

# RFID

## RADIO FREQUENCY IDENTIFICATION

ANUPAM GORTHI – 200701227  
HARSHA DEEP REDDY - 200701187

# What is RFID?

- **Radio-frequency identification (RFID)** is the use of an object applied to or incorporated into a product, animal, or person for the purpose of identification and tracking using radio waves.
- The technology basically consists of a Tags (Labels) and Interrogators (Readers)

# A Basic RFID Interaction



# RFID Tags

- ◎ RFID Tags contains two parts:
  - An Integrated Circuit for storing and processing information and Modulating and Demodulating the RF - Signal
  - An Antenna for communicating with the Reader / Interrogator

# RFID Tags - Types

- ⦿ There are three types of RFID tags available currently:
  - Active RFID tags
  - Passive RFID tags
  - Battery assisted passive RFID

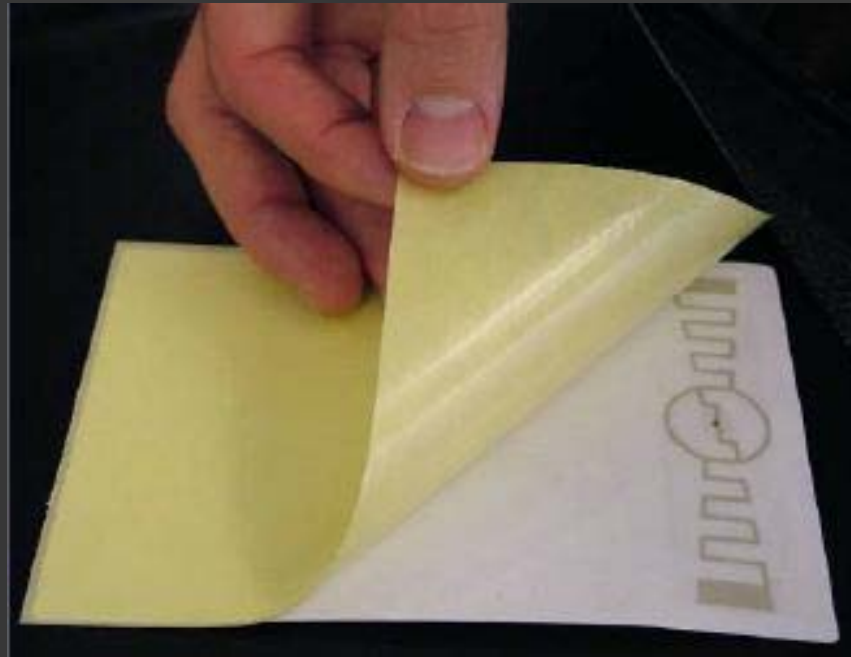
# Active RFID tags

- Tags which contain a battery and can transmit signals autonomously



# Passive RFID tags

- Tags which have no battery and require an external source to provoke signal transmission



# Battery assisted passive RFID

- RFID tags which require an external source to wake up but have significant higher forward link capability providing greater range.



# Standards on RFID

- RFID applications need to interoperate with the procedures and systems of other companies.
- Share information with a global consortium of partners, anywhere in this spectrum an individual application falls into
- The most popular standard is EPCglobal Tag Types.
- The ISO/IEC 18000 Tag standard is not so popular due to a few shortcomings

# EPCglobal Tag Types

- EPCglobal, a collaboration between GS1 and industry partners, defines a combined method of classifying tags based on:
  - Coupling methods
  - Types of keying and modulation
  - Information storage capacity
  - Modes of interoperability

## A Table Showing EPCglobal tag classes

Class	Description
Class 0	Passive, read-only
Class 0+	Passive, write-once but using Class 0 protocols
Class I	Passive, write-once
Class II	Passive, write-once with extras such as encryption
Class III	Rewritable, semi-passive (battery-powered chip, reader-powered communications), integrated sensors
Class IV	Rewritable, active, "two-way" tags that can talk to other tags, powering their own communications
Class V	Can power and read Class I, II, and III tags and read Class IV and V tags, as well as acting as Class IV tags themselves

