Challenges in RFID

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Agenda

- Introduction
- RFID Applications
- Collision Problem
- Challenges in RFID

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- **Introduction**
- **RFID Applications**
- **Collision Problem**
- **Challenges in RFID**

Introduction

- **Radio Frequency Identification (RFID)** is a wireless data capture technology that can be used to electronically identify and track objects

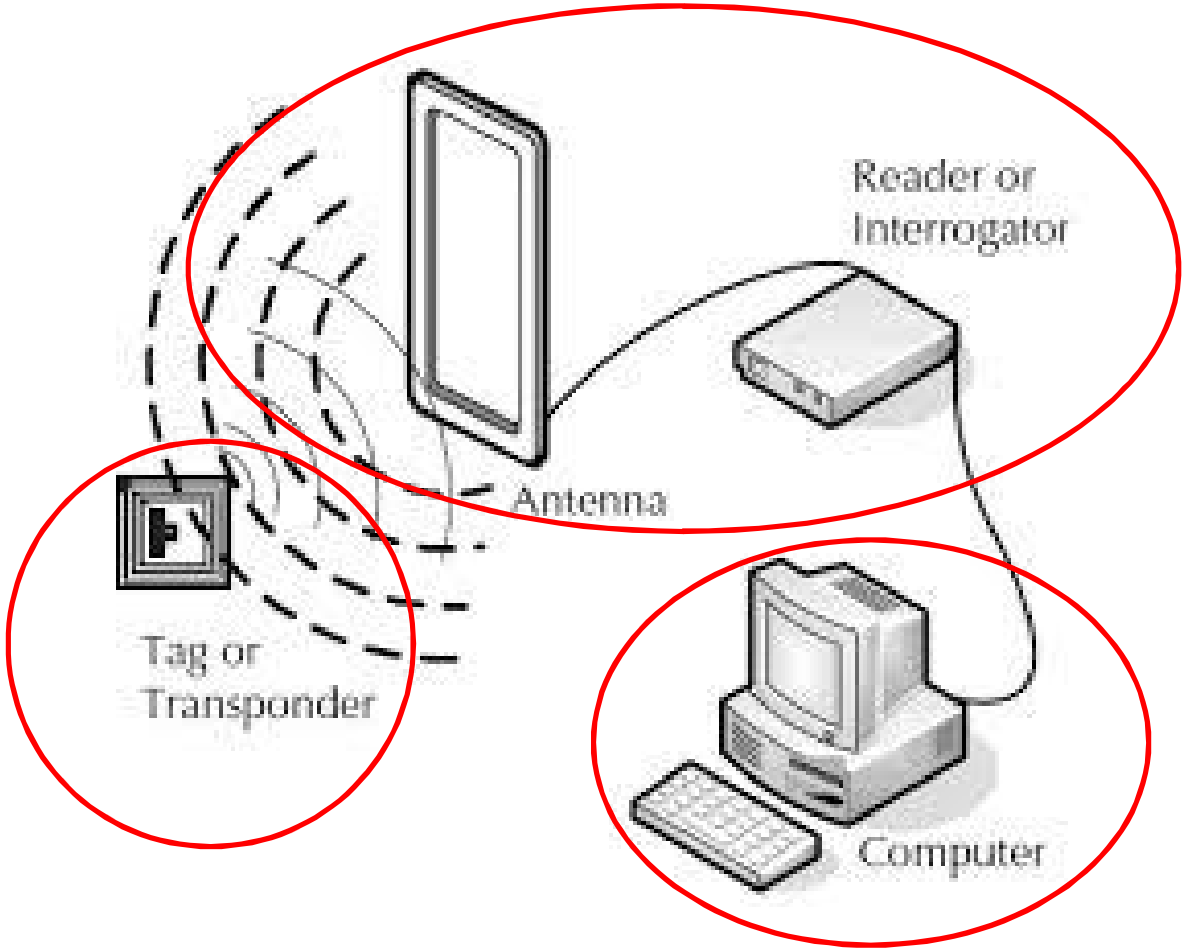
Introduction

- **RFID versus Barcodes:**

	Barcodes	RFID
		
Advantages	• Smaller • Cheaper than RFID • Higher accurecy (today)	• Large reading distance. • Non-LOS technology. • Automatic reading process. • More secure (kill, password) • Reusable. • Higher reading rate.
Disadvantages	• LOS technology. • Small reading distance. • Indvidual scanned. • Easily damaged	• Tag collision (dense network). • Reader collision.

