

Unit V-Ubiqitous Clouds and the Internet of Things

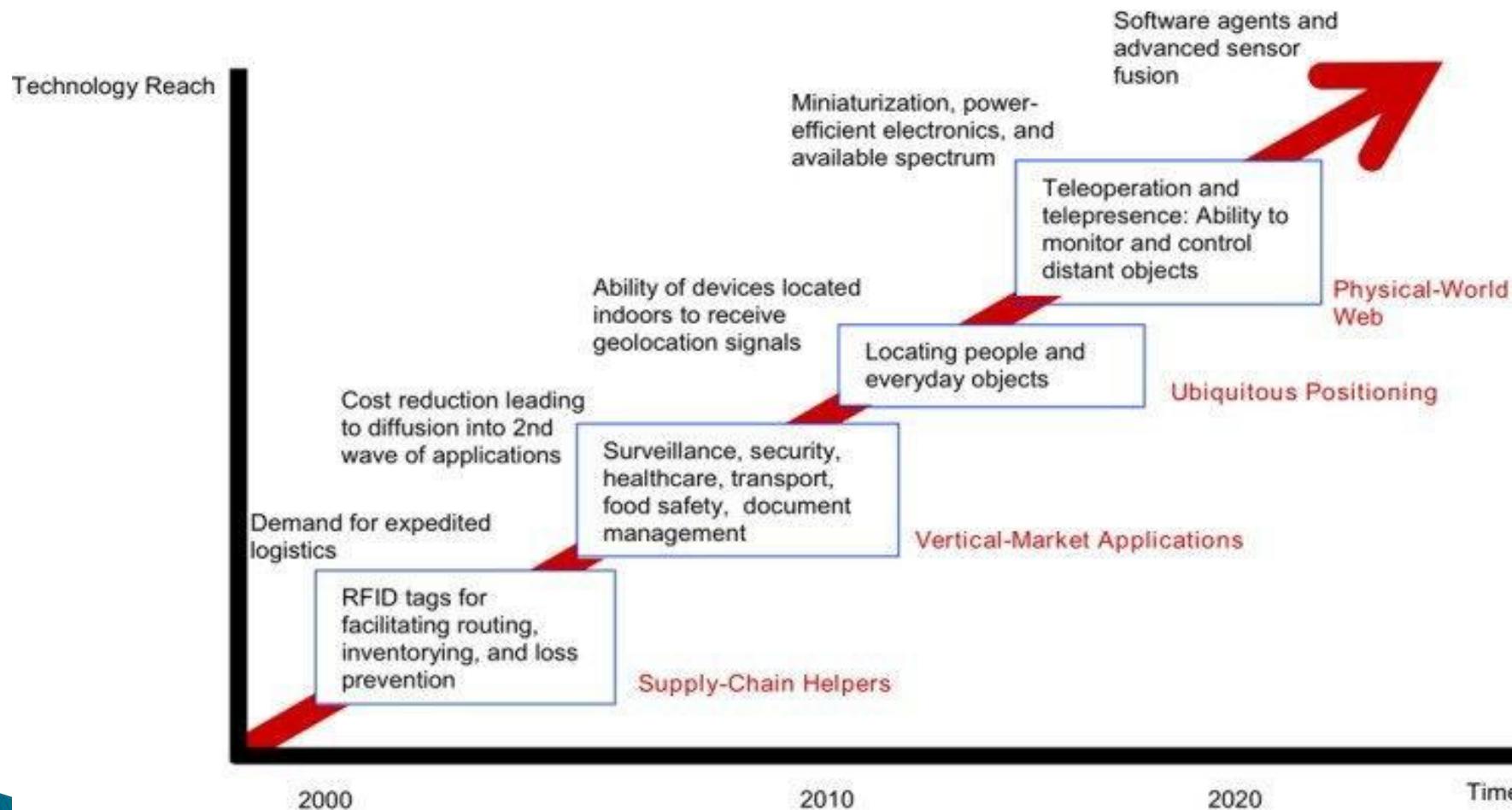
Cloud Trends in Supporting Ubiquitous Computing, Performance of Distributed Systems and the Cloud, Enabling Technologies for the Internet of Things (RFID, Sensor Networks and ZigBee Technology, GPS), Innovative Applications of the Internet of Things (Smart Buildings and Smart Power Grid, Retailing and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

Internet of Things

- The **Internet of Things** refers to uniquely identifiable objects (things) and their virtual representations in an Internet-like structure.
- The term Internet of Things was first used by Kevin Ashton in 1999.

The Internet of Things : Enabling Technologies

TECHNOLOGY ROADMAP: THE INTERNET OF THINGS



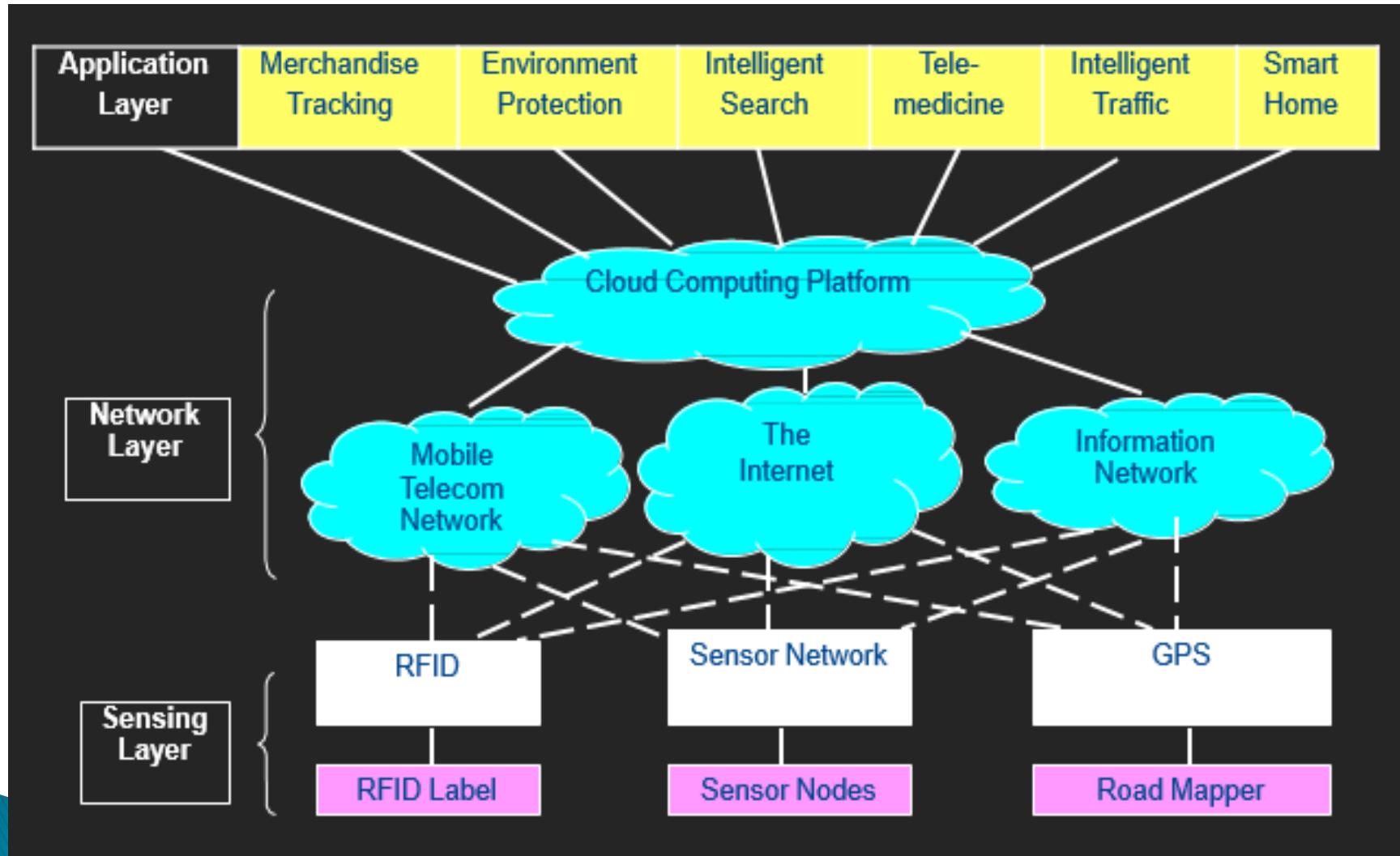
Source: SRI Consulting Business Intelligence

The Internet of Things : Enabling Technologies

Table 9.6 Enabling and Synergistic Technologies for the IoT

Enabling Technologies	Synergistic Technologies
Machine-to-machine interfaces	Geotagging/geocaching
Protocols of electronic communication	Biometrics
Microcontrollers	Machine vision
Wireless communication	Robotics
RFID	Augmented reality
Energy harvesting technologies	Telepresence and adjustable autonomy
Sensors and sensor networks	Life recorders and personal black boxes
Actuators	Tangible user interfaces
Positioning or location technology (GPS)	Clean technologies
Software engineering	Mirror worlds

Architecture of The Internet of Things



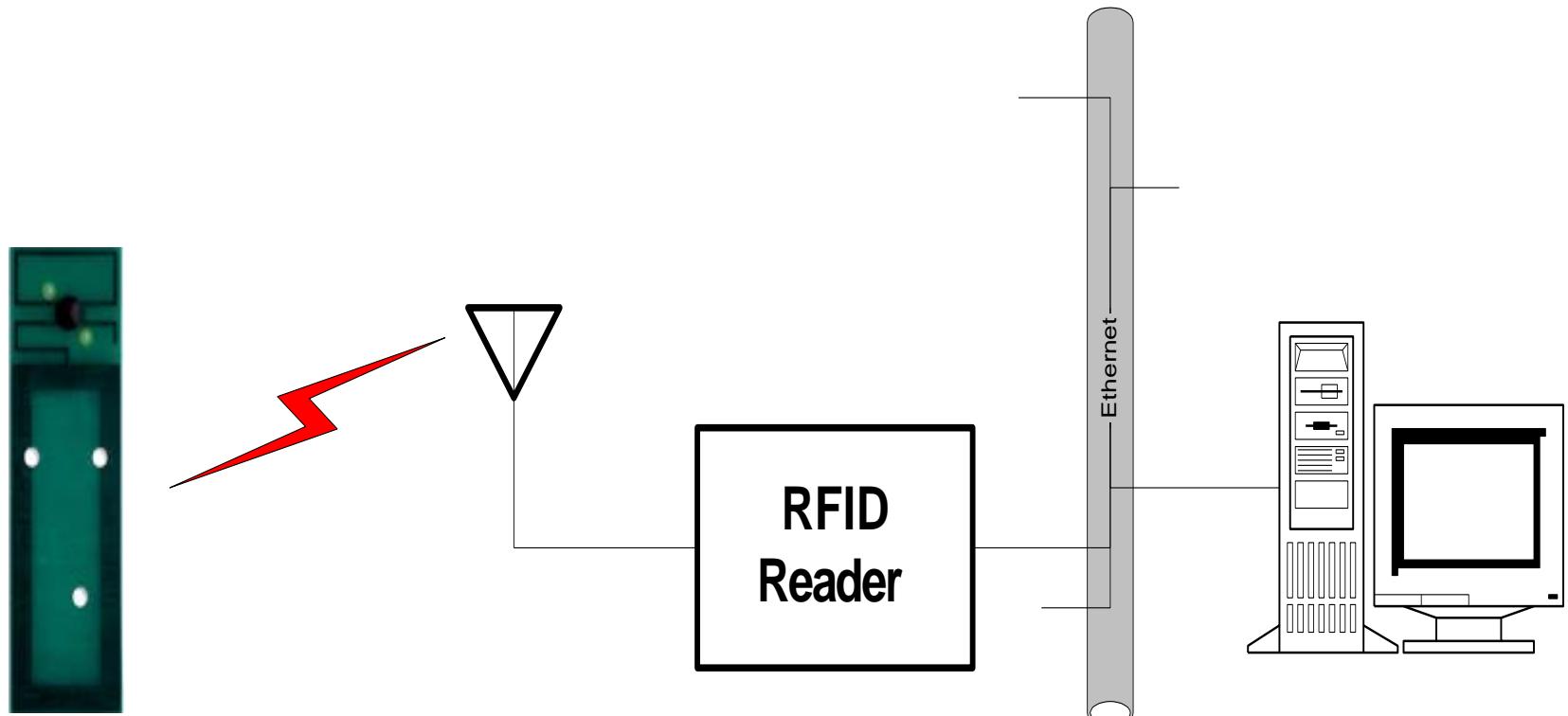
Internet of Things

- Smart and pervasive cloud applications for individuals, homes, communities, companies, and governments, etc.
- Coordinated calendar, itinerary, job management, events, and consumer record management (CRM) services
- Coordinated word processing, on-line presentations, web-based desktops, sharing on-line documents, datasets, photos, video, and databases, content distribution, etc.
- Deploy conventional cluster, grid, P2P, social networking applications in the cloud environments, more cost-effectively.
- Earthbound applications that demand elasticity and parallelism to avoid large data movement and reduce the storage costs

RFID

- ▶ RFID = Radio Frequency Identification.
- ▶ An ADC (Automated Data Collection) technology that:
 - uses radio-frequency waves to transfer data between a reader and a movable item to identify, classify and track.
 - Is fast and does not require physical sight or contact between reader/scanner and the tagged item.
 - Performs the operation using low cost components.
 - Attempts to provide unique identification and backend integration that allows for wide range of applications.
- ▶ Other ADC technologies: Bar codes, OCR.