# Frequency Ranges of RFID

- ⦿ The operating frequency is the electromagnetic frequency the tag uses to communicate or to obtain power.
- ⦿ The electromagnetic spectrum in the range in which RFID typically operates is usually broken up into
  - low frequency (LF)
  - high frequency (HF)
  - ultra-high frequency (UHF)
  - Microwave

# Frequency Ranges of RFID

- Because RFID systems broadcast electromagnetic waves, they are regulated as radio devices
- RFID systems must operate at the frequencies that do not interfere with other, protected applications, such as emergency service radios or television transmissions.

# RFID frequency ranges

Name	Frequency range	ISM frequencies
LF	30300 kHz	< 135 kHz
HF	330 MHz	6.78 MHz, 13.56 MHz, 27.125 MHz, 40.680 MHz
UHF	300 MHz-3 GHz	433.920 MHz, 869 MHz, 915 MHz
Microwave	> 3 GHz	2.45 GHz, 5.8 GHz, 24.125 GHz

# RFID Frequency – Read Range – Applications

Frequency	Typical max. read range for passive tags	Applications
LF	50 centimeters	Pet identification and close reads of items with high water content
HF	3 meters	Building access control
UHF	9 meters	Boxes and pallets
Microwave	> 10 meters	Vehicle identification of all sorts

# Interrogator / Reader

- ① An RFID reader has to communicate with the RFID Tag, Process the obtained data and send it to the RFID Middleware
- ① A RFID Reader mainly consists of:
  - Antenna Subsystem
  - Controller
  - Network Interface



# Antenna Sub - System

- The Antenna sub-system is used to handle all the communications with the communicating RFID Tags and communication with the RFID Middleware
- The Antennas present vary from two for solely Transmitting or Receiving to a DUPLEX antenna

# Controller

- The controller is responsible for controlling the reader side of the tag protocol as well as determining when information read from a tag constitutes an event to send to the network. The reader controller is also responsible for managing the reader's end of the reader protocol
- A Controller can be a tiny embedded reader on a telephone or PDA, to a complete microcomputer itself