Introduction

- **RFID Components**



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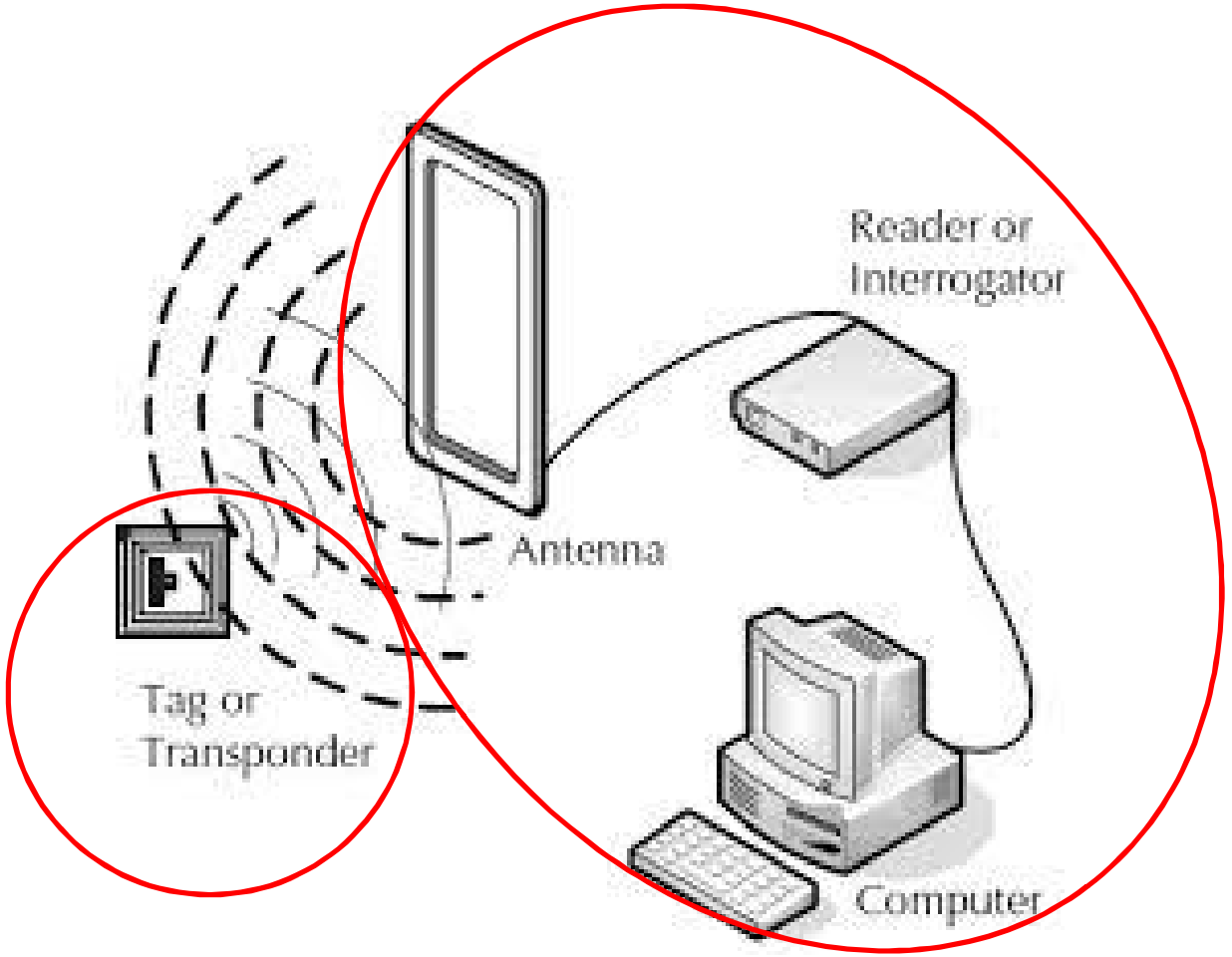

Introduction

➢ RFID operating frequencies and its specifications

	Low Frequency (LF)	High Frequency (HF)	Ultra High Frequency (UHF)	Microwave
Frequency Range	126-134 KHz	13.56 MHz	860-960 MHz	2.45-5.8 GHz
Read Range	10cm	1m	2-10m	5-100m
Coupling	Magnetic	Magnetic	Electro magnetic	Electro magnetic
Existing standards	11784/85, 14223	18000-3.1, 15693,14443 A, B, and C	EPC C0, C1, C1G2, 18000-6	18000-4

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Introduction

➢ Types of tags in RFID Systems

	Active Tags	Passive Tags
Tag Power Source	Internal to the tag	Transferred from reader using RF signal
Tag Battery	Yes	No
Avilability of Power	Continious	In reading range
Required Signal strength	Very low	Very high
Reading range	Up to 100 m	Up to 10 m

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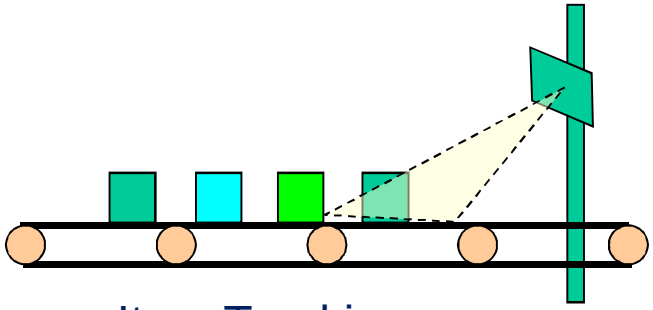
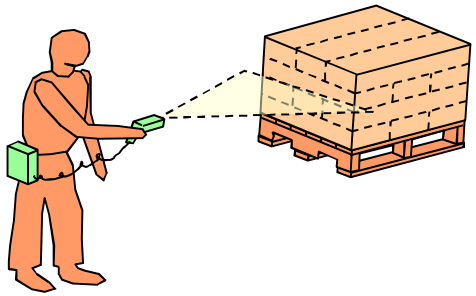
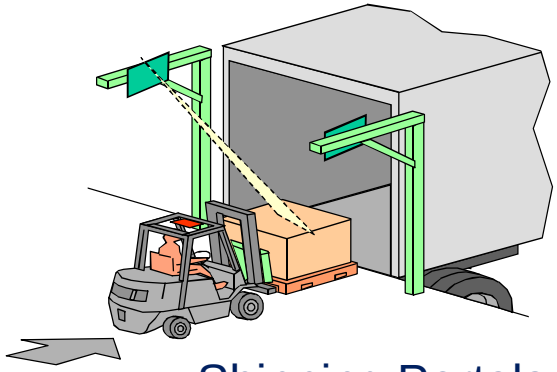
- **Passive RFID applications**



