT
 - **Wi-Fi (802.11x)** – High-speed, short-range
 - **Bluetooth/BLE** – Short-range, low-power
 - **5G/NB-IoT** – Cellular-based communication

Components of a typical Sensor Node

- 4) **Power Unit** :Provides energy to all components and is crucial for energy efficiency.
- Battery (Primary or Rechargeable) – Lithium-ion (Li-ion), Lithium-polymer (LiPo), Alkaline.
 - Energy Harvesting Modules – Solar panels, piezoelectric, RF energy harvesting for extended node life.
 - Power Management Circuit – Regulates power to different components.

Features of Sensor Nodes

- ▶ Sensors nodes are very close to each other
- ▶ Sensor nodes have local processing capability
- ▶ Sensor nodes can be randomly and rapidly deployed even in places inaccessible for humans
- ▶ Can **reorganize and reconfigure** to maintain connectivity.
- ▶ Sensor nodes can collaboratively work
- ▶ Uses **multi-hop routing** to improve data transmission efficiency.
- ▶ **low Power Consumption**

Sensor Application

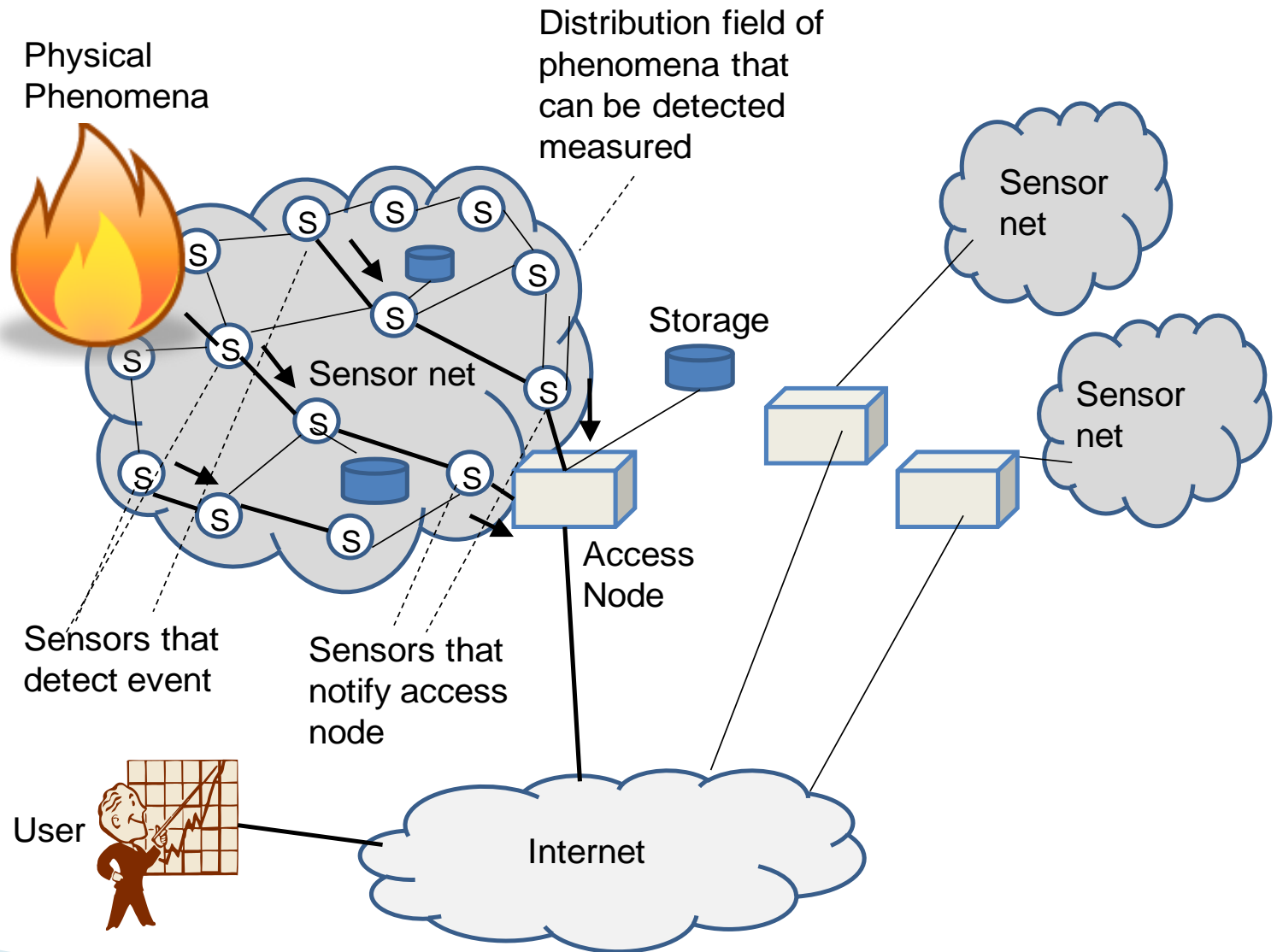
Some examples of sensor use

- ▶ **Cars-Airbag Sensors, Proximity Sensors, Rain Sensors, Tire Pressure Sensors , Temperature Sensors**
- ▶ **Computers-Fingerprint Sensors , Temperature Sensors, Light Sensors**
- ▶ **Retail, logistics:RFID Sensors, Temperature Sensors**
- ▶ **Household tasks-Voice Sensors , Gas & Smoke Sensors, Door & Window Sensors**
- ▶ **Buildings-Water Leak Sensors,**
- ▶ **Environment monitoring-CO2 & PM Sensors**
- ▶ **Industrial sensing & diagnostics-Thermal Sensors**

Sensors

- ▶ Sensors are transducers that convert some physical phenomenon into an electrical signal
- ▶ Wireless sensors:
- ▶ Sensors can be networked – sensor nets
- ▶ A **Sensor Network** (also called a **Wireless Sensor Network (WSN)**) consists of **distributed sensor nodes** that work together to monitor and collect data from the environment. These networks are used in **healthcare, industrial monitoring, smart cities, environmental monitoring, and military applications.**