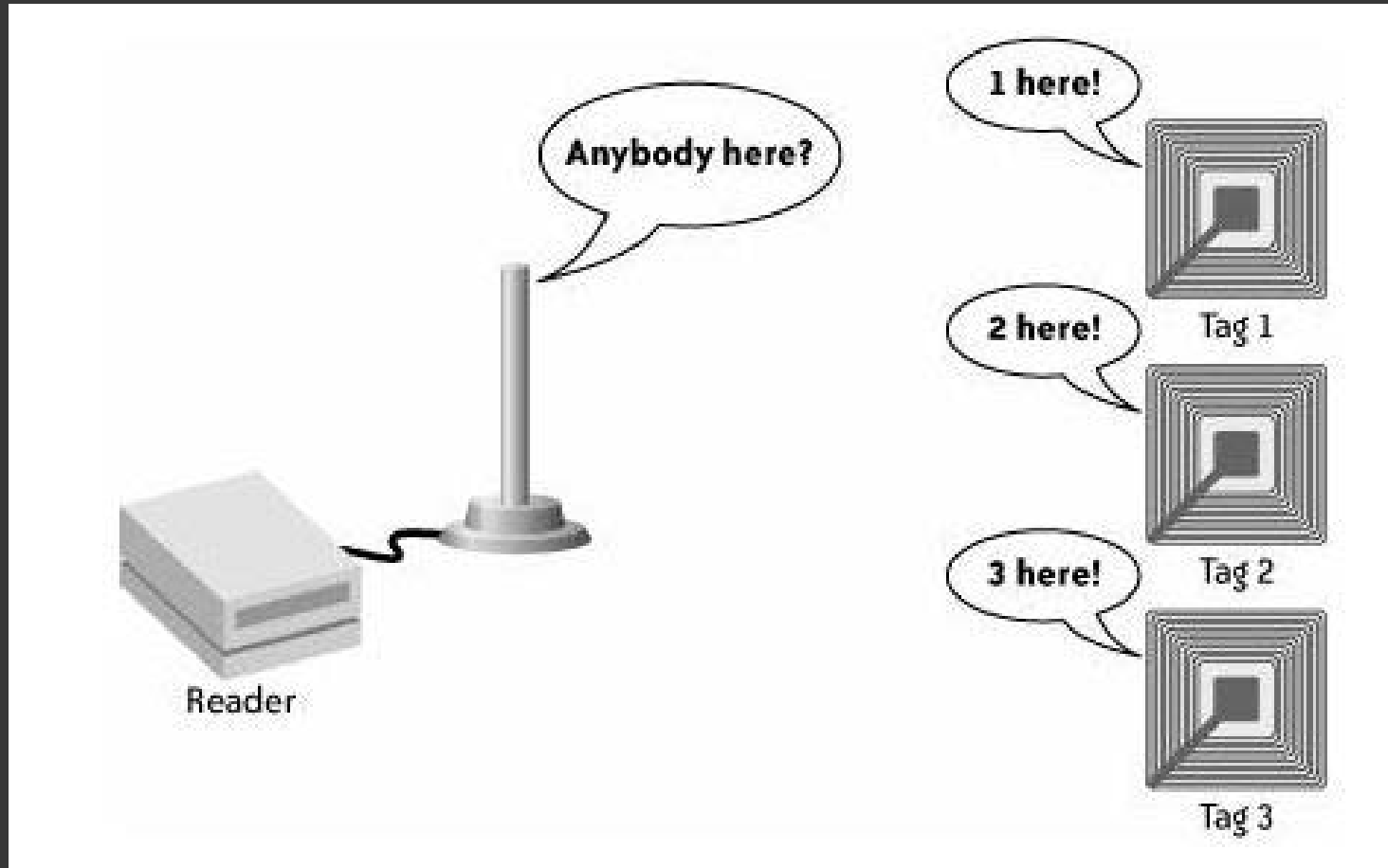
# Network Interface

- ⦿ Readers communicate with the network and other devices through a variety of Network interfaces
- ⦿ After Reading tags and recognizing events a Network Interface is used to transmit that data to a RFID Middleware
- ⦿ Most RFID readers have serial interfaces using RS 232 or RS 422 or RS 485
- ⦿ Ethernet, Bluetooth, and even ZigBee are now being used in the RFID Devices.

# How Does it Work?

- ⦿ Coupling is a way by which the reader and the tag communicate
- ⦿ A tag's coupling mechanism determines the way a circuit on the tag and a circuit on the reader influence each other to send and receive information or power.
- ⦿ The type of coupling a tag uses directly affects the read range between the tag and reader. We can group the different read ranges loosely into those systems where the read range is close (within 1 cm), remote (1 cm to 1 m), or long-range (more than 1m).