RFID



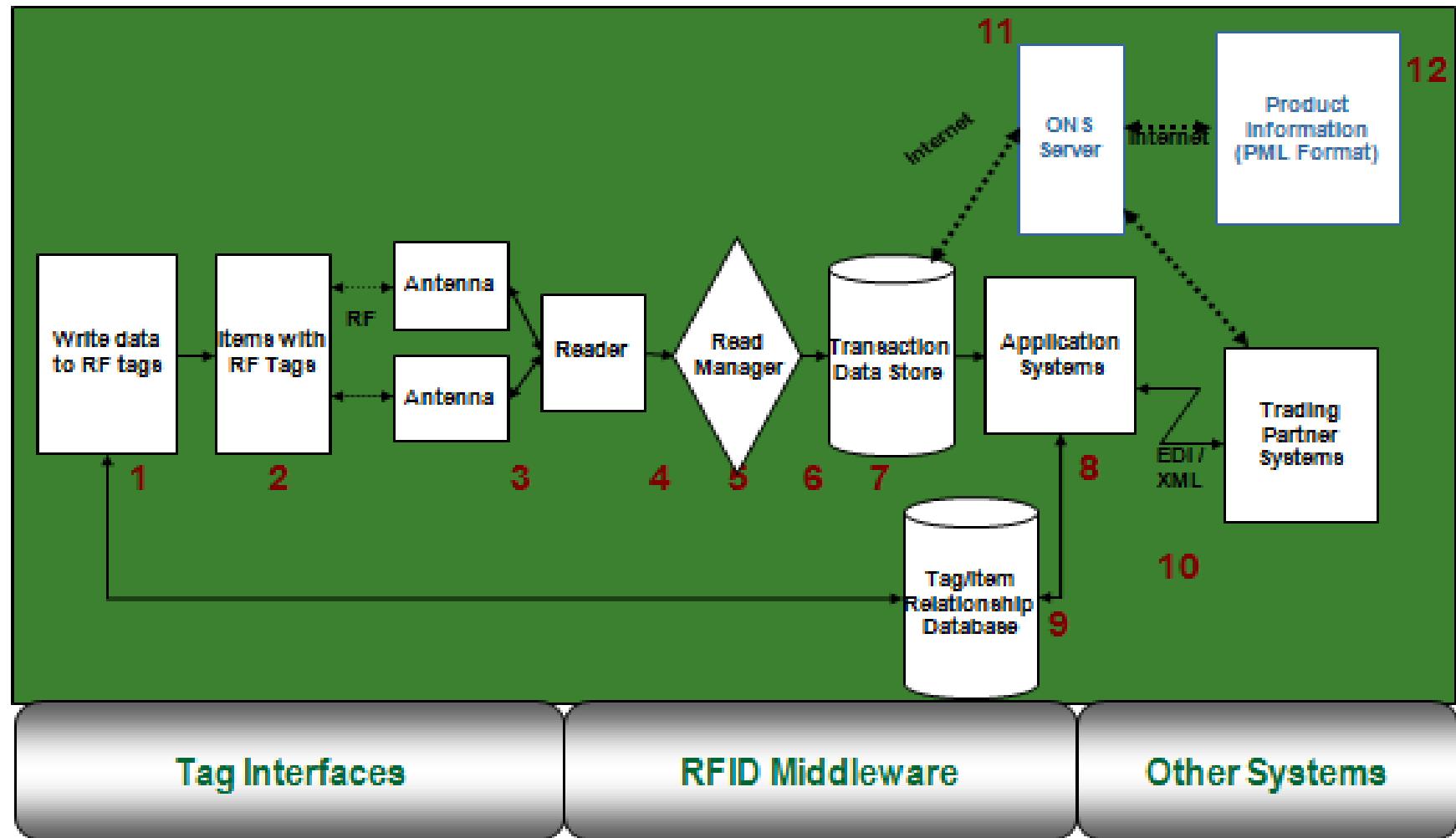
RFID Tag

RF Antenna

Network

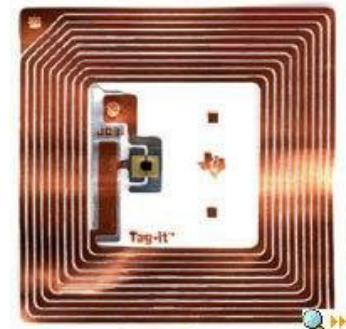
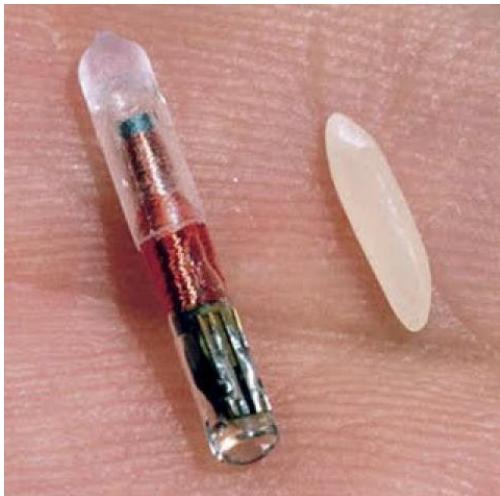
Workstation

RFID



RFID : Radio Frequency IDentification Technology

- RFID refers to small electronic devices that consist of a small chip and an antenna.
- Chip typically can carry 2,000 bytes of data or less.



RFID chip next to a grain of rice. This chip contains a radio-frequency electromagnetic field coil that modulates an external magnetic field to transfer a coded identification number when queried by a reader device. This small type is incorporated in consumer products, and even implanted in pets, for identification.

RFID tags

- ▶ Tags can be attached to almost anything:
 - Items, cases or pallets of products, high value goods
 - vehicles, assets, livestock or personnel

▶ Passive Tags

- Do not require power – Draws from Interrogator Field
- Lower storage capacities (few bits to 1 KB)
- Shorter read ranges (4 inches to 15 feet)
- Usually Write-Once-Read-Many/Read-Only tags

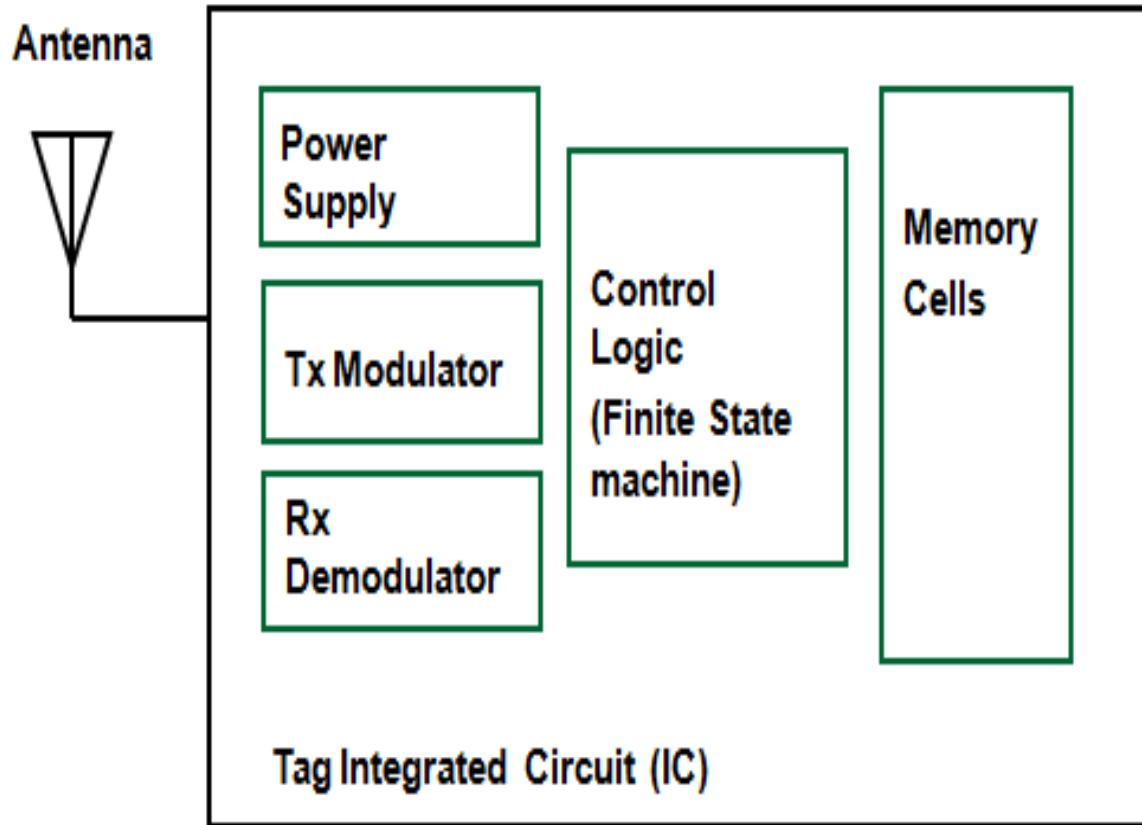
▶ Active Tags

- Battery powered
- Higher storage capacities (512 KB)
- Longer read range (300 feet)
- Read-Write Memory

RFID tag memory

- ▶ Read-only tags
 - Tag ID is assigned at the factory during manufacturing
 - Can never be changed
 - No additional data can be assigned to the tag
- ▶ Write once, read many (WORM) tags
 - Data written once, e.g., during packing or manufacturing
 - Tag is locked once data is written, similar to a compact disc or DVD
- ▶ Read/Write
 - Tag data can be changed over time
 - Part or all of the data section can be locked

Block Diagram

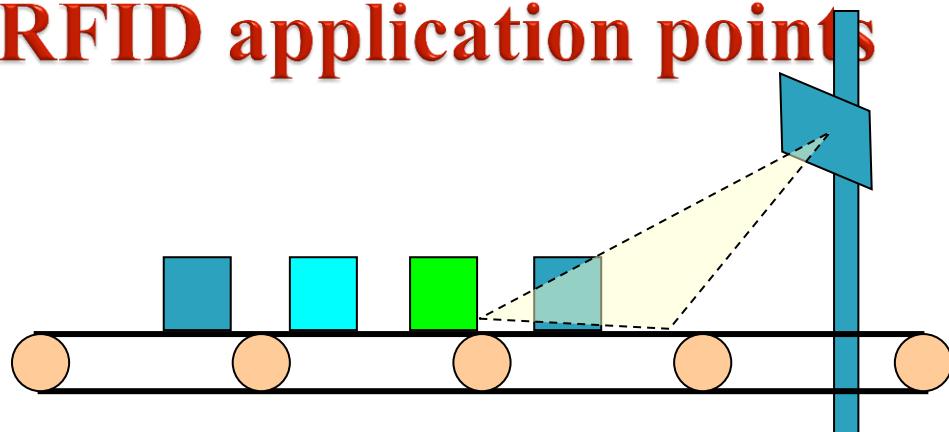


RFID readers

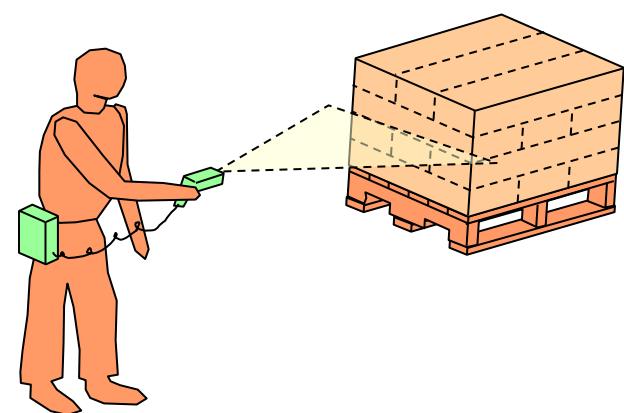
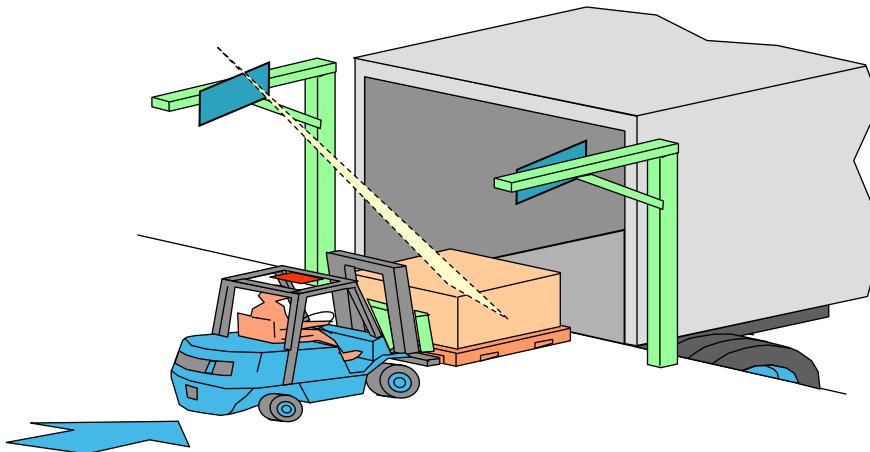
- ▶ Reader functions:
 - Remotely power tags
 - Establish a bidirectional data link
 - Inventory tags, filter results
 - Communicate with networked server(s)
 - Can read 100-300 tags per second
- ▶ Readers (interrogators) can be at a fixed point such as Entrance/exit
- ▶ Readers can also be mobile/hand-held