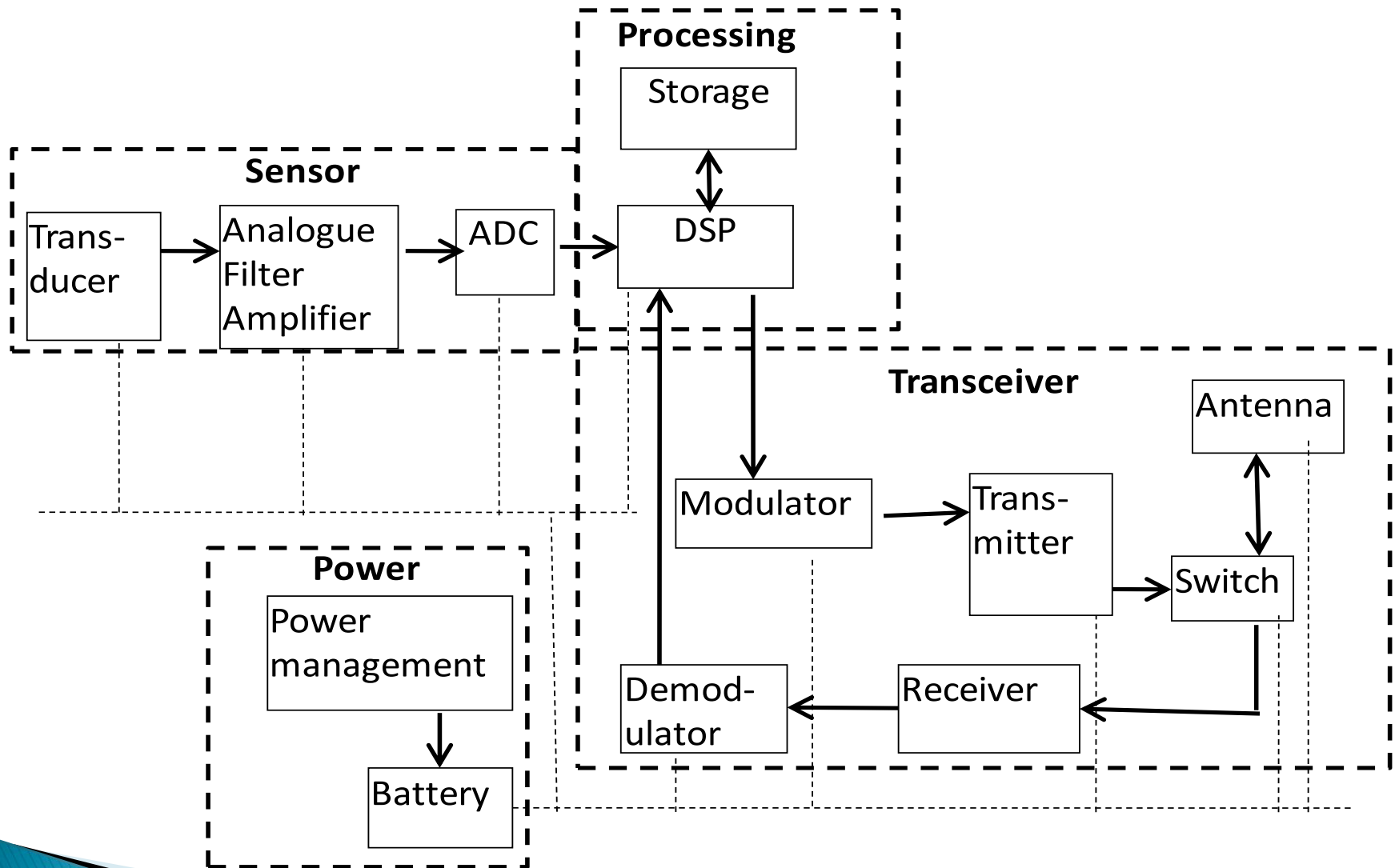
Sensor Network



Sensor Nets

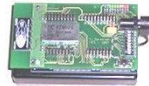
- ▶ Main components of a typical sensor network system are networked sensors nodes serviced by sensor access node.
- ▶ Slightly different but compatible view of a sensor network is to view sensors as being of three types of node):
 - *common nodes*-basic building block
 - *sink nodes*-base station
 - *gateway (access)-interface/bridge*
- ▶ In scenario given earlier, some sensors in the network can act as sink nodes within the network in addition to the access node.
- ▶ Concepts of sensor node & sensor net can be ambiguous:
 - A sensor can act as a node in a network of sensors versus there is a special sensor network server often called a sensor (access) node

Sensors



What is a Wireless Sensor Network?

- Self-organizing networks formed by many autonomous sensor nodes
 - Each node comprises its own power supply, processing unit, radio and sensors
 - Typically peer-to-peer communication (no central server)
 - Many (100 to 10.000) sensor nodes per net



- Various Applications: Industrial Automation, Building Control, Health Care, Military, Farming, Traffic Control, Home Automation, ...



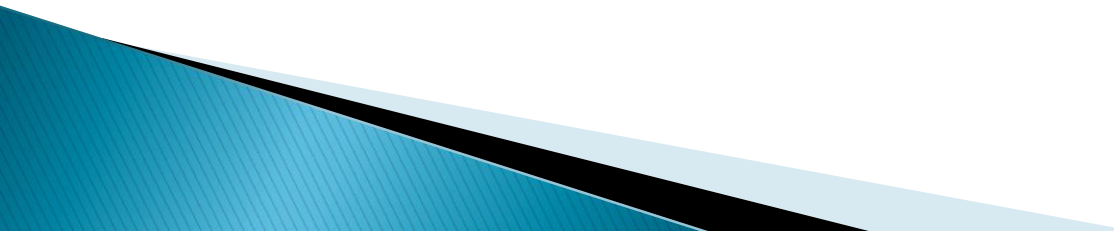
- Visions: „Smart Dust“, „Ambient Intelligence“, ...

What are the requirements for a Wireless Sensor Network?

- Must be kept cheap because large quantities are required
- Must be robust to be deployable in rough environments
- **Must not be power-hungry**
 - To be deployable in remote areas without any infrastructure
 - To keep working for several years without changing of batteries
- Basic functionalities:
 - Sensing
 - Transferring data to a base station where it will be processed

