



Embedded Systems Design

(0630414)

Lecture 14

Microcontroller-Based Wireless Sensor Networks

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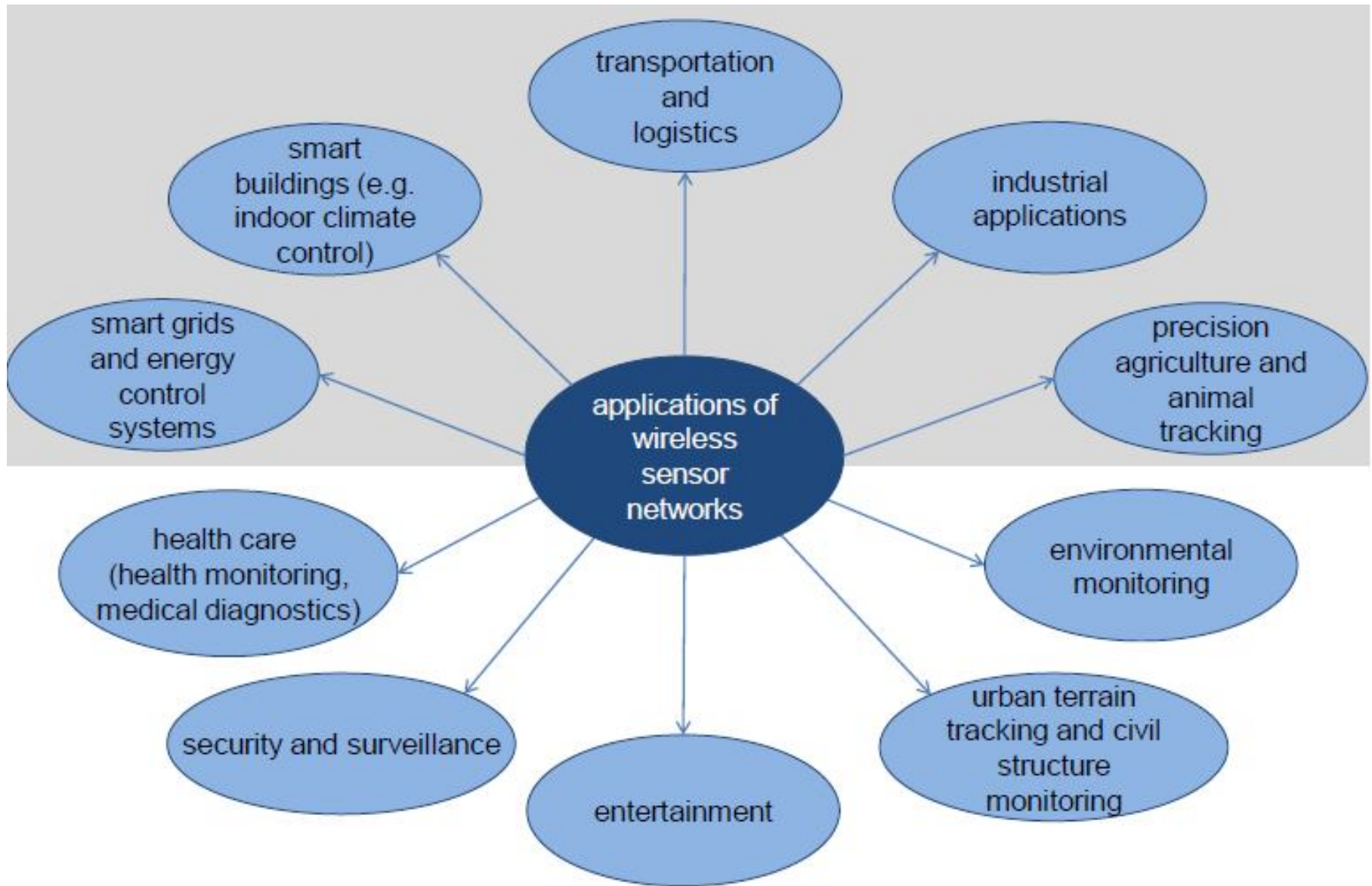
Philadelphia University