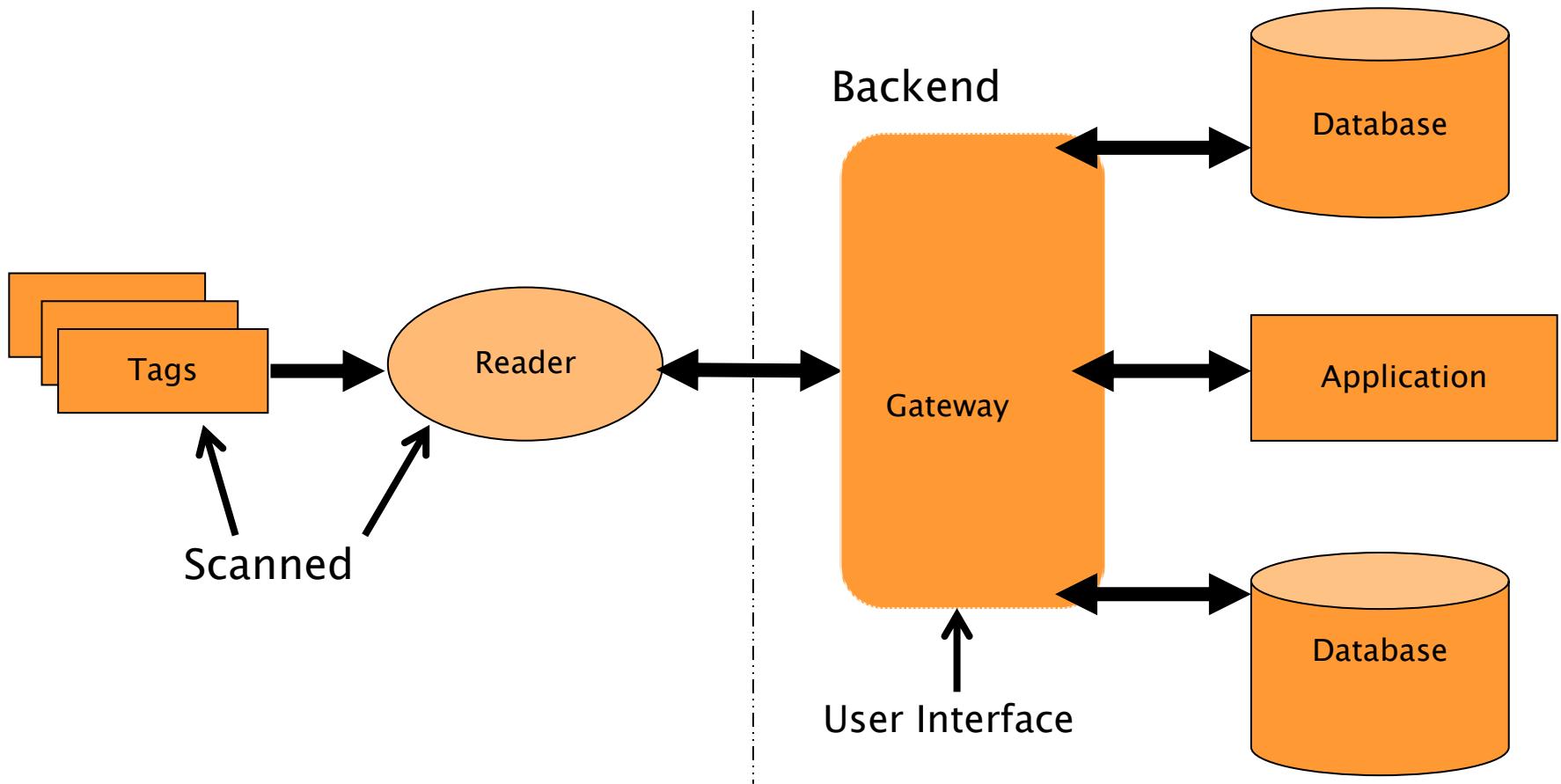
RFID application points



► Assembly Line



RFID Architecture



RFID Architecture

- Firstly items-tag are scanned by reader;
- Secondly in backend transmitted data coming through antenna (RF-wave) are being recognized by RFID-based system PC. It acts as a middleware communication gateway among items, reader and system database;
- And at the end it filters out and store data in RFID-databases for checking the data fault and relevant operation.

RFID Architecture

- ▶ Controller activates RFID reader to send RF signals
- ▶ Reader sends the signal of appropriate frequency
- ▶ Tag receives and modifies the signal
- ▶ Tag sends modified signals back through tag antenna
- ▶ Reader antenna receives the modified signal and reader decodes it
- ▶ Controller analyzes the results

RFID Brief History

- ▶ RFID (Radio Frequency Identifier) an Auto-ID data collection system surveillance, using RF waves for Identifying, Tracking and doing Management of material flow.
- ▶ Invented and used from early 1940, commercial operation begun from 1960 and more active work start from 1970.
- ▶ Most common application were tracked person and objects, identified goods in supply chain, reusable container, high value tools, security, controlling access to building, networks, payment systems and other assets

RFID Advantages

- ▶ An AUTO-ID based System
- ▶ A method for controlling inventory
- ▶ Automatically identify objects
- ▶ Saving Time and Money
- ▶ Non-Line-Sight Communication
- ▶ Minimize Work Stress of Staff
- ▶ Offering Self Check out/in
- ▶ Gathering statistics on used Items
- ▶ Improve Customer Services And
- ▶ Easily Prevent Theft

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

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.

RFID advantages over bar-codes

- ▶ No line of sight required for reading
- ▶ Multiple items can be read with a single scan

- ▶ Each tag can carry a lot of data (read/write)
- ▶ Individual items identified and not just the category

- ▶ Passive tags have a virtually unlimited lifetime
- ▶ Active tags can be read from great distances

- ▶ Can be combined with barcode technology

RFID System

- ▶ The RFID system consists of a tag (also known as a transponder) attached to the object being identified. The tag usually consists of an integrated circuit and an antenna.
- ▶ Another important component in the system is a reader. The reader queries the tag using radio frequency (RF) waves, and gets the identity of the tag via the RF waves.

RFID Frequencies

	Frequency band	Date Rate	Size of Tag Antenna	Read Range
LF	125 kHz to 134.2 kHz	Low Data Rate	Large	Lower
HF	13.56 MHz	High Data rate	Small	Long
UHF	860 to 915 MHz	High Data rate	Small	Long
MF	2.45 GHz to 5.8 GHz	High Data rate	Small	Long

- ▶ However, the UHF system does not work very well in the presence of metallic objects, water and the human body, compared to the LF system.

RFID Reader

- ▶ The RF carrier is modulated according to the information to be transmitted to the tag. The modulated carrier is amplified and radiated out of the antenna.
- ▶ The reader also receives the electromagnetic waves backscattered by the tag, amplifies the received signals, and demodulates to extract the information.

RFID Reader Antenna

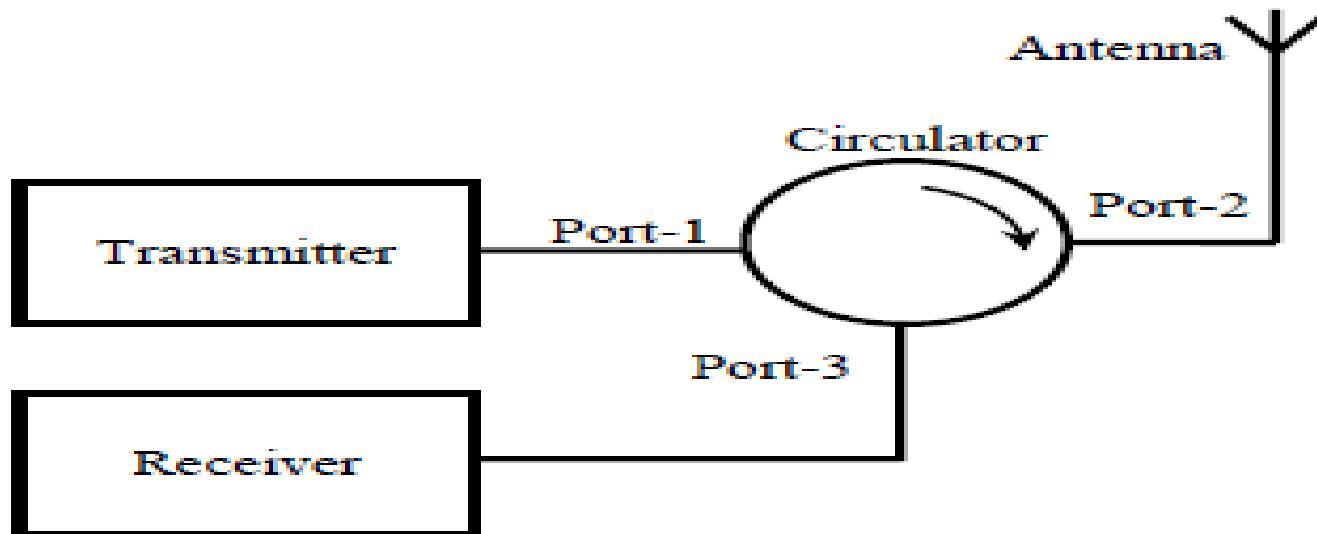
- ▶ Antennas are generally the largest and the most visible component of an RFID system.
- ▶ The size of the antenna depends on the operating frequency. The size of the reader antennas are usually of the order of wavelength.
- ▶ For example, the size of the reader antenna in an UHF system is about 200 to 300 mm. The reader antenna of an HF system can be as large as a meter in size.

RFID Reader Antenna

- ▶ **Bi-static** - One antenna is used to transmit the RF signals, and the other antenna is used to receive the signal backscattered by the tag. The two antennas are placed physically far apart to provide sufficient isolation between the transmitter and the receiver. This is necessary to ensure that the transmitter signal does not saturate or overload the receiver.
- ▶ One of the techniques is to use two antennas with orthogonal linear polarizations (for example horizontal for transmitting and vertical for receiving), and use a tag that has a circularly polarized antenna. Such a solution is much more complex and expensive compared to the earlier solution.

RFID Reader Antenna

- ▶ **Mono-static** - A single antenna transmits and receives the RF signals. Directional couplers and circulators are used to separate, transmit and receive signals. The isolator has three ports. The transmitter is connected to port 1, the antenna to port 2, and the receiver to port 3. The circulator is able to isolate, transmit and receive signals.