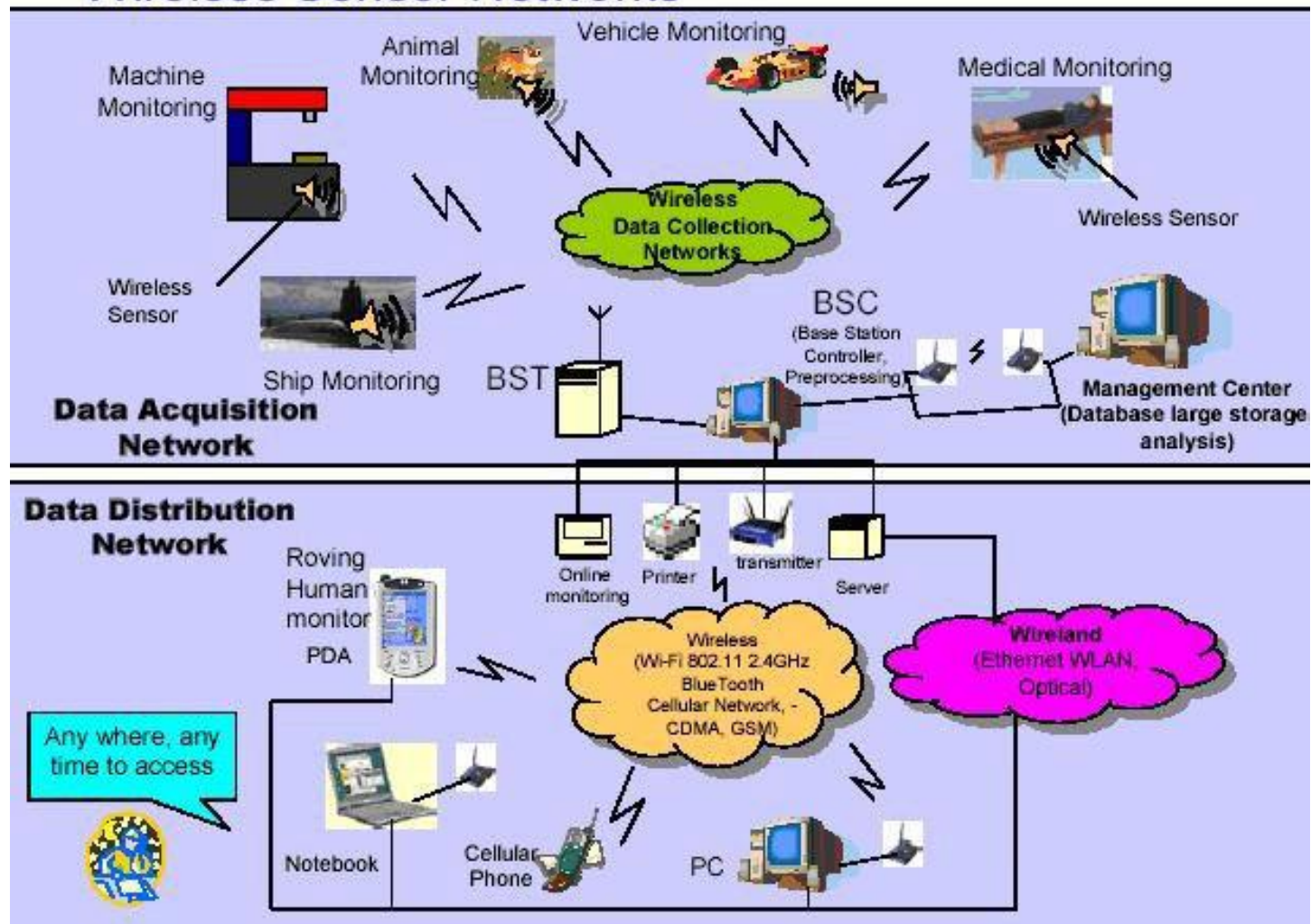


Wireless Sensor Networks(WSN)

- Limited power they can harvest or store
 - Ability to withstand harsh environmental conditions Ability to cope with node failures
 - Mobility of nodes
 - Dynamic network topology
 - Communication failures Heterogeneity of nodes Large scale of deployment Unattended operation
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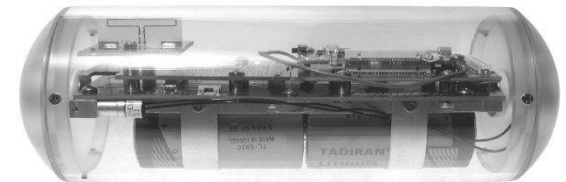
Wireless Sensor Networks(WSN)