# Reader – Tag Communication

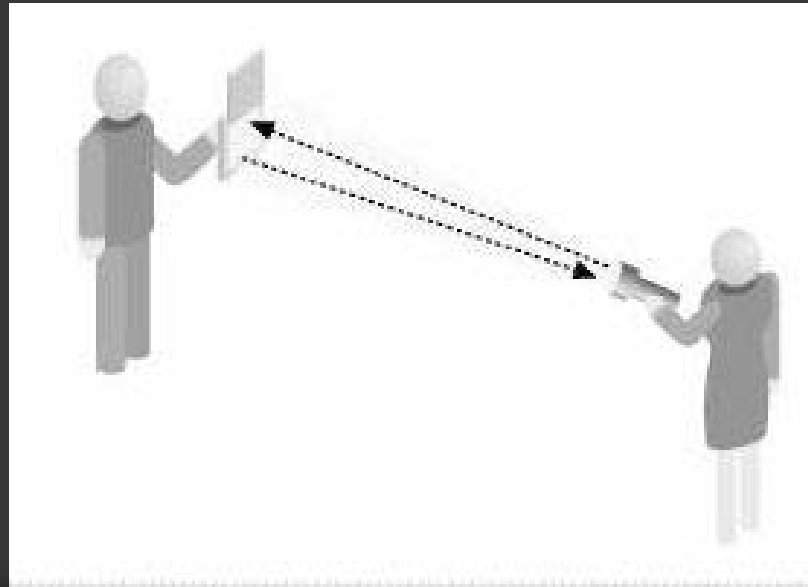


# Coupling

- ◎ The four types of are:
  - Backscatter coupling
  - Inductive coupling
  - Magnetic coupling
  - Capacitive coupling
- ◎ Capacitive and magnetic coupling are examples of close coupling ,while inductive coupling is a type of remote coupling, and backscatter coupling may be remote to long-range.

# Backscatter coupling

- In this coupling RF waves transmitted by the reader are scattered back by the tag
- The waves are reflected back to the source to send a signal