Item Tracking



Inventory Management and Control



Shipping Portals

Introduction

- **Active RFID applications**

Agenda

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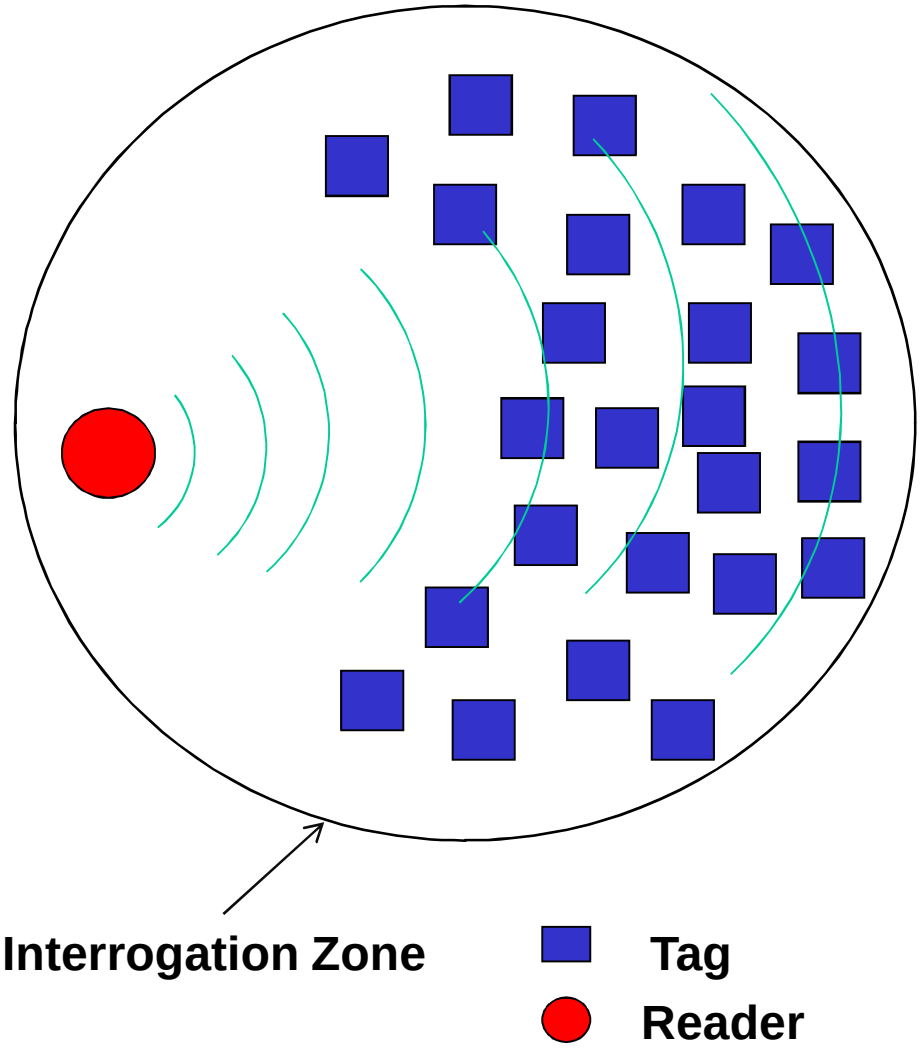
- ✓ RFID Applications
- ➢ Collision Problem
- ➢ Challenges in RFID