Wireless Sensor Networks

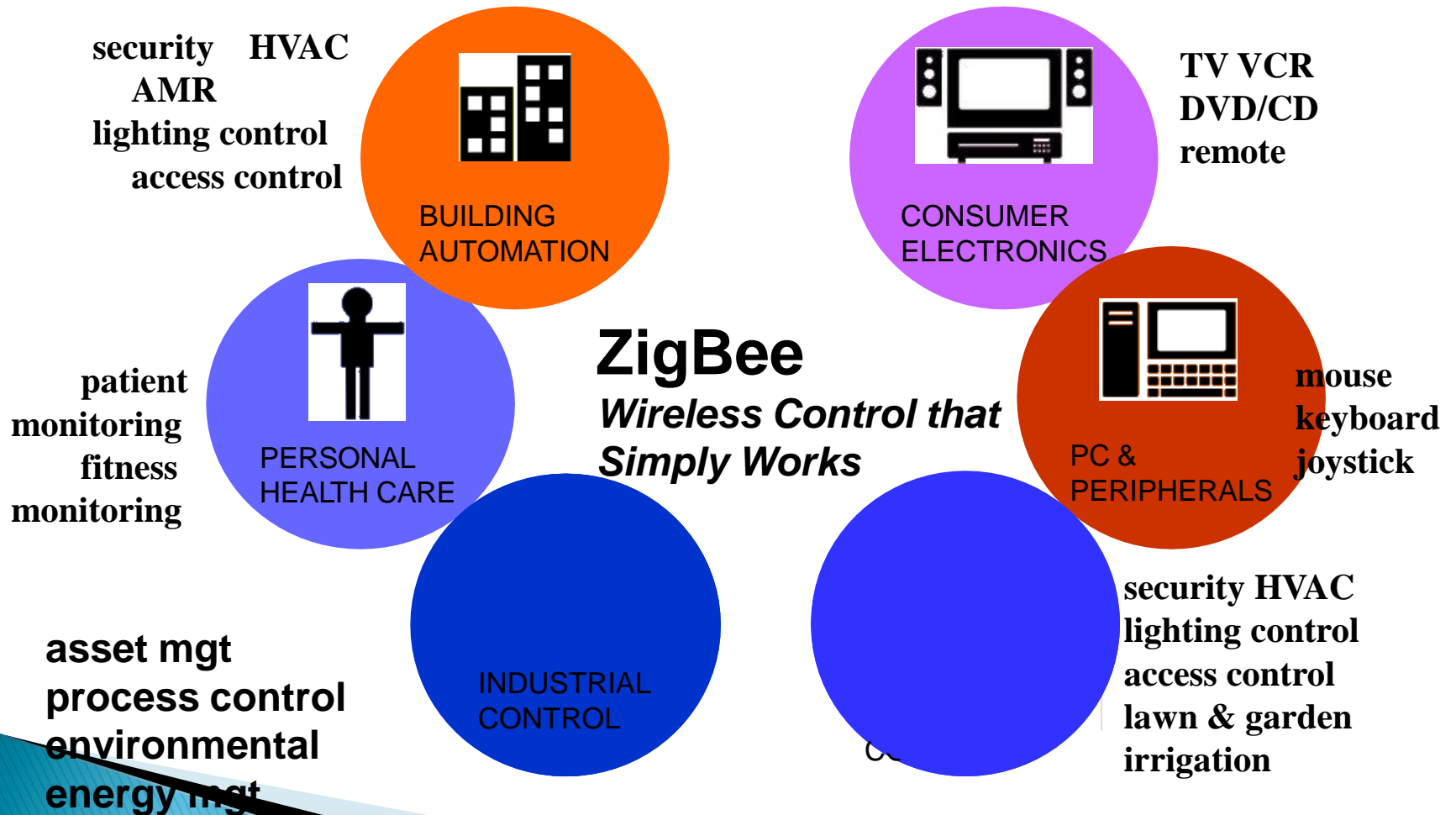


WSN Applications

- - Wild life Habitat monitoring projects Great Duck Island (UCB), -for wildlife research.
 - James Reserve (UCLA), improve biodiversity research
 - ZebraNet (Princeton.)-animal movement
 - Building/Infrastructure structure study (Earthquake impact)
- - Shooter Localization
 - Perimeter Defense (Oil pipeline protection)
 - Insurgent Activity Monitoring (MicroRadar)
- - Light/temperature control
 - Precision agriculture (optimize watering schedule)
 - Asset management (tracking freight movement/storage)



ZigBee Applications (Wireless Home-Area Networks, WHAN) <http://www.zigbee.org/>



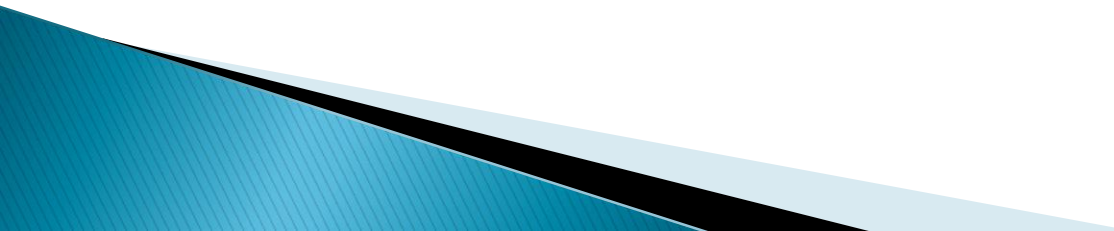
Zigbee

- ▶ Zigbee is a low-power, wireless communication protocol designed for IoT (Internet of Things), home automation, and Wireless Sensor Networks (WSNs).
- ▶ It operates on the IEEE 802.15.4 standard and is optimized for low-data rate, short-range, and energy-efficient communication.

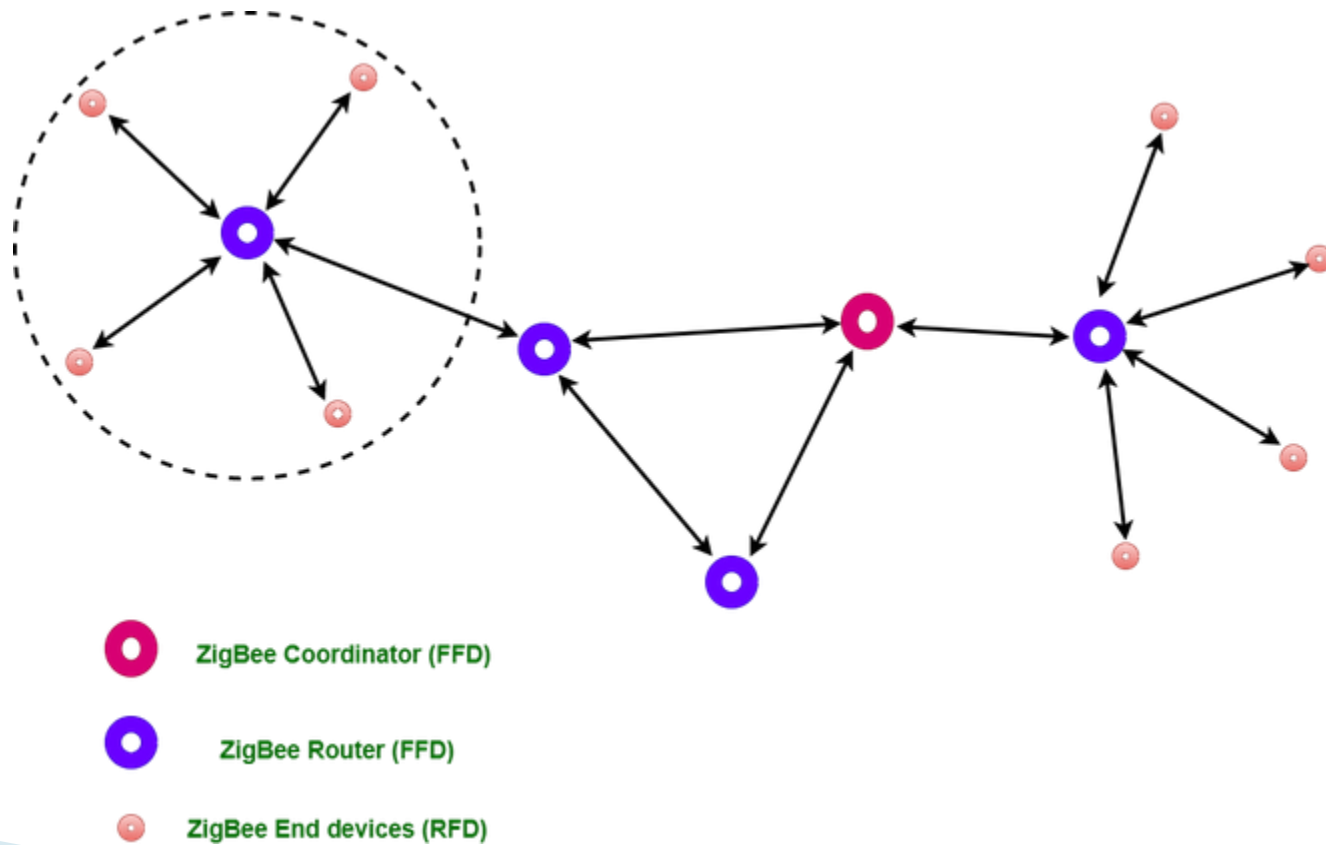
Key Features of Zigbee

- ▶ **Low Power Consumption** – Ideal for battery-operated sensors and IoT devices.
- ▶ **Short-Range Communication** – Typically covers **10-100 meters** (can extend with mesh networks)
- ▶ **Mesh Networking Support** – Devices can relay data through multiple nodes, increasing reliability.
- ▶ **Low Data Rate** – Supports **20-250 kbps**, suitable for sensor-based applications.
- ▶ **Secure Communication** – Uses **AES-128 encryption** for secure data transmission.
- ▶ **Scalability** – Can support **thousands of devices** in a single network.

Why ZigBee?