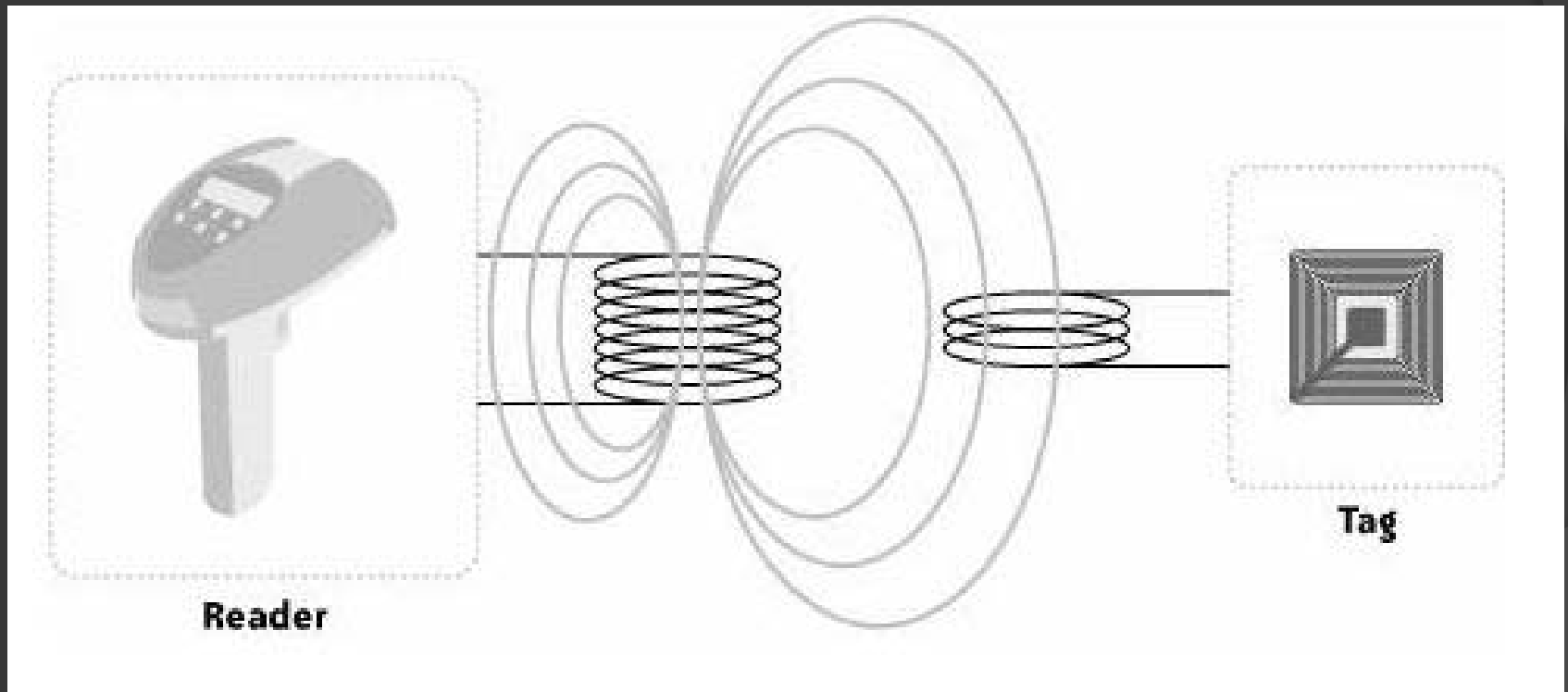


# Inductive Coupling

- A reader powers inductively coupled tags by using a coil antenna to generate a magnetic field. The field drives current through a coil on the tag by induction in much the same way that a transformer transfers energy between two coils
- Inductive coupling is a common type of remote coupling