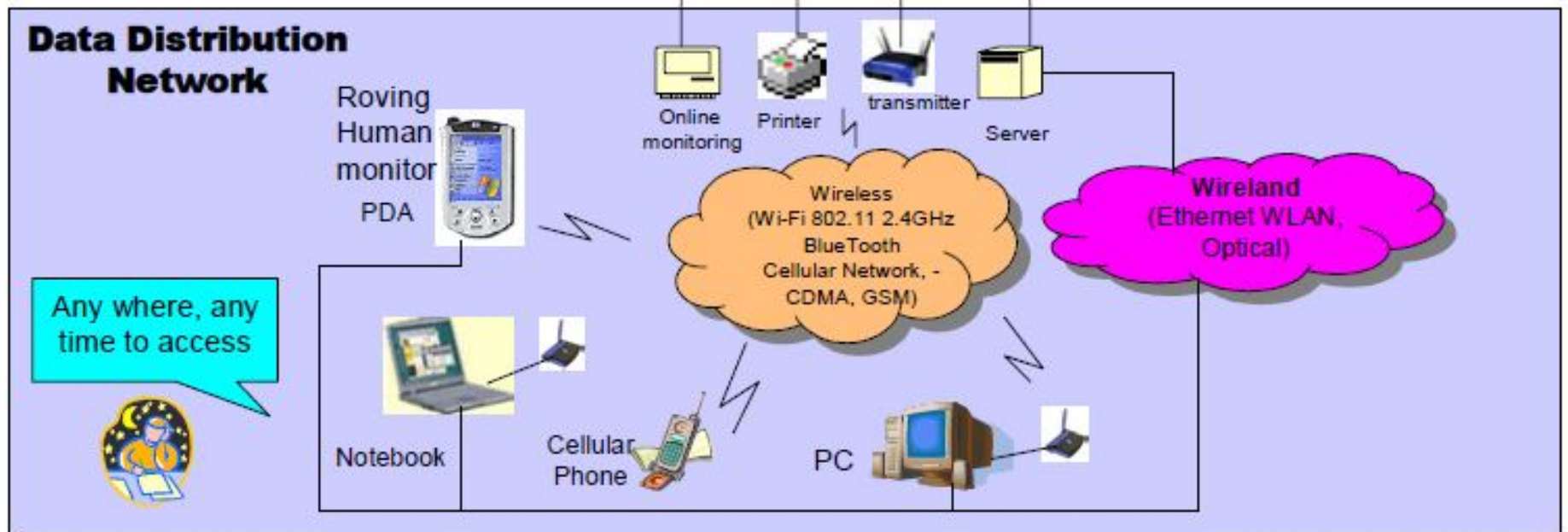
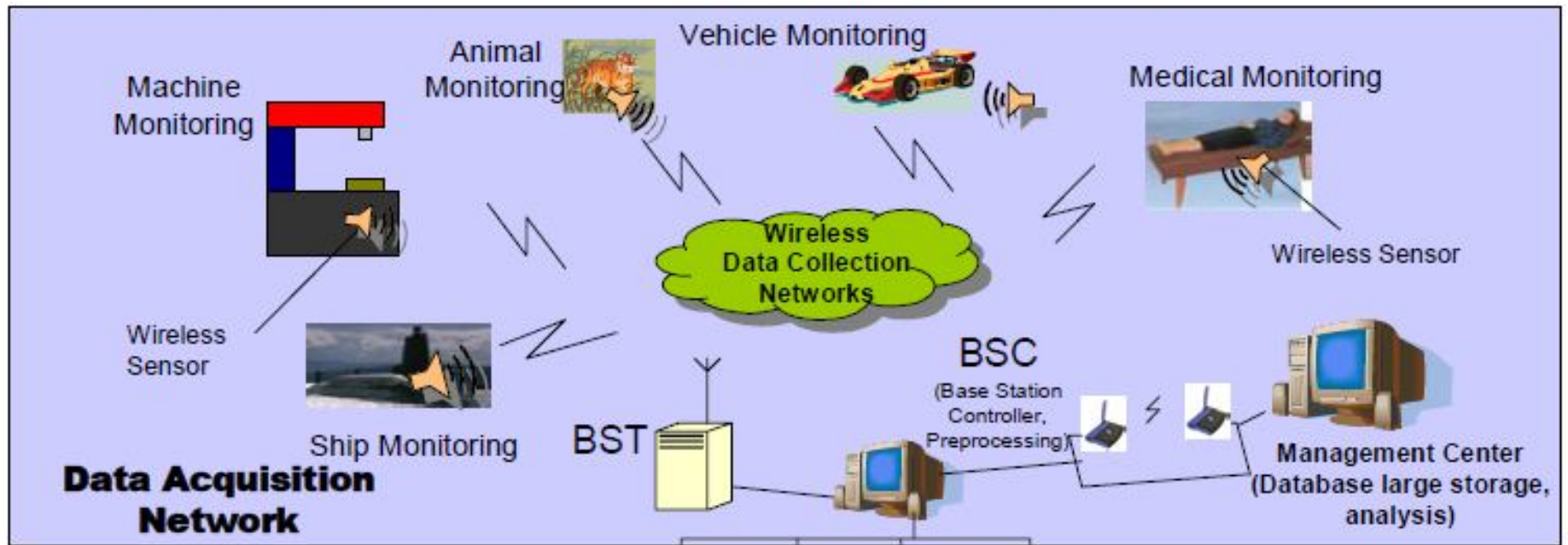
Introduction:

- Wireless Sensor Networks (WSNs) have been identified as one of the most important and promising technologies that will allow people and machines to interact with their environment in a simple way. Recently, WSNs play an important role in monitoring and control applications, and will find more applications as computer and communication technologies advances and hardware prices drop.
- WSNs consist of specially distributed devices using sensors to monitor physical or environmental conditions. Application areas of WSNs include geographical monitoring, habitat monitoring, transportation, military systems, business processes, microclimate research, medical care and others.
- Each sensor is attached to battery powered microprocessors combined with a set of specific instrumentation for environmental measurements such as sound, light and temperature. Its advantages include the mobility, simplicity, and low cost in both installation and maintenance.

Applications of WSNs:

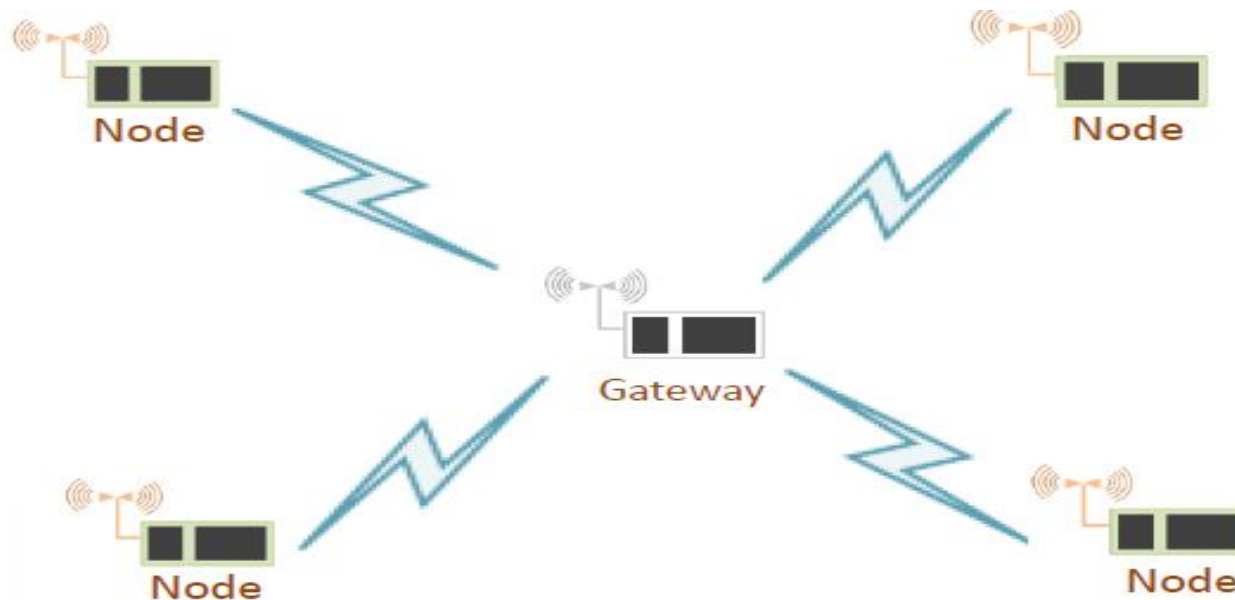
- **Environmental applications:** forest fire detection, biocomplexity mapping of the environment, greenhouses monitoring and control, flood detection, alarming and control, weather forecasting and others.
- **Health applications:** monitoring of human physiological data, monitoring and tracking patients and doctors, drug administration in hospitals and medical stores,.....
- **Smart home applications:** home automation, smart environment by incorporating sensor nodes embedded into furniture and appliances, and they can communicate with each other and the room server, and more.
- **Military applications:** Monitoring friendly forces, "command, control, communications, computing, intelligence, surveillance, reconnaissance and targeting" systems, Battle damage assessment, Nuclear, biological and chemical attack detection and reconnaissance, and more others.
- **Commercial applications:** environmental control in office buildings, Detecting and monitoring car thefts, Managing inventory control in a warehouse, Vehicle tracking and detection, and others