- *Pervasive Ad-hoc Self-organizing Mesh Networks*
 - *Configurable Radio Range:* based on service requirements, from contactless (~cm) to meters and even kilometers, using multi-hop
 - *High Security Level* (encryption and authentication at all protocol layers, concept of trust center, no collisions)
 - *Easy integration with appliance/terminals in miniaturized peripherals with integrated antenna*
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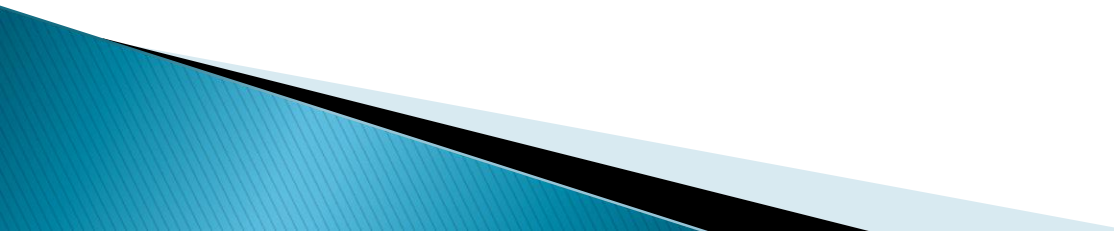
ZigBee Architecture



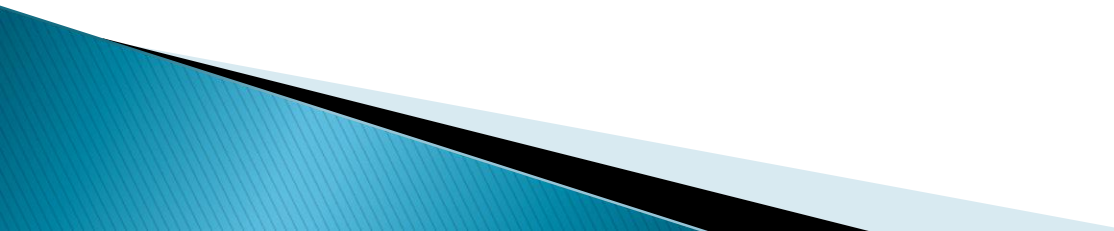
ZigBee Architecture

- *Zigbee Devices* –
- Full Function Devices (FFD's)- ZigBee Coordinator , ZigBee Router
- Reduced Function Devices (RFD's)- ZigBee End Device

1) ZigBee Coordinator (ZC) –

- Central controller of the Zigbee network.
 - Responsible for network formation, security, and management.
 - Stores network configurations and assigns addresses to new devices.
 - Communicates with Routers (ZR) and End Devices (ZED).
 - One Coordinator per network (mandatory).
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ZigBee Architecture

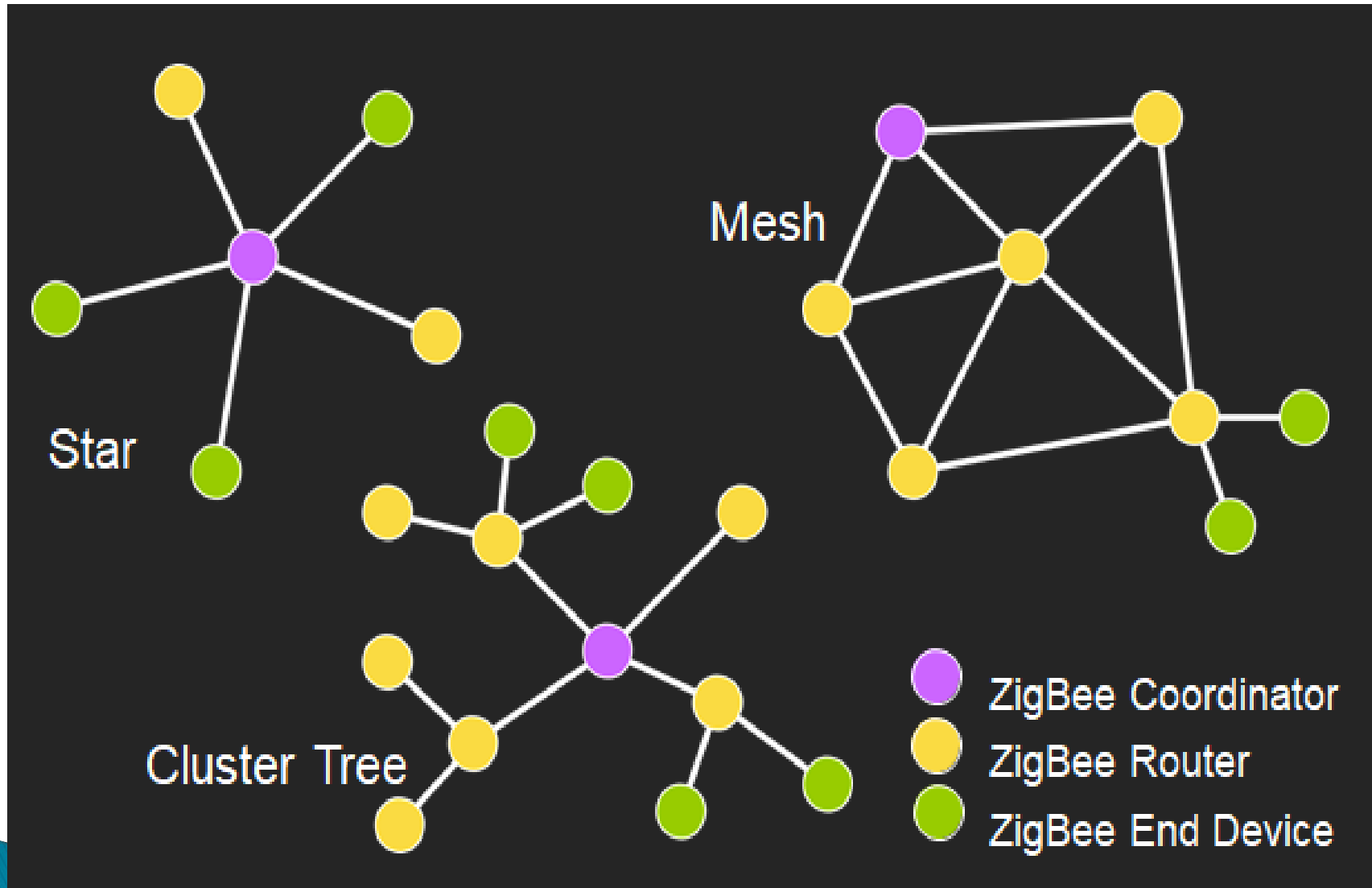
- ZigBee Router (ZR) :
 - **Connects with other Routers, the Coordinator, and End Devices**
 - Extends the network range by **forwarding data** between devices.
 - Can also function as an **End Device** while routing data.
 - Supports **multi-hop transmission** to enhance network coverage.
- 

ZigBee Architecture

3) ZigBee End Device (ZED) : **Simple, low-power** device that collects or receives data.