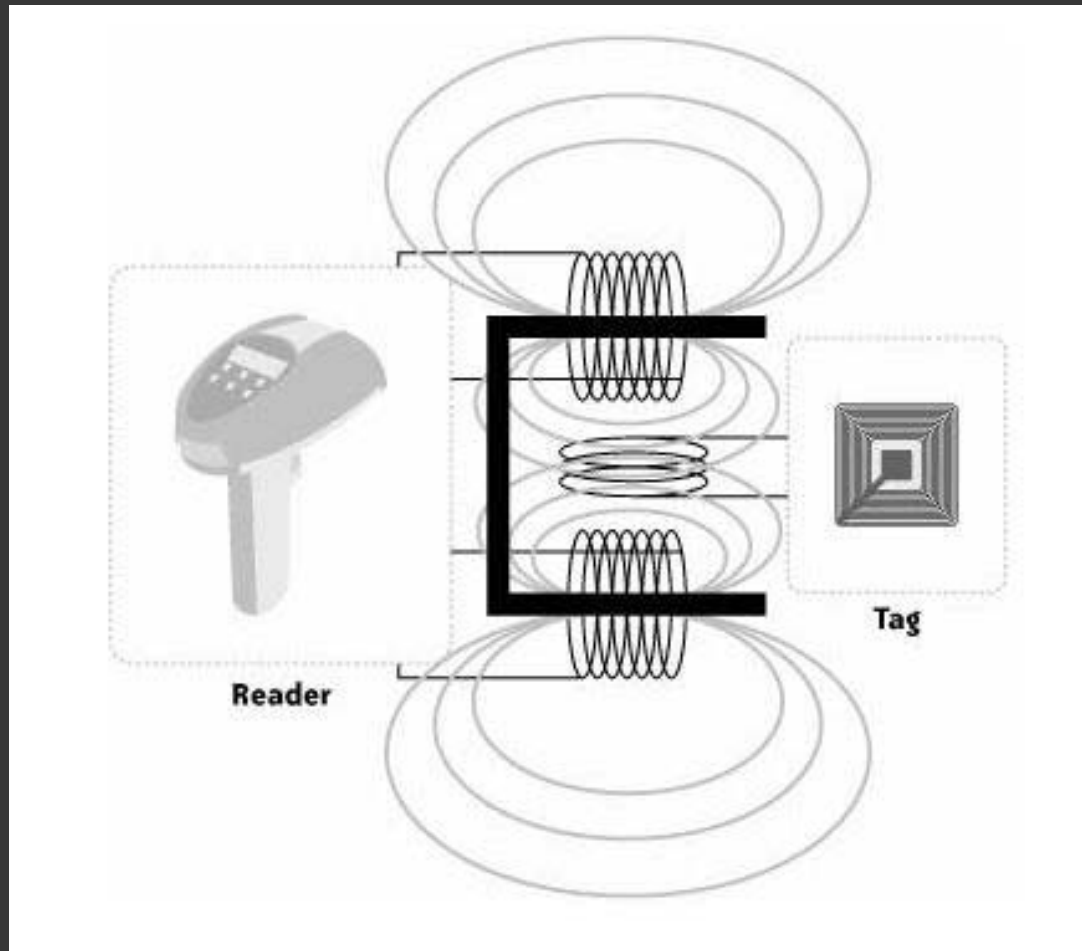
# Inductive Coupling



# Magnetic Coupling

- Magnetic coupling is a close coupling that is similar to inductive coupling in that the reader and tag form a pair of transformer coils.
- The major difference is that the reader coil in magnetic coupling is a round or U-shaped ferrite core with windings
- Since, the distance is so small the coupling is so strong compared to others