Personal use of Annotation

- ▶ Tags are less specific, deterministic, multi-modal (using multiple sensory channels) using multimedia.
- ▶ Subjective annotations are used in multiple contexts, multiple applications and multiple activities by users.
- ▶ Semantic gap challenge: between the low-level object features extracted and their high-level meaning with respect to a context of use

RFID Technology

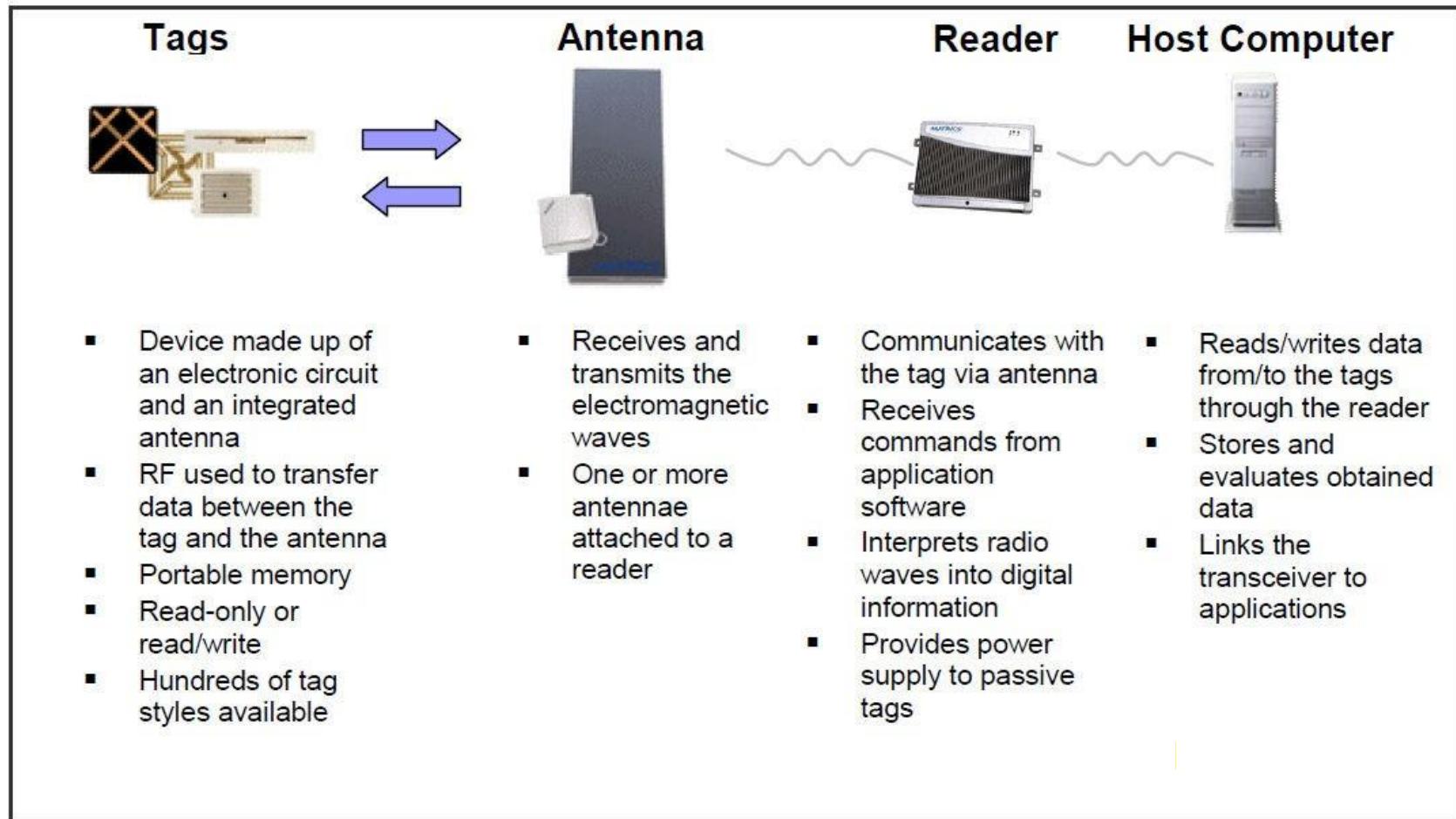


Figure D-1 Components of a Passive RFID System

RFID Technology

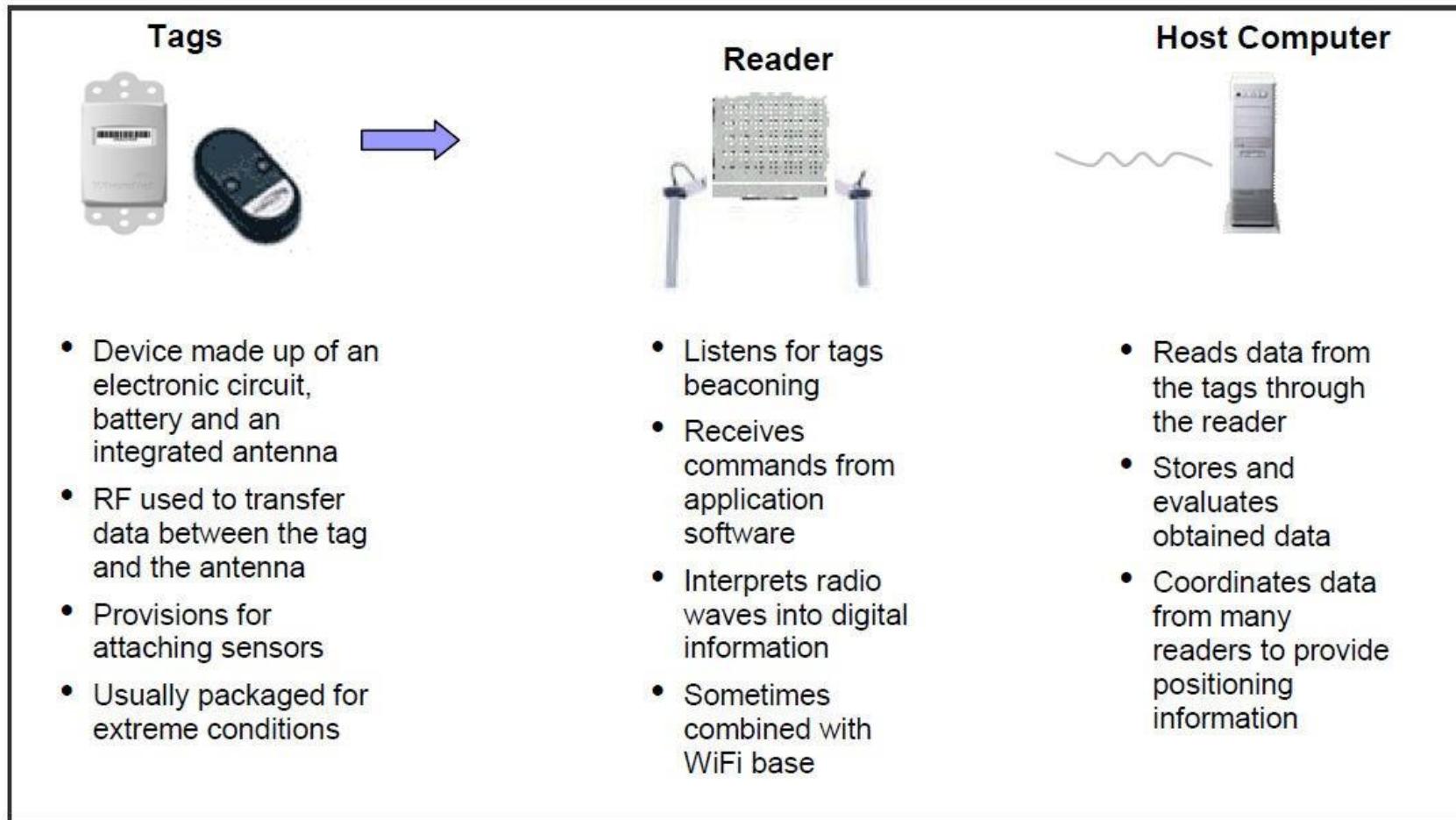
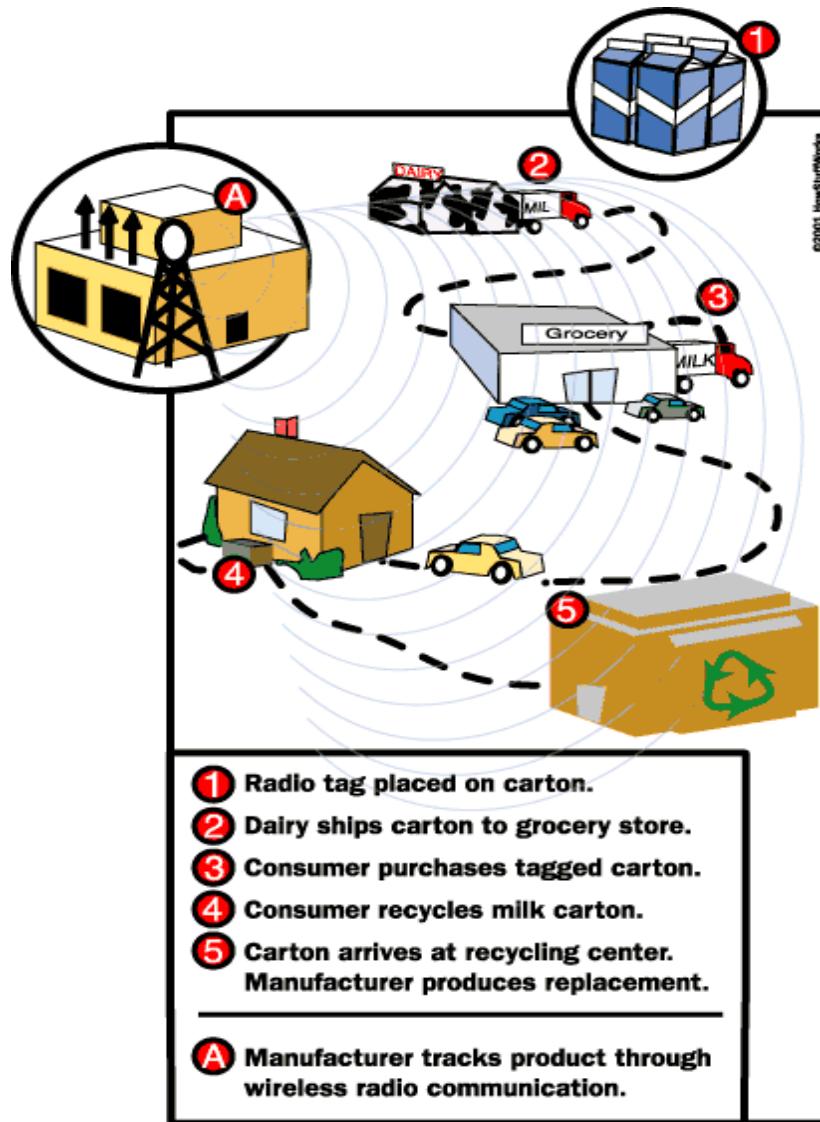
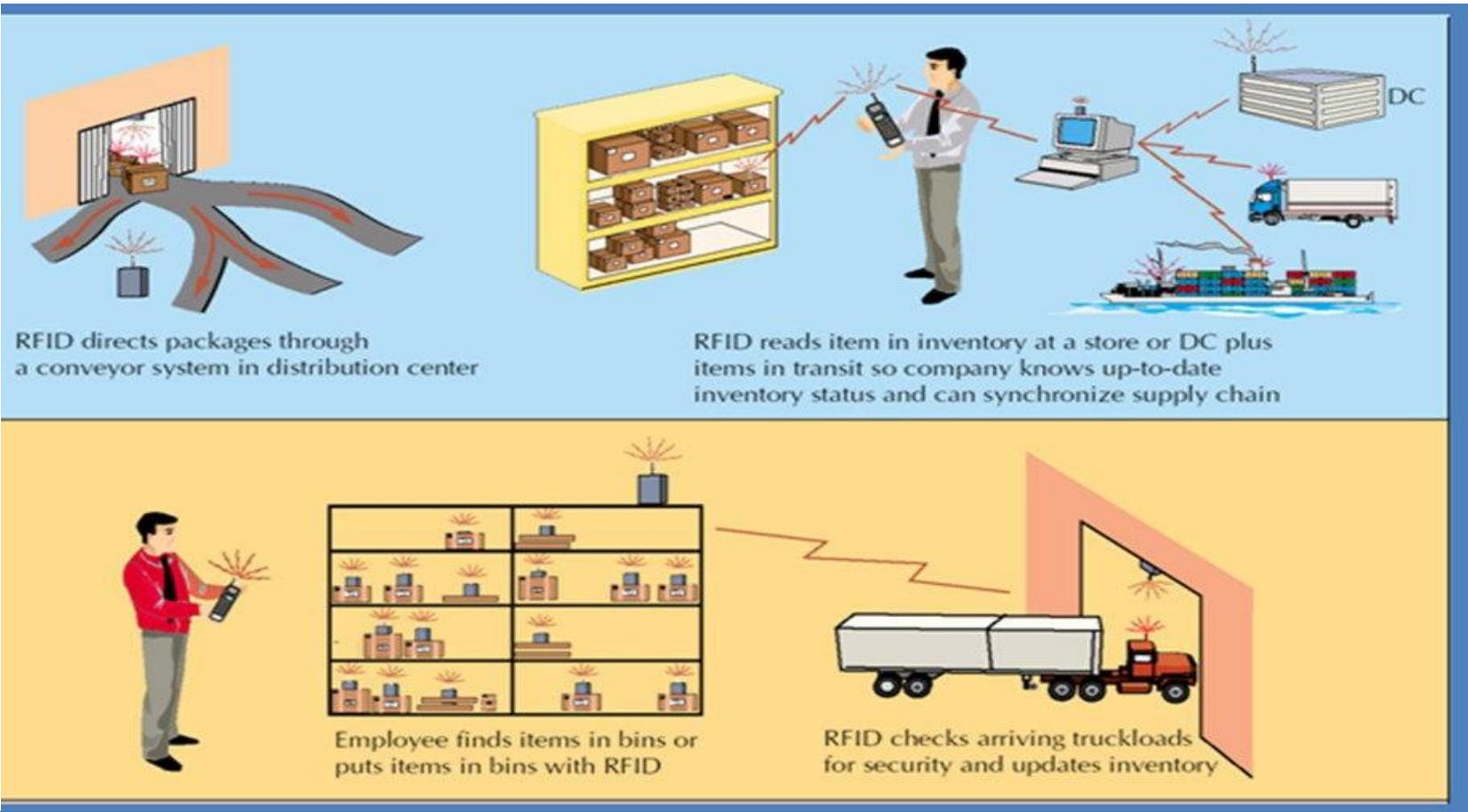