- Does not route data but **relies on Coordinators/Routers** for communication.
- Designed for **low-energy, battery-powered applications**.
- **Only connects to a Router or Coordinator** (not other End Devices).
- Enters **sleep mode** to conserve energy when not in use.

ZigBee Network Topologies

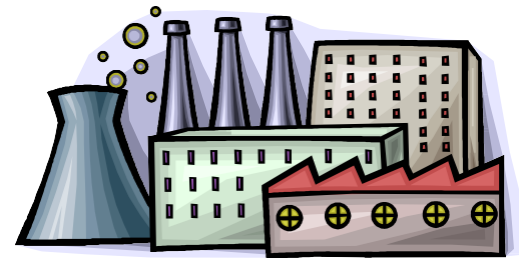


Some Application Profiles



- Home Automation [HA]

- Defines set of devices used in home automation
 - Light switches
 - Thermostats
 - Window shade
 - Heating unit
 - etc.



- Industrial Plant Monitoring

- Consists of device definitions for sensors used in industrial control
 - Temperature
 - Pressure sensors
 - Infrared
 - etc.

RFID applications

- ▶ **Manufacturing and Processing**
 - Inventory and production process monitoring
 - Warehouse order fulfillment
- ▶ **Supply Chain Management**
 - Inventory tracking systems
 - Logistics management
- ▶ **Retail**
 - Inventory control and customer insight
 - Auto checkout with reverse logistics
- ▶ **Security**
 - Access control
 - Counterfeiting and Theft control/prevention
- ▶ **Location Tracking**
 - Traffic movement control and parking management
 - Wildlife/Livestock monitoring and tracking

Smart groceries

- ▶ Add an RFID tag to all items in the grocery.
- ▶ As the cart leaves the store, it passes through an RFID transceiver.
- ▶ The cart is rung up in seconds.



Smart fridge

- ▶ Recognizes what's been put in it
- ▶ Recognizes when things are removed
- ▶ Creates automatic shopping lists
- ▶ Notifies you when things are past their expiration
- ▶ Shows you the recipes that most closely match what is available

Smart groceries enhanced

- ▶ Track products through their entire lifetime.



Some more smart applications

- ▶ “Smart” appliances:
 - Closets that advice on style depending on clothes available.
 - Ovens that know recipes to cook pre-packaged food.
- ▶ “Smart” products:
 - Clothing, appliances, CDs, etc. tagged for store returns.
- ▶ “Smart” paper:
 - Airline tickets that indicate your location in the airport.
- ▶ “Smart” currency:
 - Anti-counterfeiting and tracking.

RFID and Smart Sensors

- ▶ Sensors can be integrated with RF tags (Smart Sensors) and sensor data can be communicated using RF waves
- ▶ This enables RFID systems to gather and process sensor data in addition to identifying and tracking object
- ▶ Applications:
Machine Health Monitoring, Fluid Composition Detection.

Applications of IoT

1. Smart Traffic Control
2. Smart Band
3. Smart Thermostat
4. Smart Pen
5. Smart Windows
6. Smart Air Quality Sensing
7. Smart baby Monitor
8. Smart Waste Management
9. Smart Home
10. Smart City

Smart Traffic Control

- ▶ Many times we need to wait for long time in traffic so there is a need of traffic control.
- ▶ Sensors (in form of metal loops) embedded on roads which act as a data points . If there is an accident on road or high traffic jam, there data points will generate reports. Data goes to operation center where it will be analyzed and decisions will be taken.
- ▶ All vehicles routing on that road are informed that traffic jam is nearby and route is diverted. Alternate path is shown on dashboards. This way traffic jam is reduced and times is saved.

Smart Band

- ▶ Smart band is wear whole time from morning to sleep, this band consist of a number of sensors – heart sensors, accelerometer and synchronized with smart Phone.
- ▶ Sensors will collected data all the time and GPS will tell you how much kilometers you walk or run.
- ▶ The heart beat sensor will always monitor the heart beats , tells you how much calorie you had burned.

Smart Thermostat

- ▶ Thermostat is a device which is used to control the temperature. Smart Thermostat is connected to the internet. It is also synchronized with smart phone. So adjustment can be done by using phone.
- ▶ Every time thermostat changes the temperature. It learns how often we change the temperature, it will also save different patterns and understands the requirement of temperature all the time.
- ▶ If there is a sudden weather change, It will get the information from the internet and changes the temperature. It will sense the present or absence of peoples in home and will automatically turned off AC. Thus electricity bills will be reduced.

Smart Pen

- ▶ Smart Pen which is always connected to the internet. We need to write simply as we do on normal notes, this smart pen will record everything and will create digitized version of it.
- ▶ It will also synchronize with your accounts, - Social accounts or email account. It will also automatically upload the data to the cloud and shared with our friends.
- ▶ We can also view and edit our notes, and access from smart phones, laptops or desktop etc. There is also mike integrated inside the pen so we can record the sound and listen it whenever required.

Smart Windows

- ▶ Consider the glass which changes its glaze accordingly to applied voltage. It will also connected to the internet and synchronized with smart phones.
- ▶ If we change the brightness on smart phone, it will change the voltage at window, it will lighten or darken the tilt on windows. It will also learnt how often we are change the setting of windows and according to that it automatically changes the brightness.
- ▶ If there is sudden change in environment, then it will take data from Internet and will make the adjustment in no time. It will also save the electricity.

Smart Air Quality Sensing

- ▶ A device – Alima, Cube Sensors etc are helpful for sensing the quality of air particles, this tiny device is equipped with a number of sensors, It will measure the quantity of CO, CO₂, Temperature, Humidity and a number of gases.
- ▶ Algorithms deployed on device will collect and analyze all data, generate reports and gives information about pollutants around us.
- ▶ It will also synchronized with smart phone and will notify by flashing the background of smart phone with different colors. This will be helpful for the patient suffering from allergy and astama. It will also learn from different patterns/data and informed us accordantly.

Smart Baby Monitor

- ▶ A device – Mimo (A Smart Shirt) equipped with different respiratory sensors. These sensors will continuously monitor the baby and collect all data related to respiration.
- ▶ It will also be connected with cloud so that the parents can continuously monitor activities of the baby. i.e. How much he slept, How fast or slow he is breathing, body position, Skin temperature.
- ▶ Data can also be sent to the doctor directly where he can make an analysis and diagnosis. If any wrong thing happens like baby falls, notification goes to the parents where immediate action can be taken.