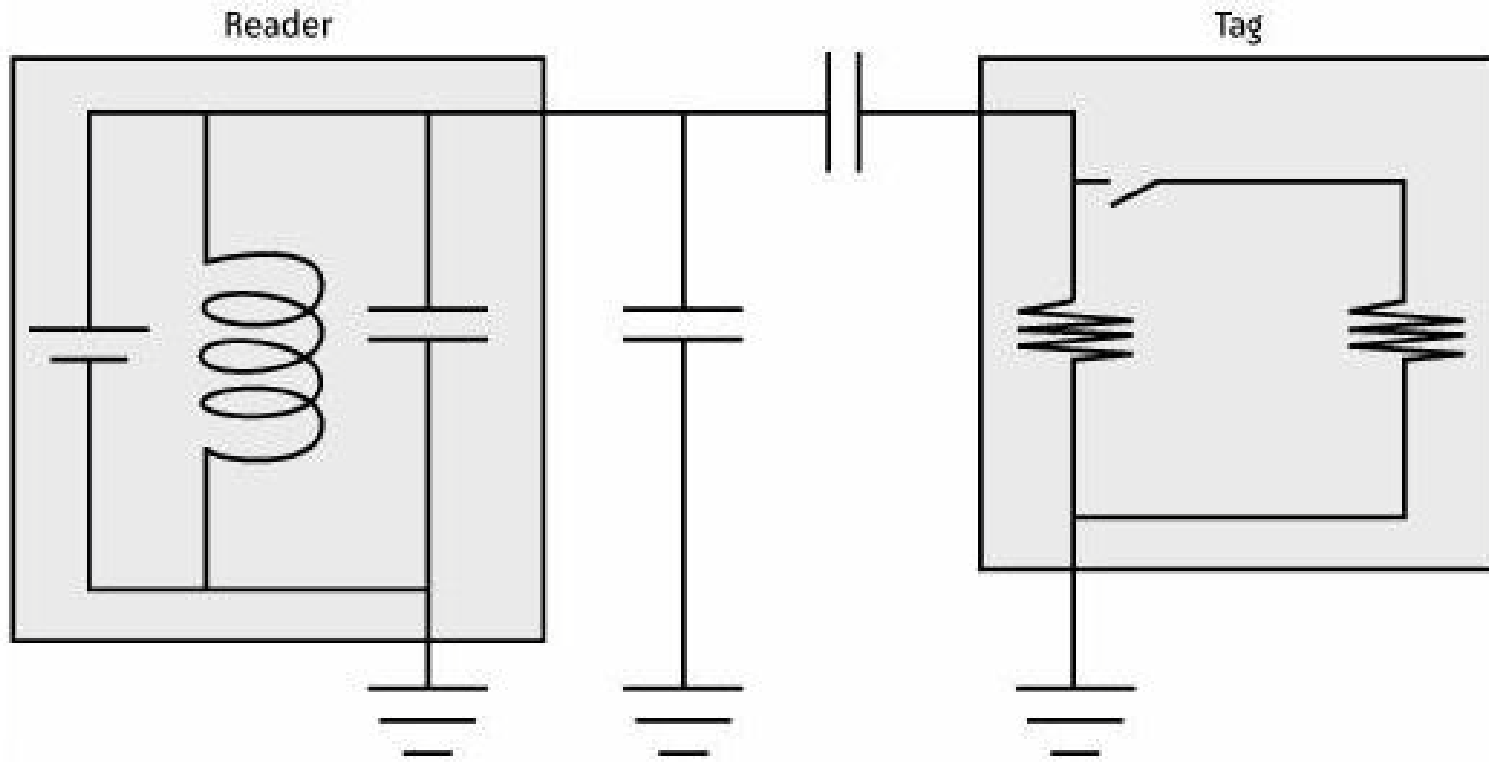
# Magnetic Coupling



# Capacitive Coupling

- Capacitive coupling is another form of close coupling that works best with the tag inserted into the reader
- This is also widely used for smart cards.
- Capacitive coupling dispenses with antennas and replaces them with electrodes.
- The reader and tag each have conductive patches that together form a capacitor when held exactly parallel to each other without touching.

# Capacitive Coupling



# Problems of RFID

- ⦿ Problems with RFID Standards
  - RFID has been implemented in different ways by different manufacturers and global standards are still being worked on.
- ⦿ RFID systems can be easily disrupted
  - Since RFID systems make use of the electromagnetic spectrum, they are relatively easy to jam.

# Problems of RFID

## ⦿ RFID Reader Collision

- Reader collision occurs when the signals from two or more readers overlap. The tag is unable to respond to simultaneous queries.

## ⦿ RFID Tag Collision

- Tag collision occurs when many tags are present in a small area.

# Applications



# Applications of RFID

- ⦿ Classic Example of RFID – Walmart
- ⦿ New applications in Recent Years
  - Student Monitoring on the move
  - Library Management System
  - Payment by mobile phones
- ⦿ Future Application
  - RFID for consumer of the future
  - Traffic Light Power Savings System – Our own idea

# Walmart:

## Driving New Technologies

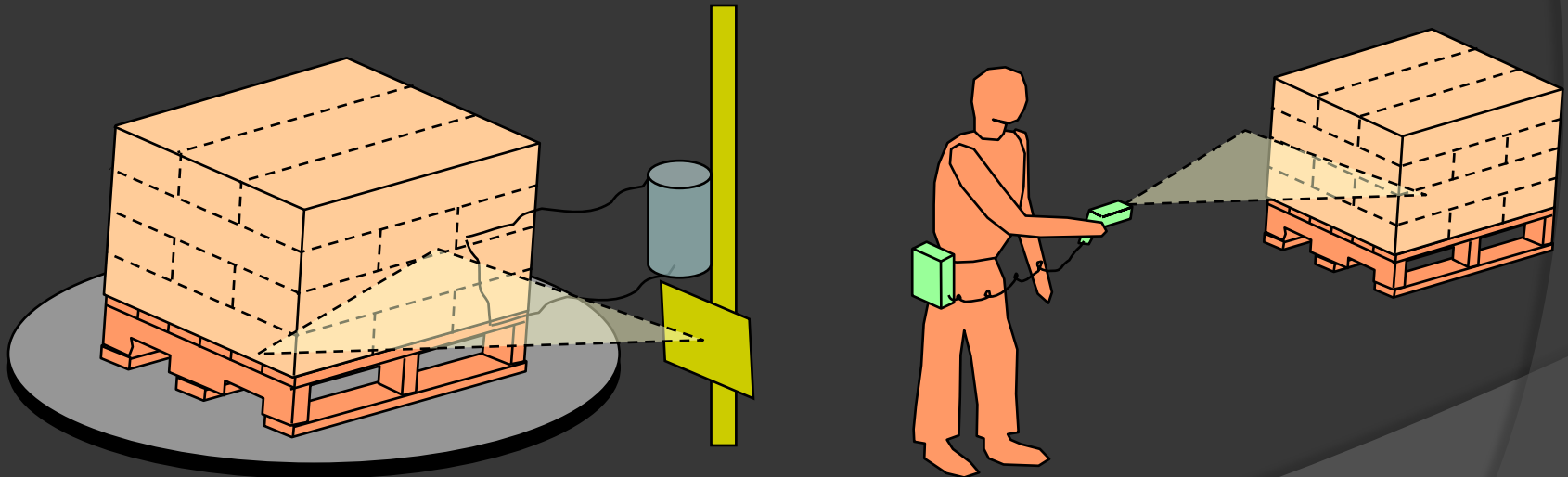
- ◎ 1984 – Walmart Stressed that suppliers use bar codes for every batch of products
  - As a result thousands were driven to use bar codes and now it is the standard used by many
- ◎ 2003 – Walmart Stressed that all its suppliers use RFID tags at a product level.
  - As a result they have the data of each and every product they ship out.
  - Many predict RFID is the future of Supply Chains around the world.