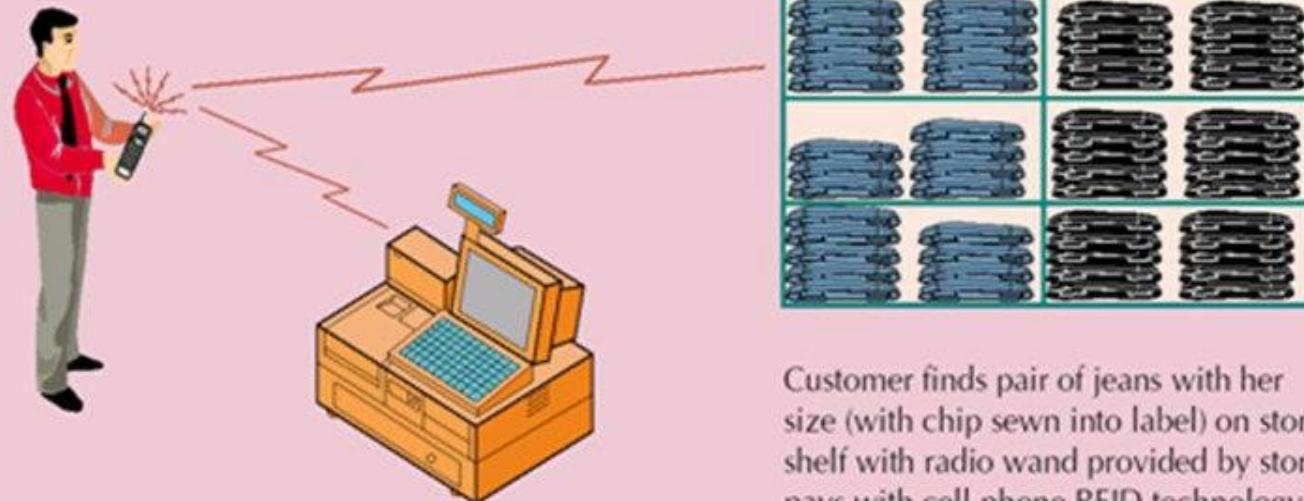
Figure D-2 Components of an Active RFID System



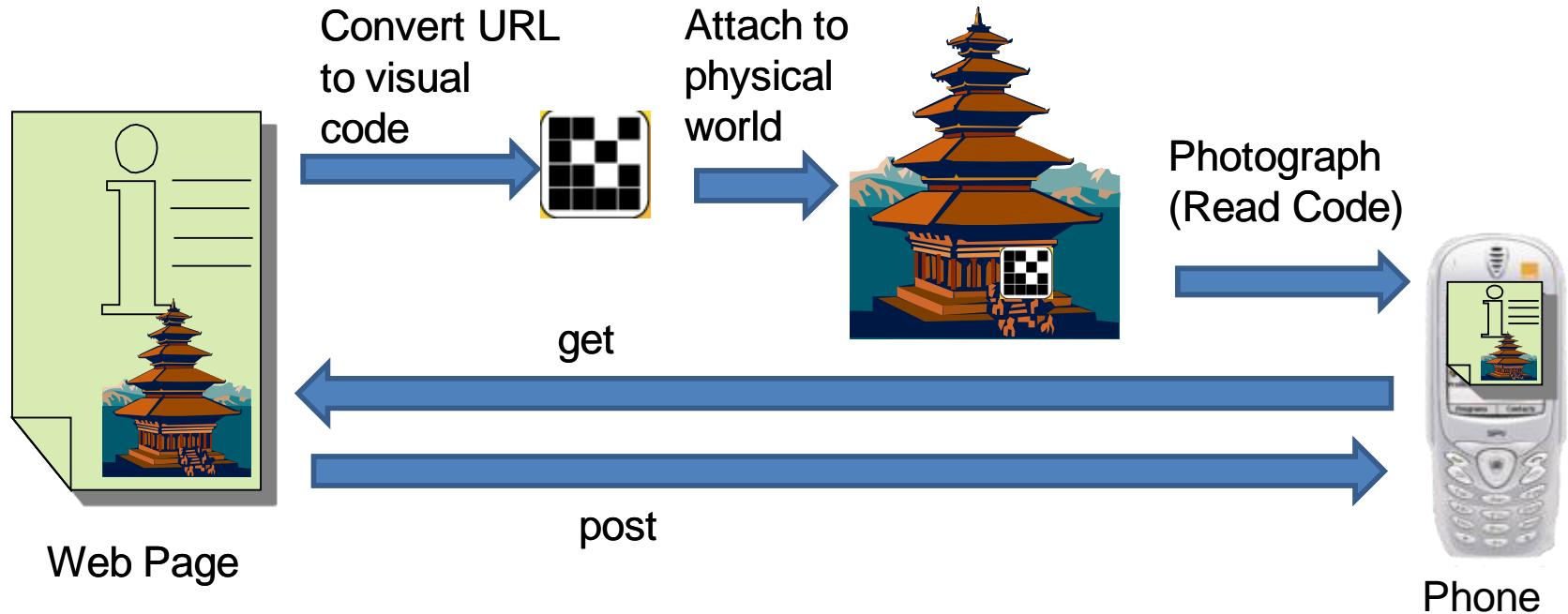
Retail and logistics : How RFID Works in Business Sales

RFID Merchandise Tracking in Distribution Center





Semacode



UbiComp Components

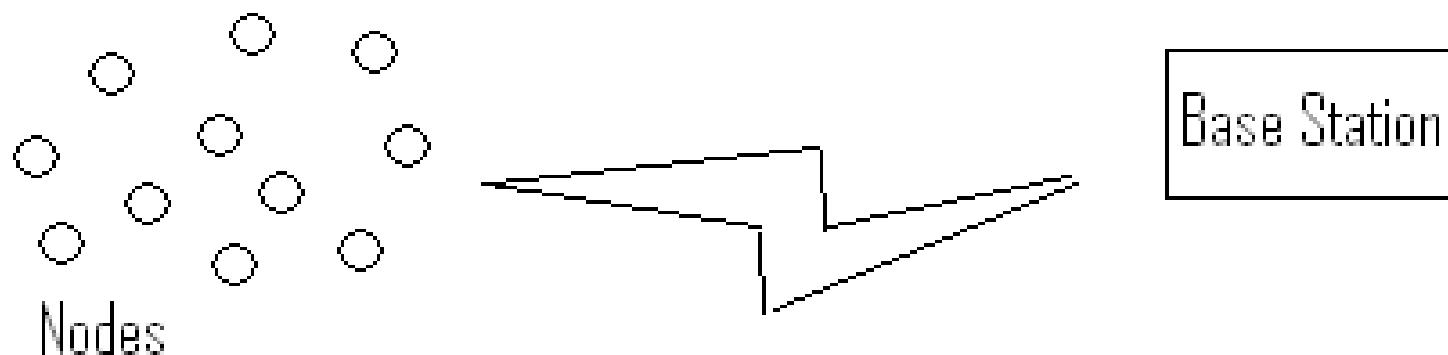
- ▶ Radios
- ▶ Sensors
- ▶ Microcontrollers
- ▶ Platform Softwares
- ▶ Application Software
- ▶ Device
- ▶ Airtime
- ▶ Service

Wireless Sensor Networks

- ▶ Wireless sensor networks (WSNs) are usually composed of a large number of sensors, which are densely and randomly deployed over inaccessible terrains and are utilized in applications such as environment surveillance and security monitoring.
- ▶ A MANET is an autonomous system of mobile nodes. The system may operate in isolation, or may have gateways to and interface with a fixed network.

Wireless Sensor Networks

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



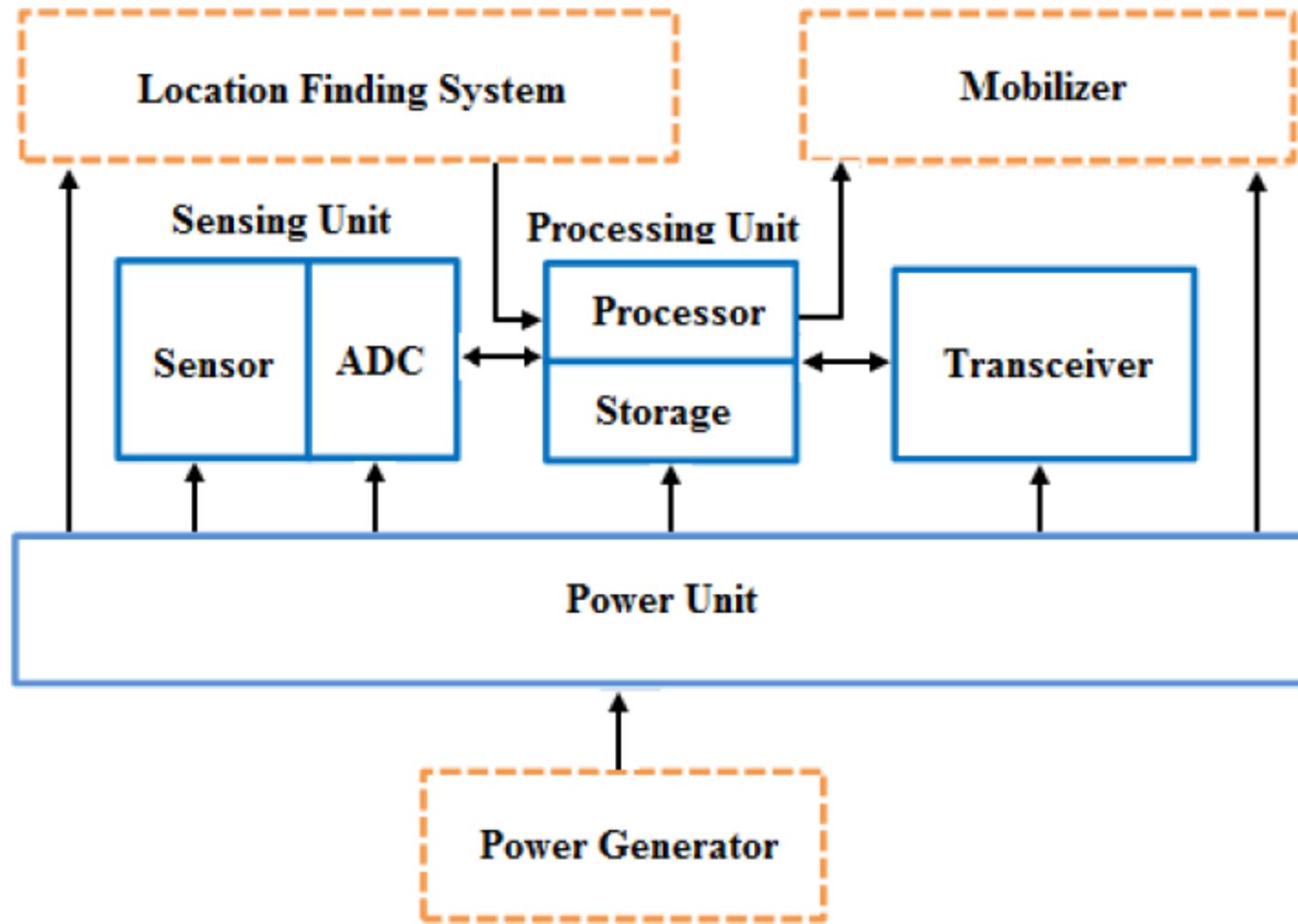
Wireless Sensor Networks

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

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 an router, to process packets to their destinations.