Smart Waste Management

- ▶ Collection and disposal of waste is big problems in city. A device – **enevo ONE**, which is equipped with a number of sensors.
- ▶ This sensors will continuously monitor how much dustbins are filled, and collect the data of recycling containers. As they are connected to the cloud, they are sending this data to garbage trucks.
- ▶ They will also get the traffic information continuously, and informed to the central stations and traffic / route of garbage trucks will be controlled.

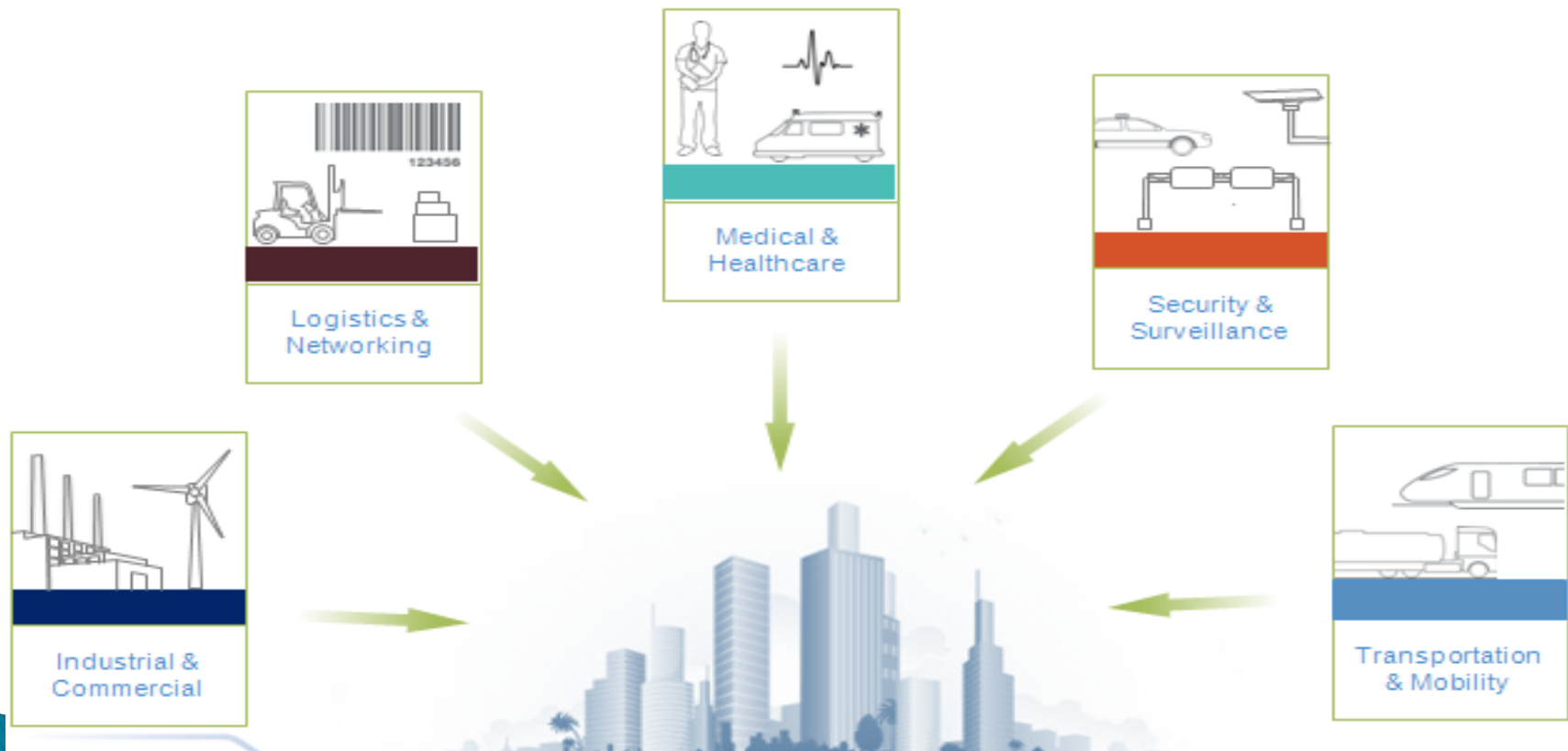
Smart Home

- ▶ Robot outside the home
- ▶ Door with touch and ultrasonic sensor.
- ▶ General purpose robot
- ▶ Fan with sensing mechanism to control its speed
- ▶ Cleaner robot

Smart City

Smart City

A Combination of many Vertical Solutions



Smart City

The Internet of Things

Smart Cities - M2M Applications Everywhere



Smart Food/Water Monitoring

- ▶ **Water Quality:** Study of water suitability in rivers and the sea for fauna and eligibility for drinkable use.
- ▶ **Water Leakages:** Detection of liquid presence outside tanks and pressure variations along pipes.
- ▶ **River Floods:** Monitoring of water level variations in rivers, dams and reservoirs.
- ▶ **Water Management:** Real-time information about water usage and the status of waterlines could be collected by connecting residential water meters to an Internet protocol (IP) network.

Smart Food/Water Monitoring

- ▶ **Supply Chain Control:** Monitoring of storage conditions along the supply chain and product tracking for traceability purposes.
- ▶ **Green Houses:** Control micro-climate conditions to maximize the production of fruits and vegetables and its quality.
- ▶ **Golf Courses:** Selective irrigation in dry zones to reduce the water resources required in the green.

Smart Health

- ▶ **Fall Detection:** Assistance for elderly or disabled people living independent.
- ▶ **Physical Activity Monitoring for Aging People:** Body sensors network measures motion, vital signs, unobtrusiveness and a mobile unit collects, visualizes and records activity data.
- ▶ **Medical Fridges:** Control of conditions inside freezers storing vaccines, medicines and organic elements.

Smart Health

- ▶ **Sportsmen Care:** Vital signs monitoring in high performance centers and fields. Health and fitness products for these purposes exist, that measure exercise, steps, sleep, weight, blood pressure, and other statistics.
- ▶ **Patients Surveillance:** Monitoring of conditions of patients inside hospitals and in old people's home.
- ▶ **Chronic Disease Management:** Patient-monitoring systems with comprehensive patient statistics could be available for remote residential monitoring of patients with chronic diseases.

Smart Health

- ▶ **Ultraviolet Radiation:** Measurement of UV sun rays to warn people not to be exposed in certain hours.
- ▶ **Hygienic hand control:** RFID-based monitoring system of wrist bands in combination of Bluetooth LE tags on a patient's doorway controlling hand hygiene in hospitals, where vibration notifications is sent out to inform about time for hand wash; and all the data collected produce analytics which can be used to potentially trace patient infections to particular healthcare workers.

Smart Health

- ▶ **Sleep control:** Wireless sensors placed across the mattress sensing small motions, like breathing and heart rate and large motions caused by tossing and turning during sleep, providing data available through an app on the smartphone.
- ▶ **Dental Health:** Bluetooth connected toothbrush with smartphone app analyzes the brushing uses and gives information on the brushing habits on the smartphone for private information or for showing statistics to the dentist.