Collision Problem

- **Single Reader Vs. multiple tags.**



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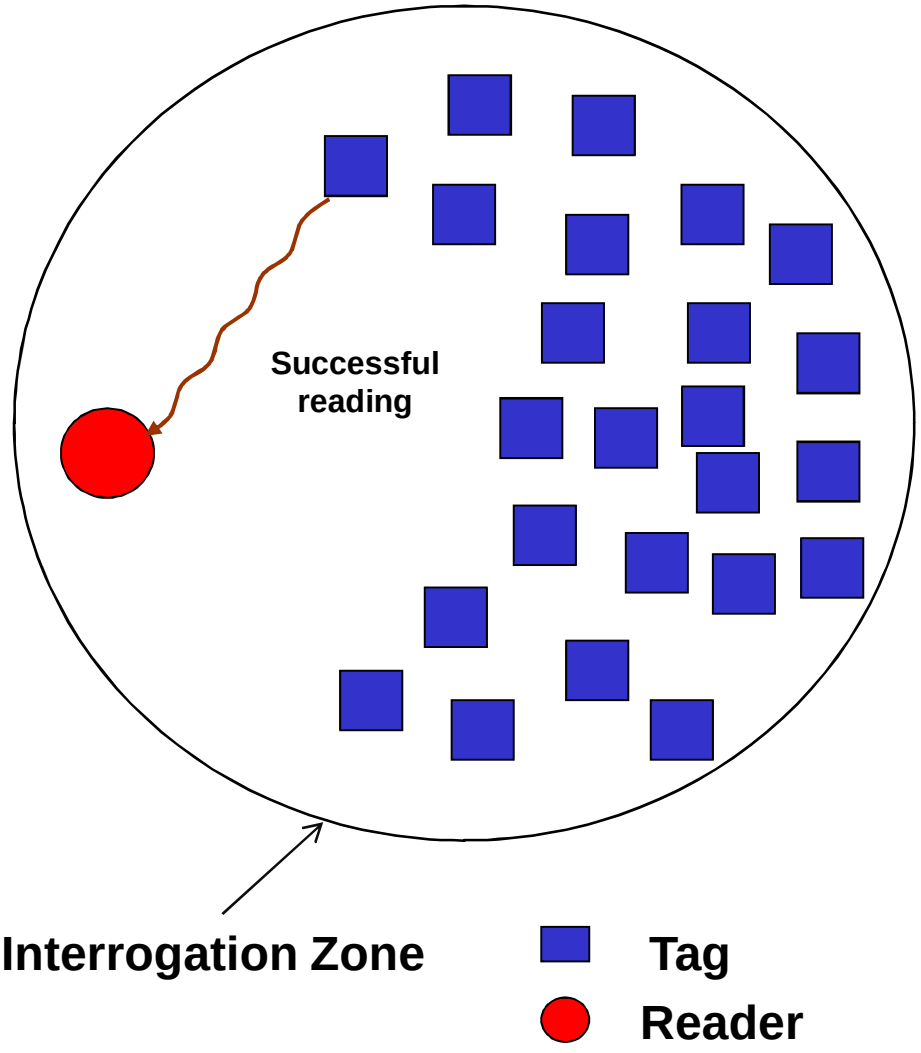

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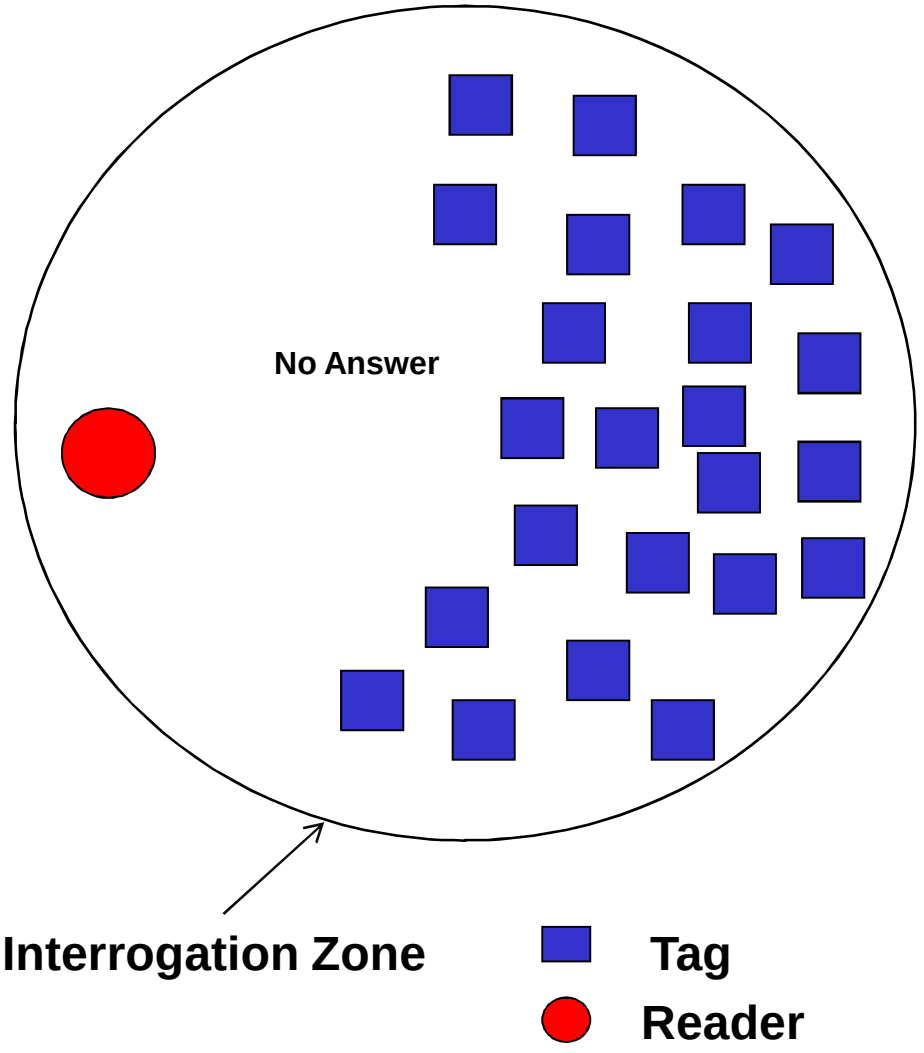