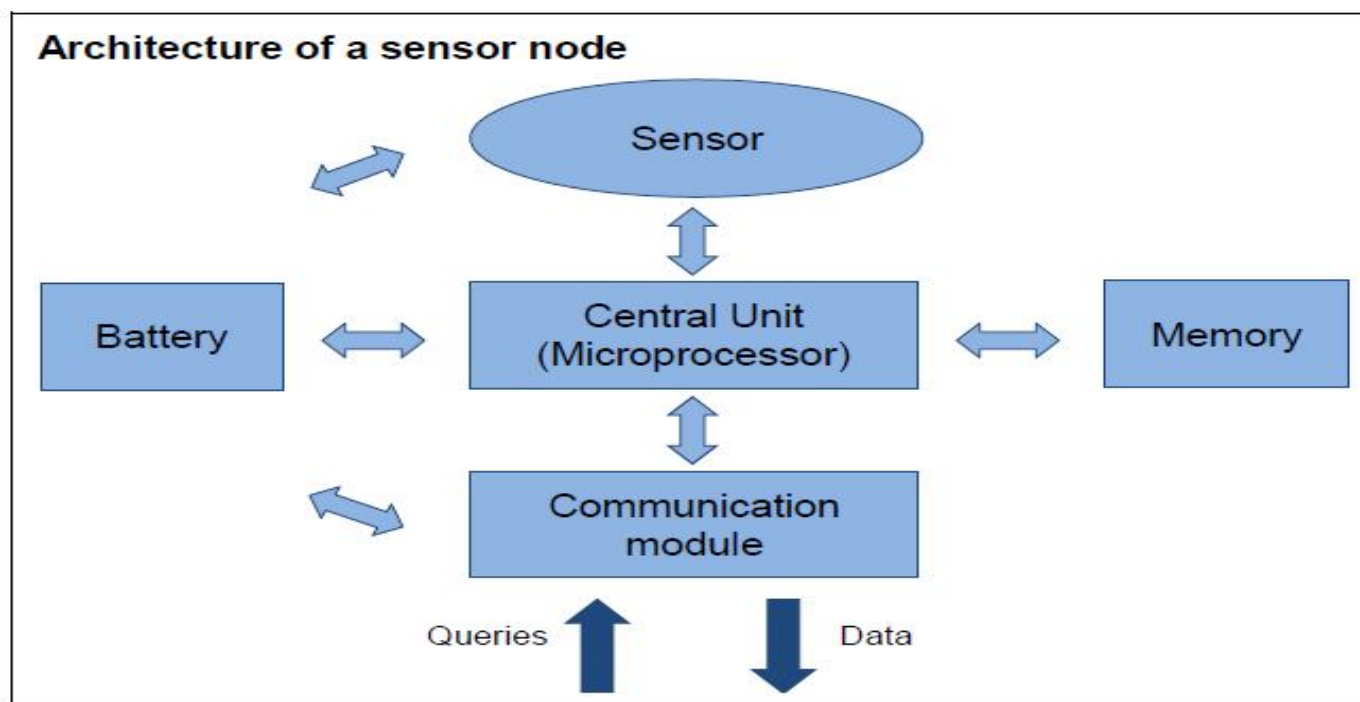
WSN Architecture:

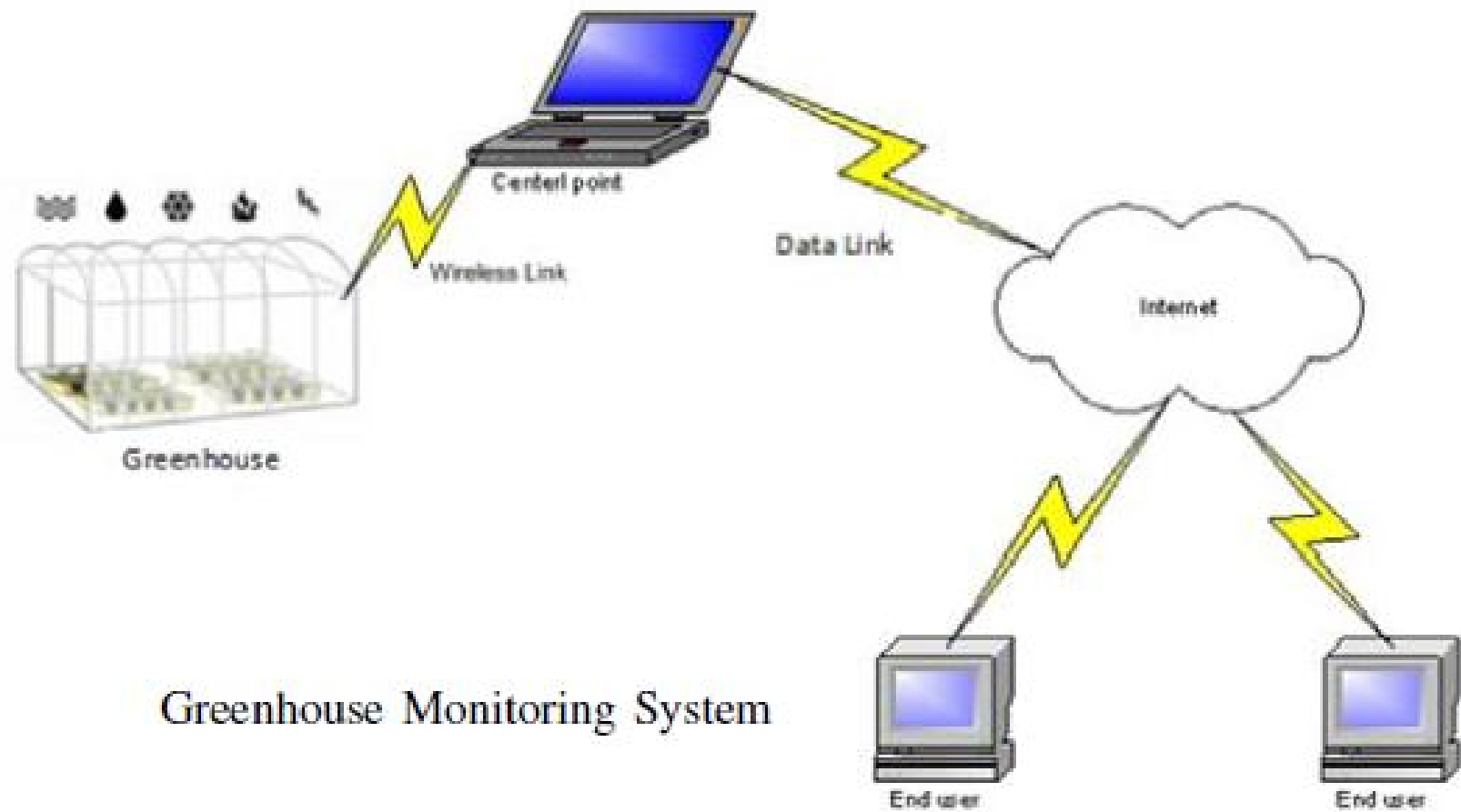
- Nodes in the WSN are classified into two types according to their function:
- Source node: It is any entity in the network that can provide information. It could be a sensor node, or an actuator node that provides feedback information about an operation.
- Sink node: It is the entity where information is required. It could be another sensor/actuator node used to interact with sensor network or as a gateway to interact with another larger network such as the Internet.



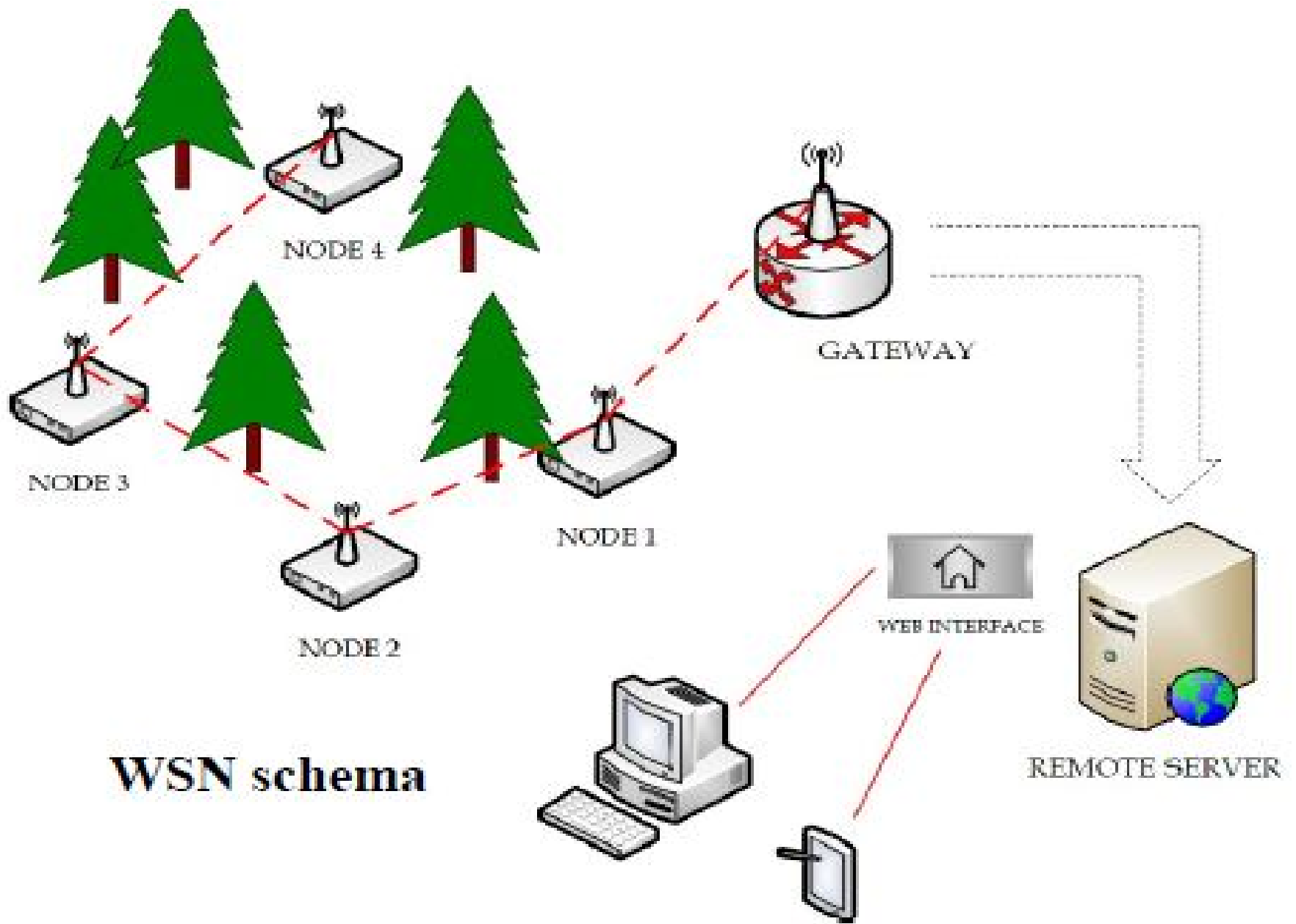
Each sensor node comprises five main components:

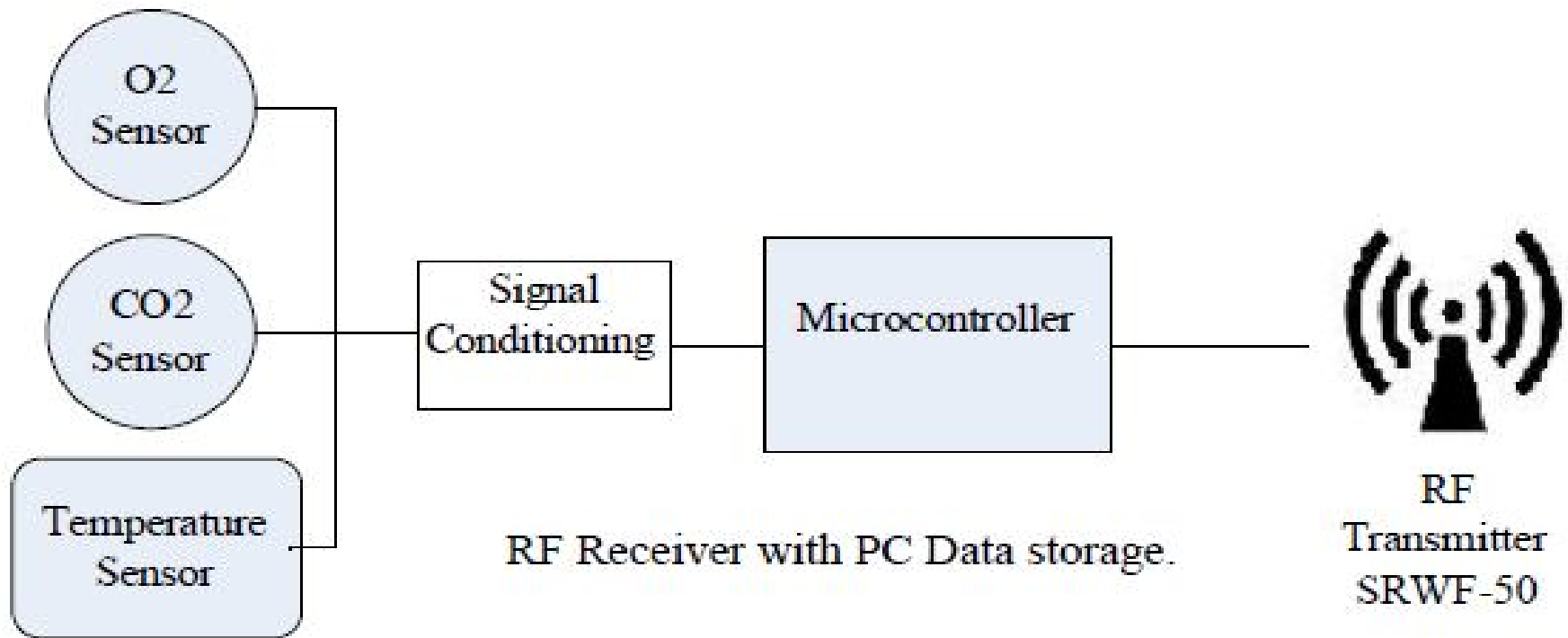
- **Controller:** A microcontroller to process data received from sensors or other nodes.
- **Memory:** storage unit of the controller to store programs and intermediate data.
- **Sensors:** set of devices required to interface controller with physical parameters of the environment, such as temperature sensors.
- **Communication Link:** Connecting nodes into a network requires a device for sending and receiving information over a wireless link.
- **Power Supply:** An energy source, such as solar cell or batteries is required.





Greenhouse Monitoring System





Wireless system hangs at plant

❑ Each individual node in the WSN can monitor its local region and communicate through a wireless channel with other nodes.

❑ Wireless communication can be achieved using one of the following technologies:

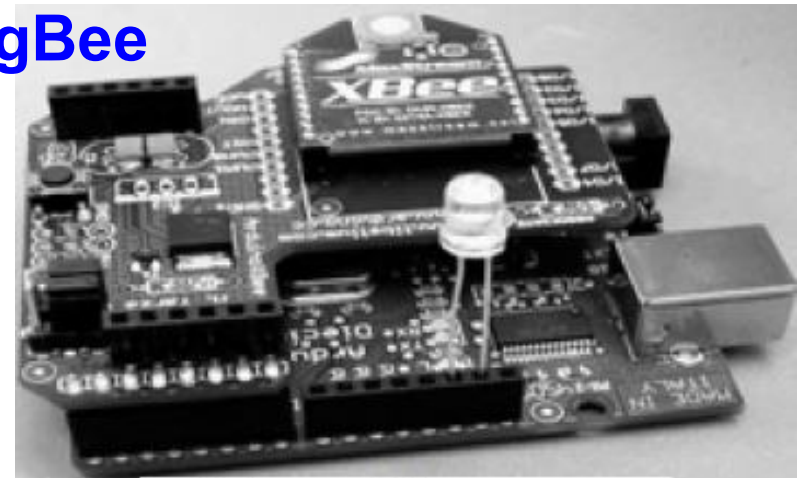
- Bluetooth.**
- Zigbee**
- WiFi**

❑ It is useful to use mobile communication in the remote monitoring and control to avoid all disadvantages of the above technologies.