# Walmart: Driving New Technologies



# Walmart - Process

- Each product has a RFID tag associated
- When being supplied the products are scanned at a box level and shipped off.



Automatic Box/Unit Level Inventory

Manual Box/Unit Level Inventory

# New Applications: Library Management System

## LibBest Library RFID Management System



# Library Management System

- ⦿ RFID tags replace both the EM security strips and Barcode.
- ⦿ Simplify self check-out / check-in.
- ⦿ The information contained on microchips in the tags affixed to library materials is read using radio frequency technology regardless of item orientation or alignment.
- ⦿ Radio Frequency anti-theft detection is innovative and safe.
- ⦿ Identify items which are out of proper order.
- ⦿ RFID tags last longer than barcodes because nothing comes into contact with them. Most RFID vendors claim a minimum of 100,000 transactions before a tag may need to be replaced.

# Future Looks Bright

## RFID for future Consumer

- ① Easy item returns: You might be able to return RFID-tagged items of apparel without a store receipt. The unique identifier in the tag would reference a database record with the time of purchase and the original price and even credit card information, if desired.
- ① Smart appliances: Your washing machine could choose its cycle setting based on tag information in the items to be washed. Your “smart” refrigerator could take inventory automatically, alerting you to expired or recalled foodstuffs, creating shopping lists automatically, and even searching the Internet to find recipes you can prepare with the items in the refrigerator. Your closet could alert you to what clothing it contains and what is out for cleaning – and search the Internet for fashion advice.

# Future Looks Bright

## RFID for future Consumer

- ① Personalization: You might carry an RFID tag that stores (or references) personalization data. When you walk up to a clothing rack in a shop, LEDs might flash on the hangers with items in your size and preferred colours.
- ① Easy shopping: You could purchase or rent items by simply walking out of a shop with them. The RFID payment device in your pocket and the RFID tags in the items you carry would allow payment to be made automatically.



# Traffic Light Power Savings System

- ⦿ The street lights within a particular range say 300m from vehicle are switched on
- ⦿ Under heavy traffic the operations remains same i.e. All lights are on since RFID devices can communicate with more than one tag
- ⦿ Lights out of the range are off and hence can save a lot of power
- ⦿ Very useful in late nights between 2AM – 5AM when traffic is least
- ⦿ Issues –
  - Pedestrians
  - System faulty
  - A tag from a vehicle has fallen down

# Traffic Light Power Savings System



# Issues with RFID

- Still a lot of technological improvements needed until RFID devices get cheaper
- If RFID does become successful we would be surrounded by a world of tags which unlike bar codes, might remain with the product and hence with us forever - Anonymity and privacy?
- RFID faces a lot of problems when brought close to metal devices.

# Conclusion

- RFID is technology used from super-markets to Space Stations
- The penetration has been minimum till now, given the scope of the technology
- But the pace it is expected to grow it would change the whole world.

# And finally ending with A Quote

- With RFID about to arrive in full force, don't be lulled at all. Major changes are coming, and not all of them will be positive. The law of unintended consequences is about to encounter surveillance devices smaller than the period at the end of this sentence.



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Writer for  
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**Any Questions ?**



**Thank You**