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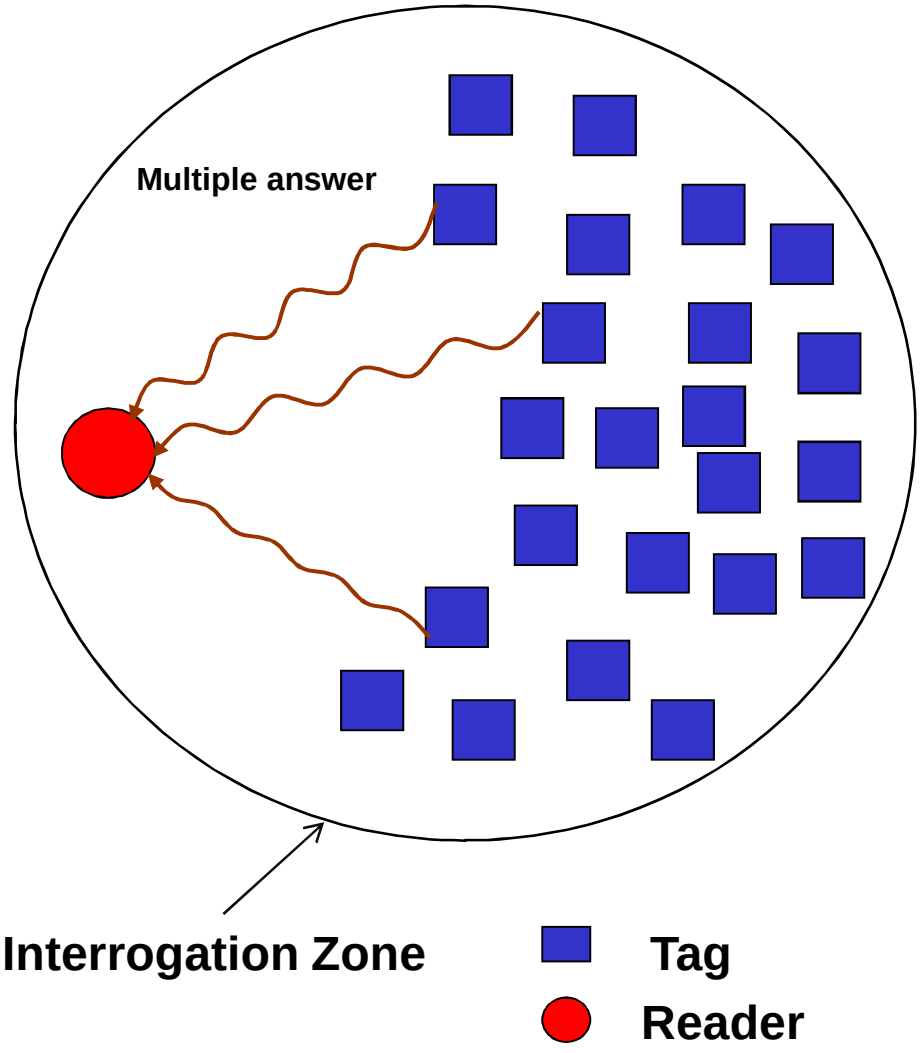
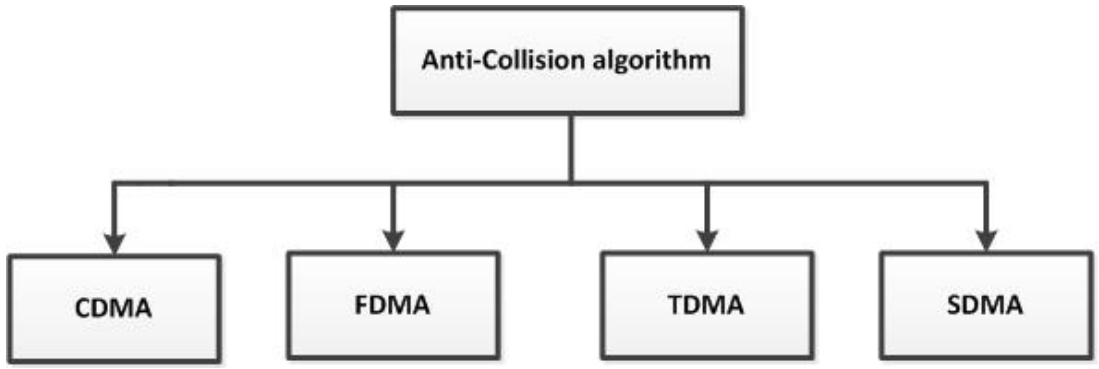


Collision Problem

- **Possible Solutions**
  - Code Division Multiple Access (CDMA)
    - Not used due to its complexity
  - Frequency Division Multiple Access (FDMA)
    - Not used due to its complexity
  - Space Division Multiple Access (SDMA)
    - Multiple transmit and receive antennas are combined together to form an array that can sense the presence of tags in different locations.
  - Time Division Multiple Access (TDMA).