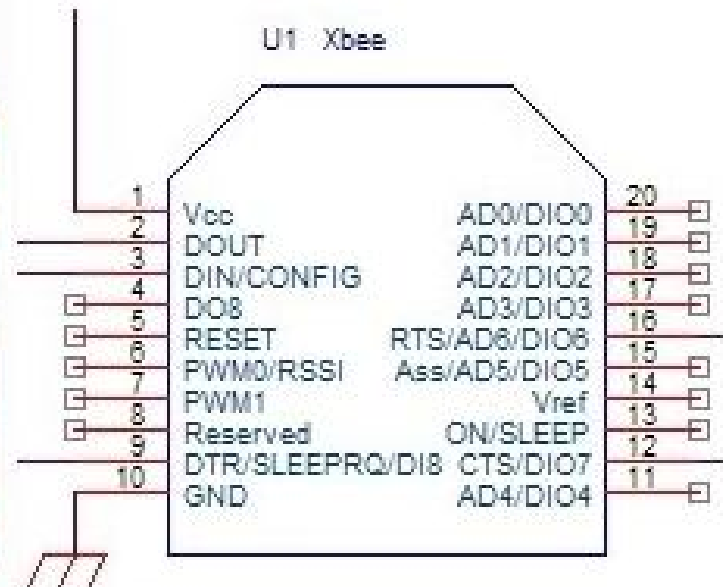
Comparison between ZigBee and Bluetooth:

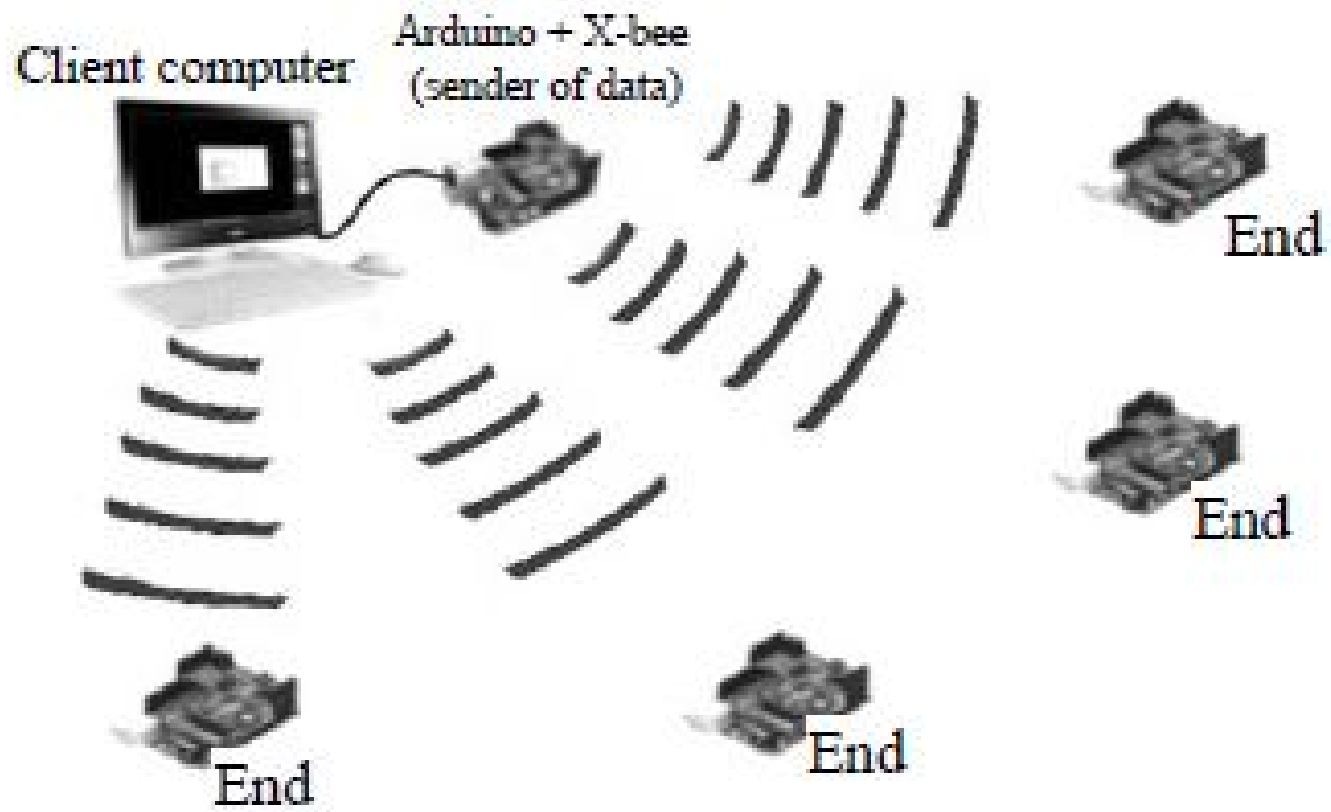
System	ZigBee™ 802.15.4	Bluetooth™ 802.15.1
Application	Monitoring and control	Cable replasment
System resources	4-32 KB	250 KB
Battery life (days)	100-1000+	1-7
Nodes in network	255 / 65K+	7
Baseband(Kb/s)	20-250	720
Distance (meters)	1-75+	1-10+
Key characteristics	stability, low consumption, low cost	price, easy to use comfort