Components of a typical Sensor Node



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
- ▶ Sensor nodes can organize themselves to communicate with an access point
- ▶ Sensor nodes can collaboratively work

Sensors

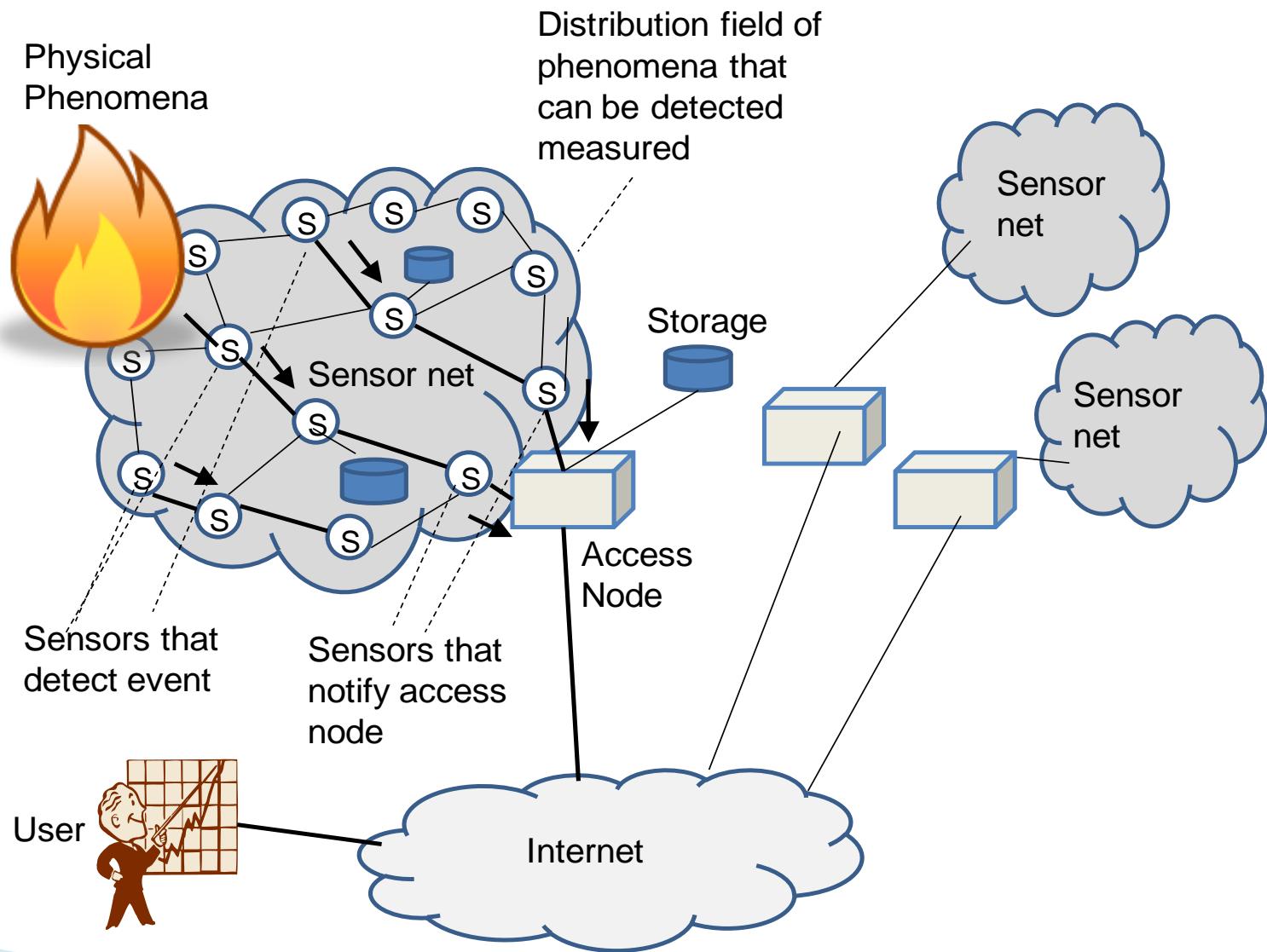
- ▶ Sensors are transducers that convert some physical phenomenon into an electrical signal
- ▶ Wireless sensors:
- ▶ Sensors can be networked – sensor nets

Sensor Application

Some examples of sensor use

- ▶ Cars
- ▶ Computers
- ▶ Retail, logistics:
- ▶ Household tasks
- ▶ Buildings
- ▶ Environment monitoring
- ▶ Industrial sensing & diagnostics

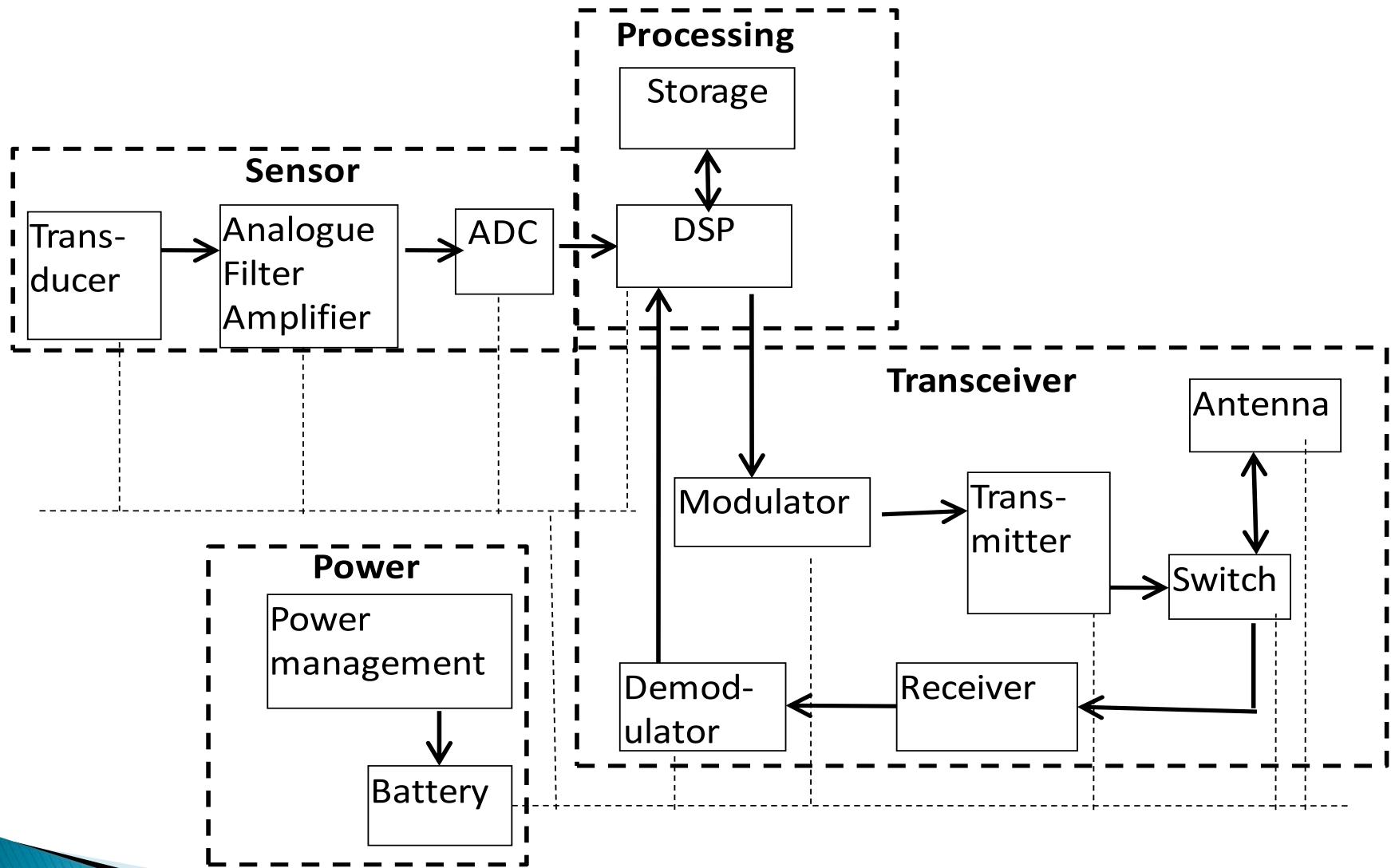
Sensor Network



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***
 - ***sink nodes***
 - ***gateway (access)***
- ▶ 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



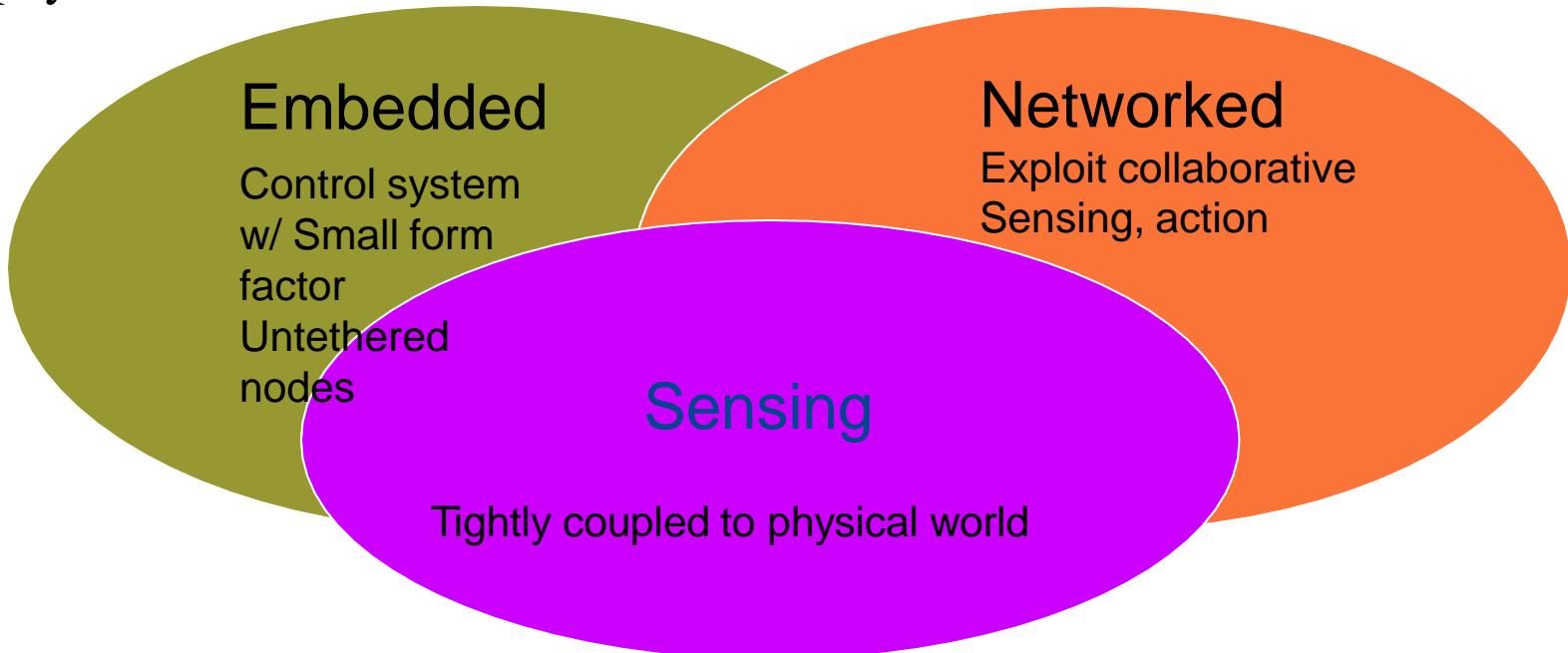
Sensor Net Design: Positioning & Coverage

- ▶ Given: sensor field (either known sensor locations, or spatial density)
 - Where to add new nodes for max coverage?
 - How to move existing nodes for max coverage?
- ▶ Can Control
 - Area coverage:
 - Detectability:
 - Node coverage:

Sensor Nets: Enabling Technologies

Embed numerous distributed devices to monitor and interact with physical world

Network devices to coordinate and perform higher-level tasks



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

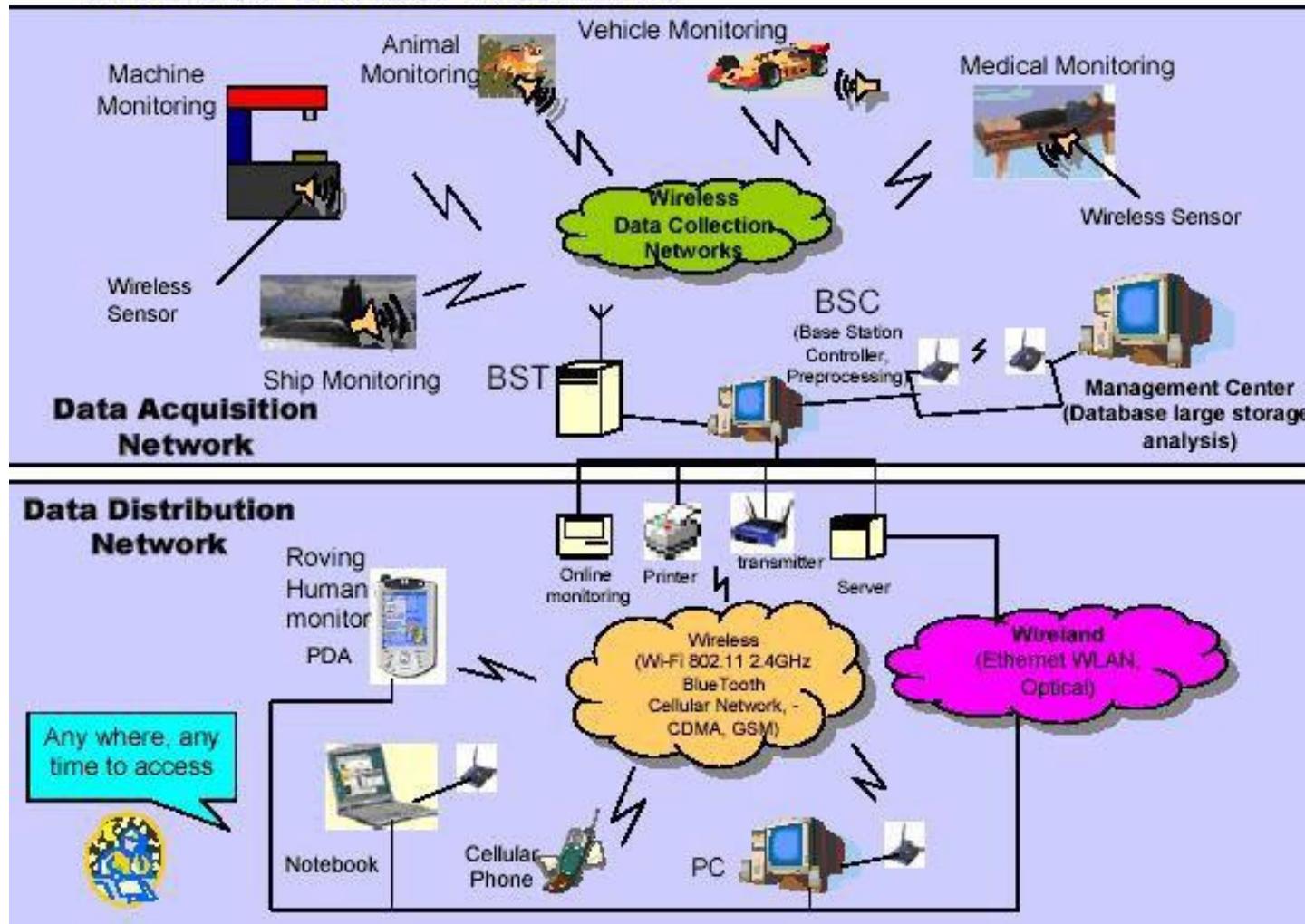


Wireless Sensor Networks(WSN)

- 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

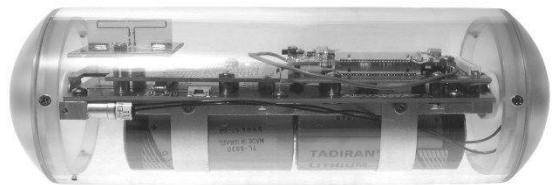
Wireless Sensor Networks(WSN)

Wireless Sensor Networks

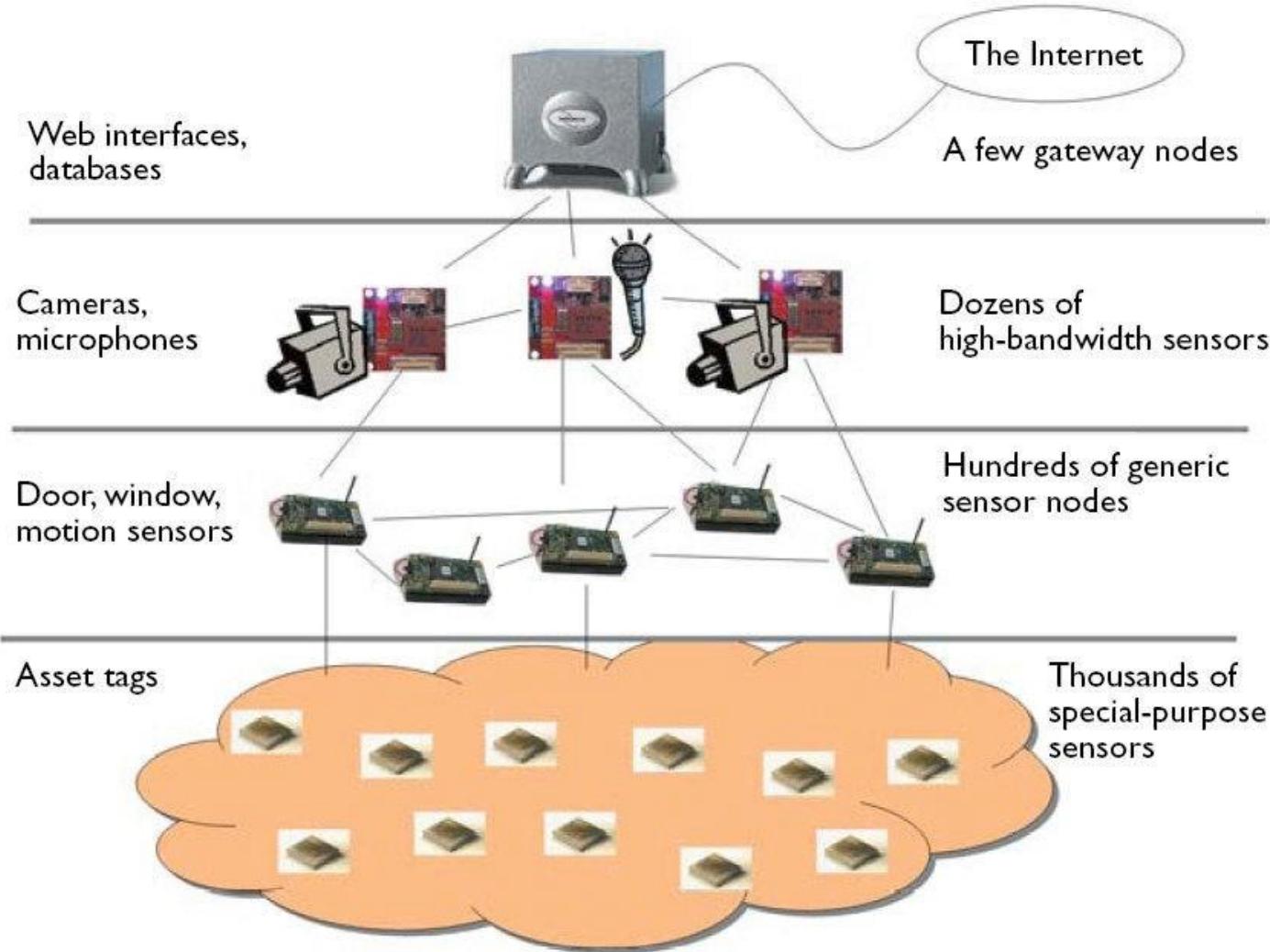


WSN Applications

- - Wild life Habitat monitoring projects Great Duck Island (UCB), James Reserve (UCLA), ZebraNet (Princeton).
 - 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)



Wireless Sensor Network



Stargate

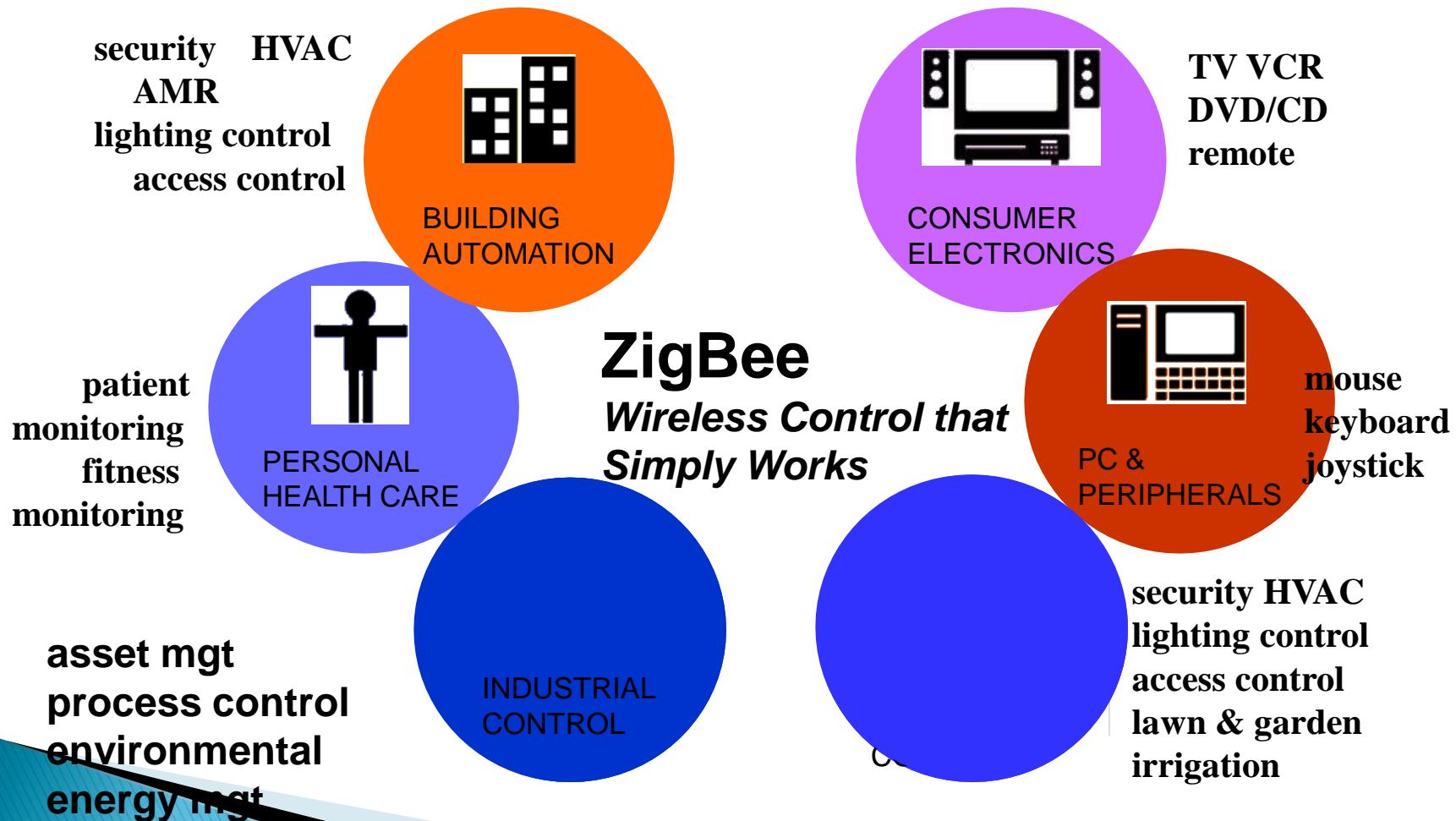
Table 9.7 Wireless Networks for Supporting Ubiquitous Computing

Market Name Standard	ZigBee 802.15.4	GSM/GPRS CDMA/1XRTT	WiFi 802.11g	Bluetooth 802.15.1
Application focus	Monitoring and control	Wide area voice and data	Web, e-mail, video	Cable replacement
System Resources	4 KB–32 KB	18 MB+	1 MB+	250 KB+
Battery Life (days)	100–1,000+	1–7	0.5–5	1–7
Network Size	Unlimited (2^{64})	1	32	7
Bandwidth (Kbps)	20–250	64–128+	54,000+	720
Range (meters)	1–100+	1,000+	1–100	1–10+
Success Metrics	Reliability, power, cost	Reach, quality	Speed, flexibility	Cost, convenience

Table 9.8 Three Generations of Wireless Sensor Networks

WSN Features	First Generation (1990s)	Second Generation (2000s)	Third Generation (2010s)
Manufacturers	Custom constructors (e.g., for TRSS)	Crossbow Technology, Inc., Sensoria Corp., Ember Corp.	Dust, Inc., and others
Physical Size	Large shoebox and up	Pack of cards to shoebox	Dust particle
Weight	Kilograms	Grams	Negligible
Node Architecture	Separate sensing, processing, and communication	Integrated sensing, processing, and communication	Integrated sensing, processing, and communications
Topology	Point-to-point, star	Client/server, P2P	P2P
Power Supply	Large batteries; hours, days, and longer	AA batteries; days to weeks	Solar; months to years
Lifetime			
Deployment	Vehicle-placed or air-drop single sensors	Hand-placed	Embedded, sprinkled, left behind

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



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*

ZigBee Architecture

- *Zigbee Devices* - Full Function Devices (FFD's)- ZigBee Coordinator , ZigBee Router- Reduced Function Devices (RFD's)- ZigBee End Device
- ZigBee Coordinator (ZC) - Only one required for each ZB network, Initiates network Acts as 802.15.4 2003 PAN coordinator (FFD). May act as router once network is formed.
- ZigBee Router (ZR) : Optional component, may associate with ZC , Acts as 802.15.4 2003 coordinator (FFD). Multihop routing of messages.
- ZigBee End Device (ZED) : Optional network component, Shall not allow association, Shall not participate in routing.