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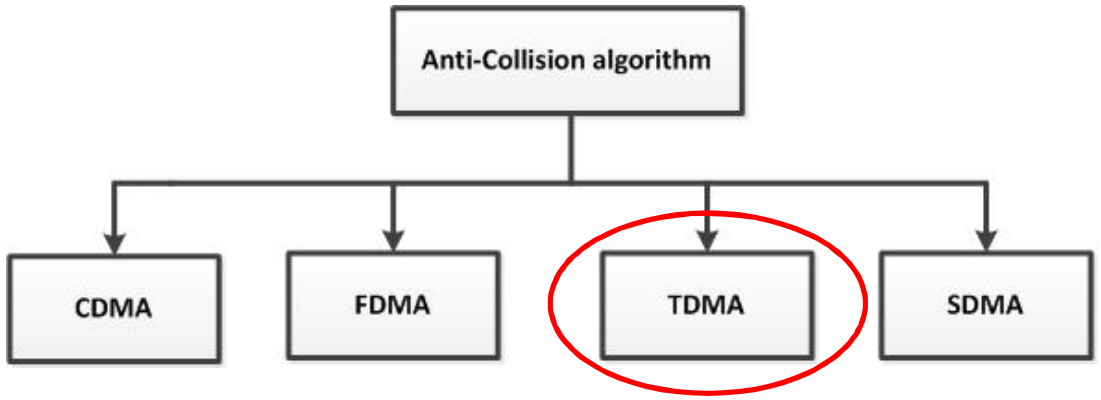
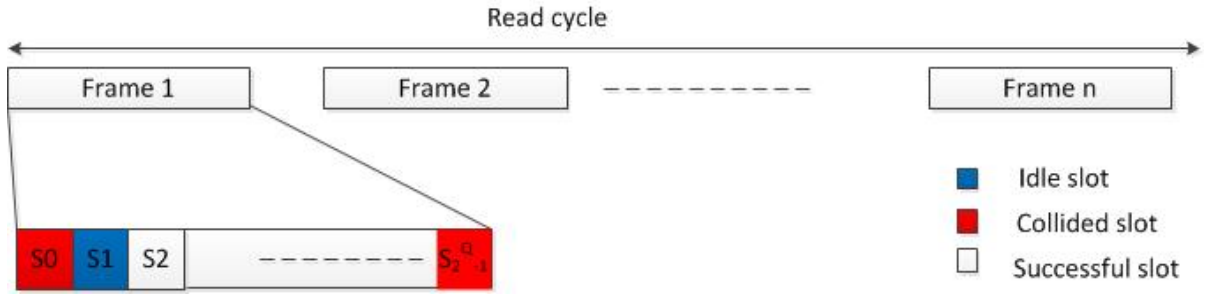


Collision Problem

- **TDMA Solution (Frame Slotted ALOHA [1] "FSA")**



$\eta_{\max}$ (throughput) $= 36\%$

iff. $L = n.$ where n : number of tags.

L = frame size.

Unknown number of tags → **Variable frame length DFSA [2]**

Collision Problem

➢ Optimizing Frame length

	Without tag estimation	With tag estimation
Idea	Adjust the frame length by counting the number of collided and idle slots then modify the Q parameter. $Q_{i+1}=Q_i+C(n_c-n_i)$ $L_{i+1}=2^{Qi+1}$	Estimate the number of tags first then calculate the optimum frame length for the next frame. $L=2^{round(\log_2 n_{est})}$
Advantages	• Simple. • Save the estimation time.	• More accurate. • Better channel efficiency.
Disadvantages	• Limited Performance. • Lower channel efficiency.	• Time consuming. • Complex (needs high performance processing).
Example algorithms	• Dynamic EPC[3]. • Q^{+-} algorithm[4] • SCS Q algorithm[5]. • Optimum C[6]	• Lower Bound[7]. • MSE [7]. • MSE-SbS[8] . • ML estimation. Chen[9]

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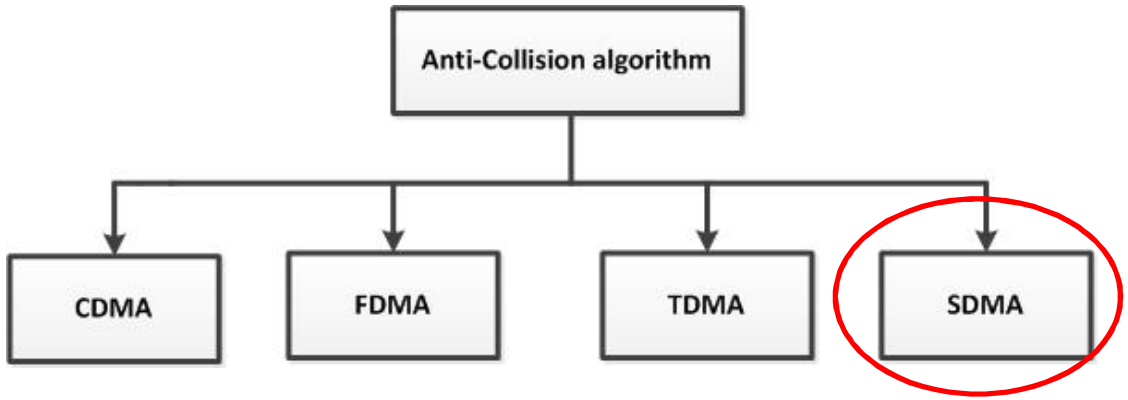