Single-Board Microcontroller + ZigBee

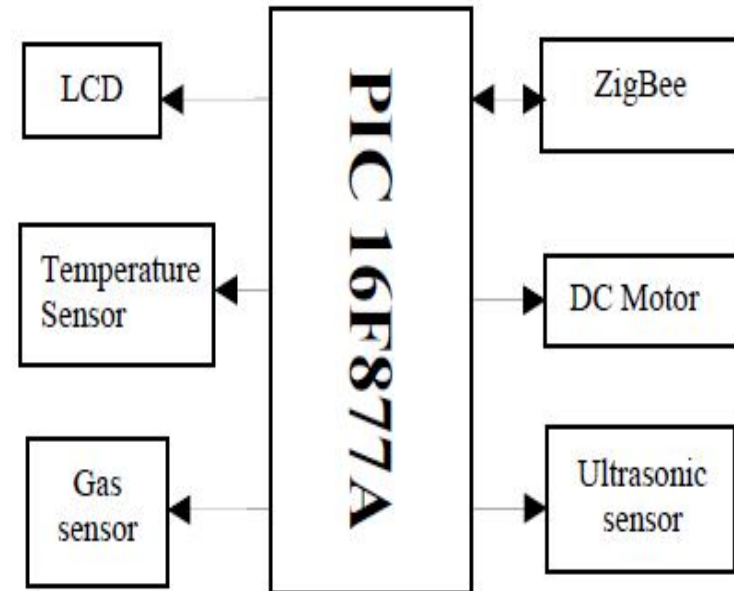
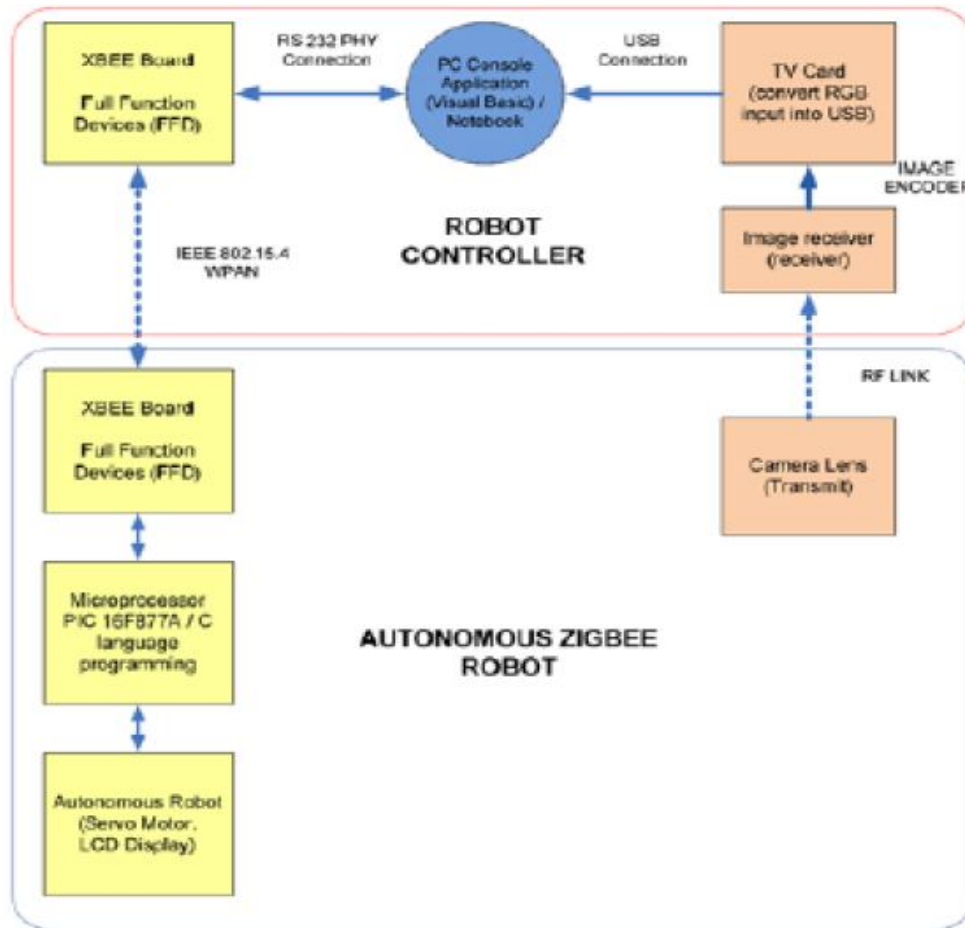


Arduino + X-bee.