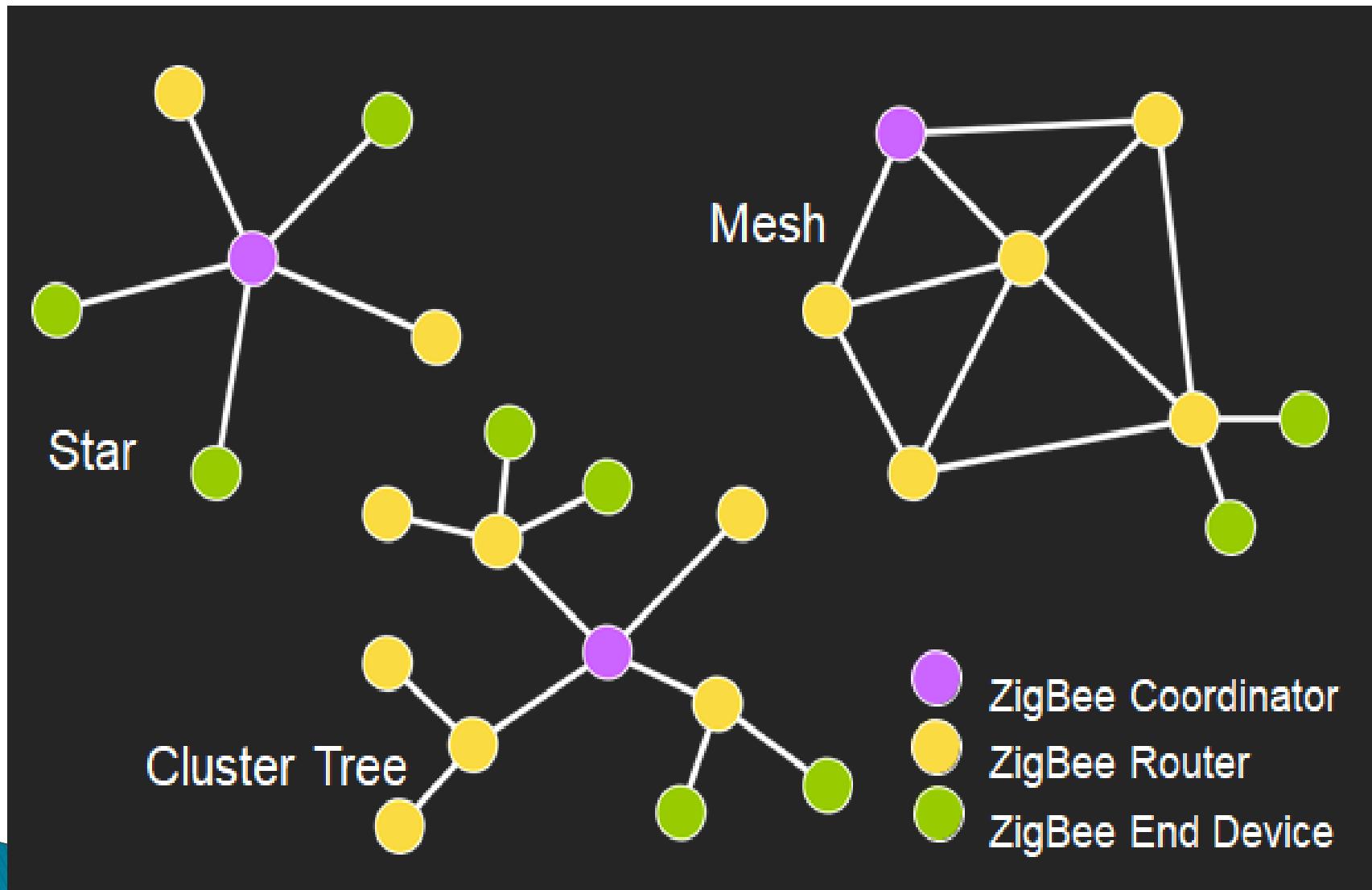
Basic Network Characteristics

- *65,536 network (client) nodes*
- *27 channels over 2 bands*
- *250Kbps data rate*
- *Optimized for timing-critical applications and power management*
- *Full Mesh Networking Support*

ZigBee Device Types

- ZigBee Coordinator (ZC)
 - One required for each ZB network.
 - Initiates network formation.
- ZigBee Router (ZR)
 - Participates in multihop routing of messages.
- ZigBee End Device (ZED)
 - Does not allow association or routing.
 - Enables very low cost solutions

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.

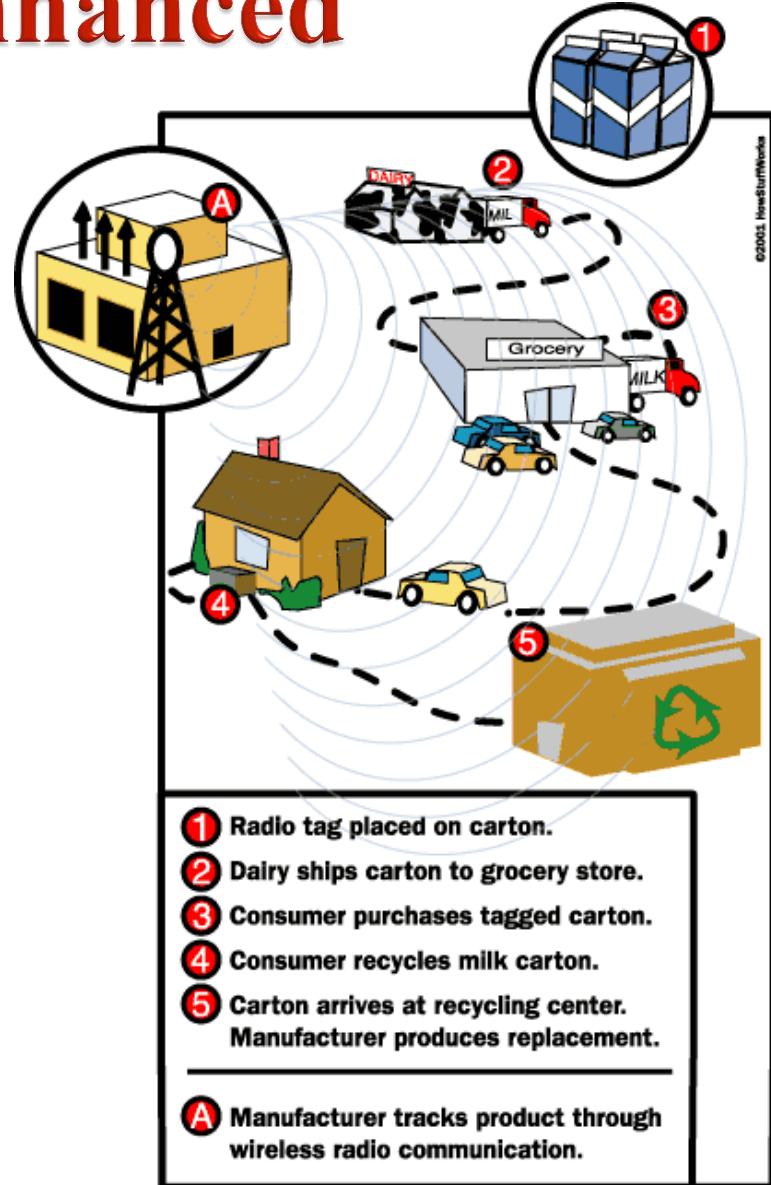


Smart fridge

- ▶ 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 records 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 connect 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 send to the doctor directly where he can make analyze 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.
- ▶ These 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.

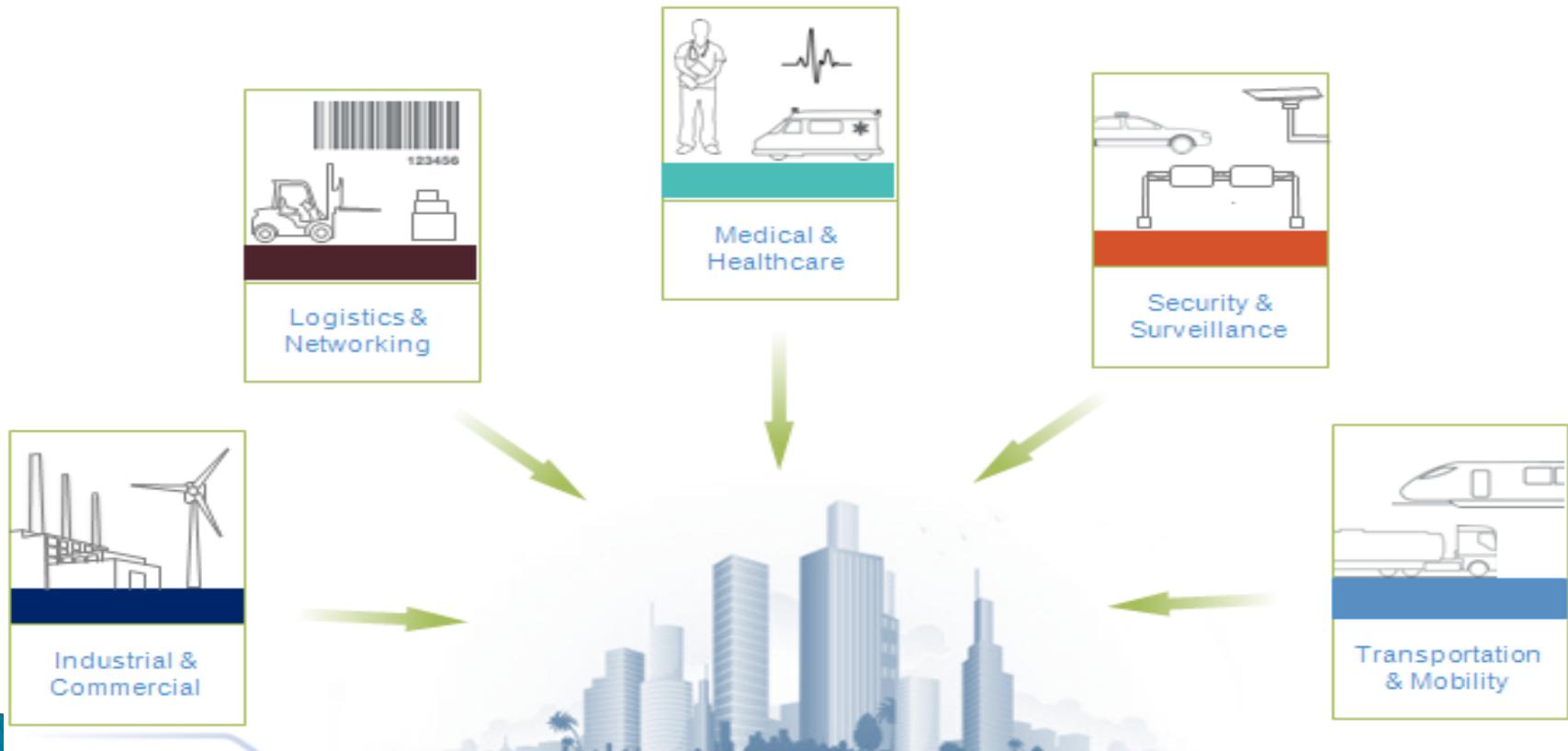
Smart Home

- ▶ 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



Logistics

Air Conditions

Smart City

Rail



Waste Management
Sports Medical Application

Ticketing

Industrial

Environmental

Irrigation

Public Transport

Smart Grid

Smart Buildings
Automatic Vehicle Location

Remote Monitoring
Signage

Transportation

Elderly Living

Retail

Cool Chain Monitoring

Energy Monitoring

Vending

Green Houses

First Responders

Metering

Reverse Vending
Medical

Value Transport



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!