Collision Problem

- **SDMA using Multi-Antennas (MIMO- techniques):**

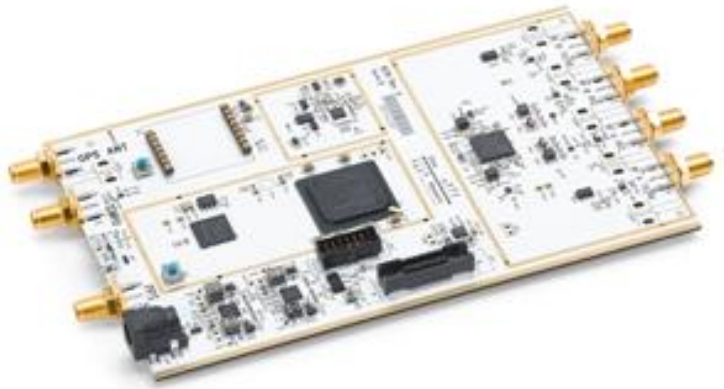
	Maximum Ratio Combining MRC	Equal Gain Combining EGC	Selection Combining SC
Idea	• Weight the received branches based on SNR. The output is a weighted sum of all branches	• Assume equal amplitude from each branch. Just estimate the phase of each branch.	• Choose the branch with the highest SNR. Start with random branch above threshold, when it is below choose another one.
Adv.	Maximum possible Coding gain	Simpler channel estimation	The coherent sum of all branches is not needed. Simple
Disadv.	Requires knowledge of the time-varying SNR on each branch	Limited in practice to coherent modulations with equal energy symbols	Lower performance

Collision Problem

➢ Current Stage

• **Design the complete reader on USRP B210 (Single Antenna).**
https://www.ettus.com/product/details/UB210-KIT

• **Scan the channel using IZT R3301 recording system.**
http://www.iztlabs.de/uploads/tx_cnizt/Product_Information_IZT_RecPlay_V1.0_02.pdf



Collision Problem

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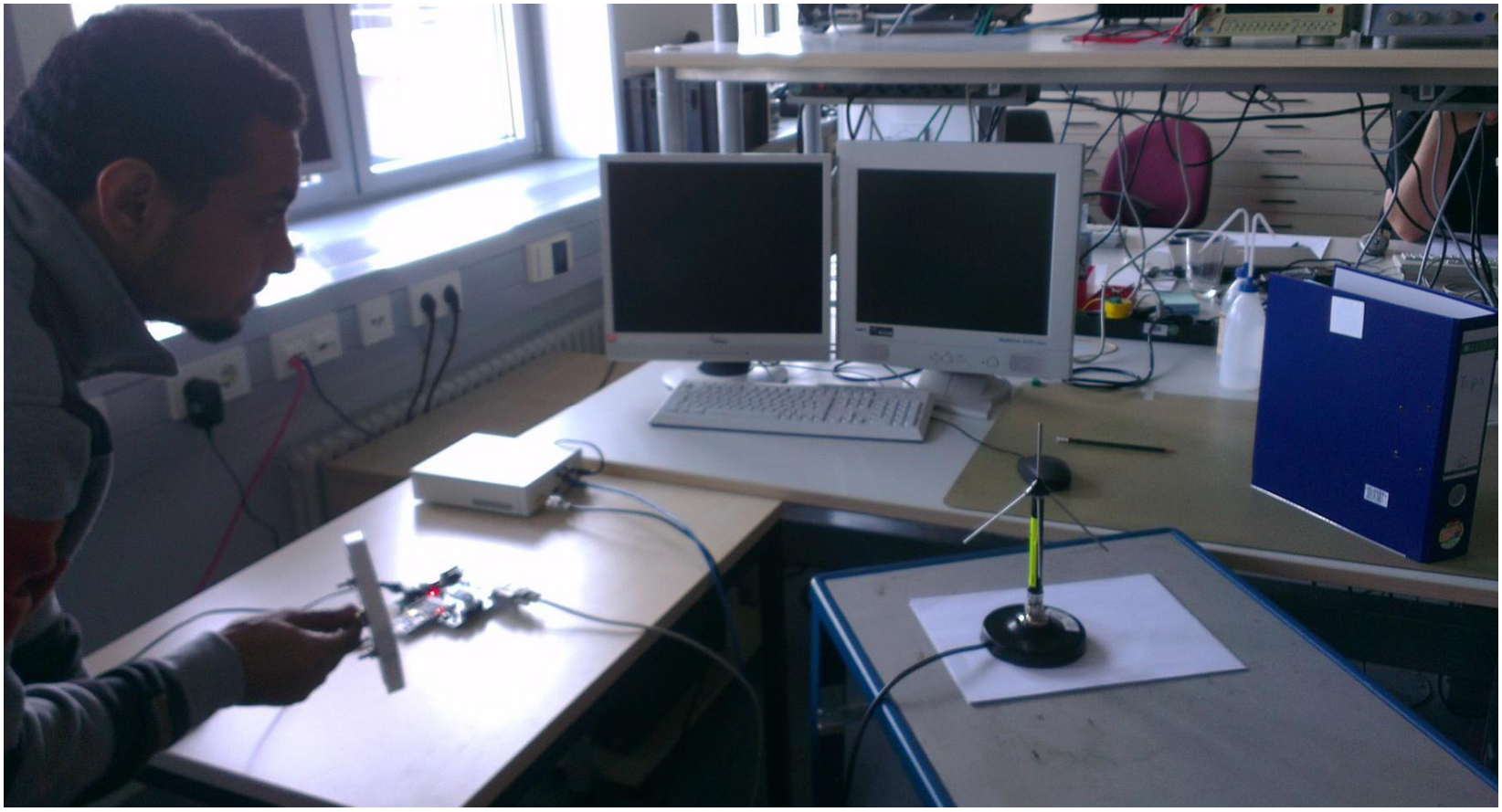