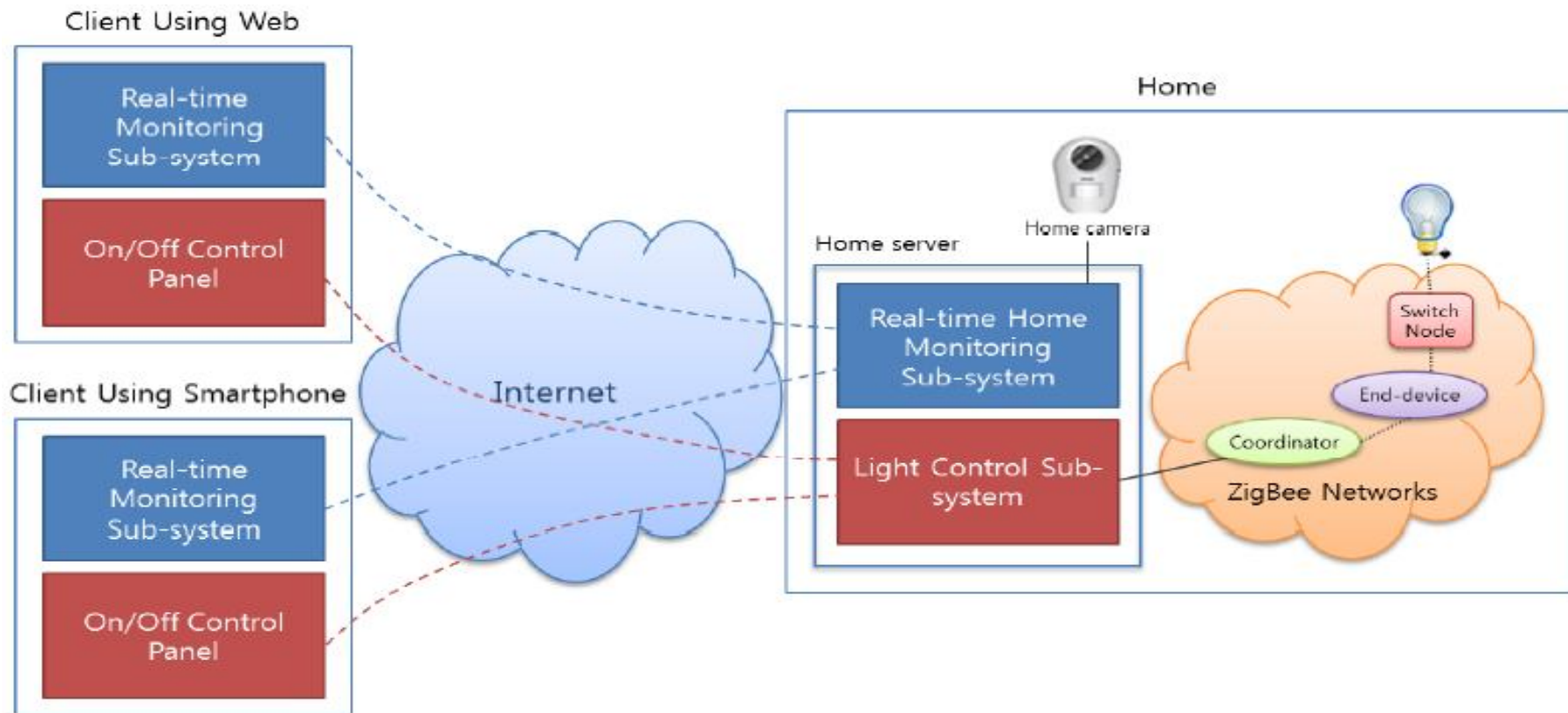




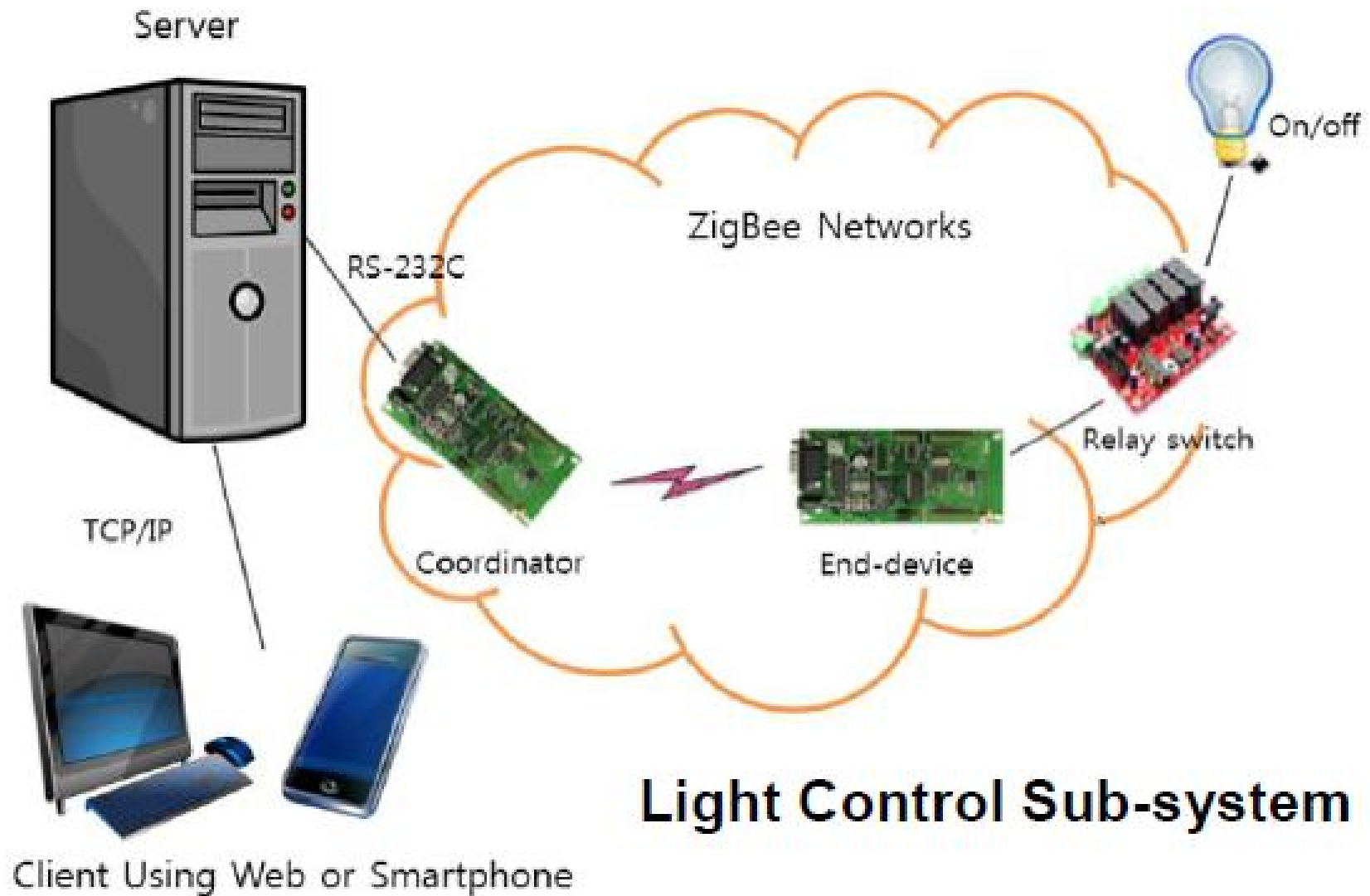
Example: Mobile Robot control using Zigbee Technology



Example: Smart Home



The system consists of a real-time home monitoring sub-system and a light control sub-system. A home server with a home camera caters for home status through video to client. It also works as a home gateway to provide interoperability between the heterogeneous ZigBee and Internet and local and remote control over the home's light devices through the light control sub-system.



Light Control Sub-system