Smart Living

- ▶ **Intelligent Shopping Applications:** Getting advice at the point of sale according to customer habits, preferences, presence of allergic components for them, or expiring dates.
- ▶ **Energy and Water Use:** Energy and water supply consumption monitoring to obtain advice on how to save cost and resources. Maximizing energy efficiency by introducing lighting and heating products, such as bulbs, thermostats and air conditioners.
- ▶ **Remote Control Appliances:** Switching on and off remotely appliances to avoid accidents and save energy.

Smart Living

- ▶ **Weather Station:** Displays outdoor weather conditions such as humidity, temperature, barometric pressure, wind speed and rain levels using meters with ability to transmit data over long distances.
- ▶ **Smart Home Appliances:** Refrigerators with LCD screen telling what's inside, food that's about to expire, ingredients you need to buy and with all the information available on a smartphone app. Washing machines allowing you to monitor the laundry remotely, and run automatically when electricity rates are lowest. Kitchen ranges with interface to a smartphone app allowing remotely adjustable temperature control and monitoring the oven's self-cleaning feature.

Smart Living

- ▶ **Gas Monitoring:** Real-information about gas usage and the status of gas lines could be provided by connecting residential gas meters to an Internet protocol (IP) network.
- ▶ **Safety Monitoring:** Baby monitoring, cameras, and home alarm systems making people feel safe in their daily life at home.
- ▶ **Smart Jewelry:** Increased personal safety by wearing a piece of jewelry inserted with Bluetooth enabled technology used in a way that a simple push establishes contact with your smartphone, which through an app will send alarms to selected people in your social circle with information that you need help and your location.

Smart Environment Monitoring

- ▶ **Forest Fire Detection:** Monitoring of combustion gases and preemptive fire conditions to define alert zones.
- ▶ **Air Pollution:** Control of CO₂ emissions of factories, pollution emitted by cars and toxic gases generated in farms.
- ▶ **Landslide and Avalanche Prevention:** Monitoring of soil moisture, vibrations and earth density to detect dangerous patterns in land conditions.
- ▶ **Earthquake Early Detection:** Distributed control in specific places of tremors.

Smart Environment Monitoring

- ▶ **Protecting wildlife:** Tracking collars utilizing GPS modules to locate and track wild animals and communicate their coordinates via SMS.
- ▶ **Meteorological Station Network:** Study of weather conditions in fields to forecast ice formation, rain, drought, snow or wind changes.
- ▶ **Marine and Coastal Surveillance:** Using different kinds of sensors integrated in planes, unmanned aerial vehicles, satellites, ship etc. to control the maritime activities and traffic in important areas, keep track of fishing boats, supervise environmental conditions and dangerous oil cargo etc.

Smart Manufacturing

- ▶ **Smart Product Management:** Control of rotation of products in shelves and warehouses to automate restocking processes.
- ▶ **Compost:** Control of humidity and temperature levels in alfalfa, hay, straw, etc. to prevent fungus and other microbial contaminants.
- ▶ **Offspring Care:** Control of growing conditions of the offspring in animal farms to ensure its survival and health.

Smart Manufacturing

- ▶ **Animal Tracking:** Location and identification of animals grazing in open pastures or location in big stables.
- ▶ **Toxic Gas Levels:** Study of ventilation and air quality in farms and detection of harmful gases from excrements.
- ▶ **Production Line:** Monitoring and management of the production line using RFID, sensors, video monitoring, remote information distribution and cloud solutions enabling the production line data to be transferred to the enterprise-based systems.

Smart Energy

- ▶ **Smart Grid:** Energy consumption monitoring and management.
- ▶ **Photovoltaic Installations:** Monitoring and optimization of performance in solar energy plants.
- ▶ **Wind Turbines:** Monitoring and analyzing the flow of energy from wind turbines, and two-way communication with consumers' smart meters to analyze consumption patterns.

Smart Energy

- ▶ **Water Flow:** Measurement of water pressure in water transportation systems.
- ▶ **Radiation Levels:** Distributed measurement of radiation levels in nuclear power stations surroundings to generate leakage alerts.
- ▶ **Power Supply Controllers:** Controller for AC-DC power supplies that determines required energy, and improve energy efficiency with less energy waste for power supplies related to computers, telecommunications, and consumer electronics applications.

Smart Building

- ▶ **Perimeter Access Control:** Access control to restricted areas and detection of people in non-authorized areas.
- ▶ **Liquid Presence:** Liquid detection in data centres, warehouses and sensitive building grounds to prevent break downs and corrosion.
- ▶ **Indoor Climate Control:** Measurement and control of temperature, lighting, CO2 fresh air in ppm etc.

Smart Building

- ▶ **Intelligent Thermostat:** Thermostat that learns the users programming schedule after a few days, and from that programs itself. Can be used with an app to connect to the thermostat from a smart telephone, where control, watching the energy history, how much energy is saved and why can be displayed.
- ▶ **Intelligent FireAlarm:** System with sensors measuring smoke and carbon monoxide, giving both early warnings, howling alarms and speaks with a human voice telling where the smoke is or when carbon monoxide levels are rising, in addition to giving a message on the smartphone or tablet if the smoke or CO alarm goes off

Smart Building

- ▶ **Intrusion Detection Systems:** Detection of window and door openings and violations to prevent intruders.
- ▶ **Motion Detection:** Infrared motion sensors which reliably sends alerts to alarm panel (or dialer) and with a system implementing reduced false alarms algorithms and adaption to environmental disturbances.
- ▶ **Art and Goods Preservation:** Monitoring of conditions inside museums and art warehouses.
- ▶ **Residential Irrigation:** Monitoring and smart watering system.

Smart Transport and Mobility

- ▶ NFC Payment
- ▶ Quality of Shipment Conditions
- ▶ Item Location
- ▶ Storage Incompatibility Detection
- ▶ Fleet Tracking
- ▶ Electric Vehicle Charging Stations Reservation
- ▶ Vehicle Auto-diagnosis
- ▶ Management of cars
- ▶ Road Pricing
- ▶ Connected Militarized Defence

Smart Industry

- ▶ Tank level
- ▶ Silos Stock Calculation
- ▶ Explosive and Hazardous Gases
- ▶ M2M Applications
- ▶ Maintenance and repair
- ▶ Indoor Air Quality
- ▶ Temperature Monitoring
- ▶ Ozone Presence

Smart City

- ▶ Smart Parking
- ▶ Structural health
- ▶ Noise Urban Maps
- ▶ Traffic Congestions
- ▶ Smart Lighting
- ▶ Waste Management
- ▶ Intelligent Transport System
- ▶ Safe City
- ▶ Connected Learning

THANK YOU!