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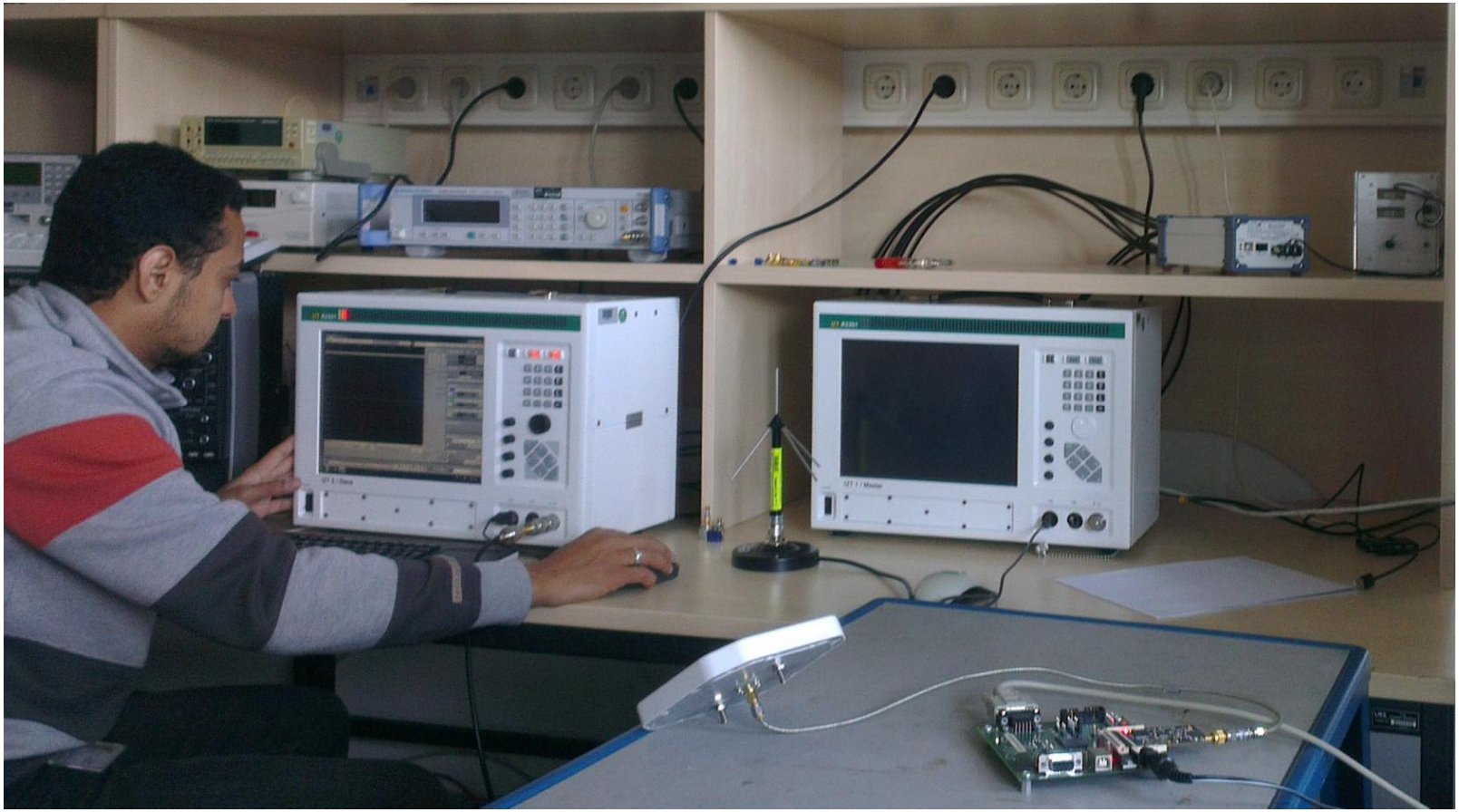
- **Current Stage**



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Challenges in RFID

- **Reading accuracy for 3000 tags upto (99.95%).**
  - Increase tag estimation accuracy.

- **Resolve tag collision using MIMO techniques:**
  - Maximum Ratio Combining (MRC).
  - Equal Gain Combining (EGC).
  - Selection Combining (SC).

- **Decrease the price of the tags.**

- **Model the capture effect in the RFID environment.**

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Thanks for your attention

References

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