Radio Frequency Identification (RFID) Technology

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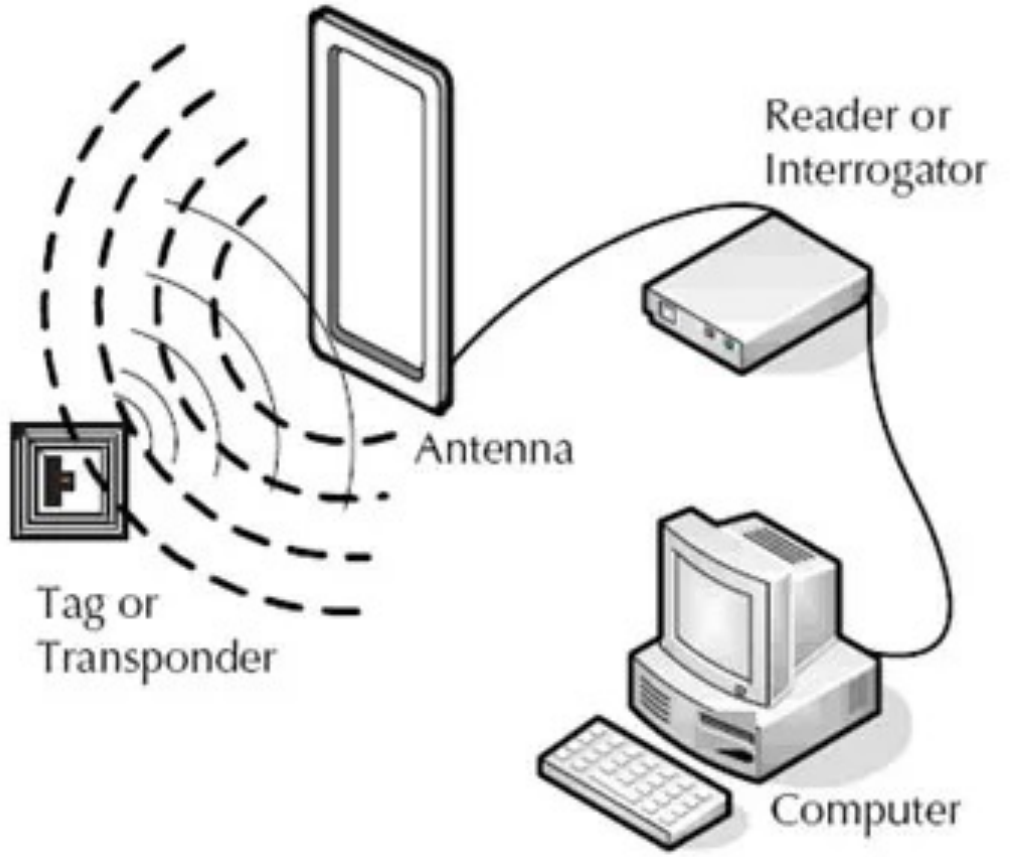
Presentation

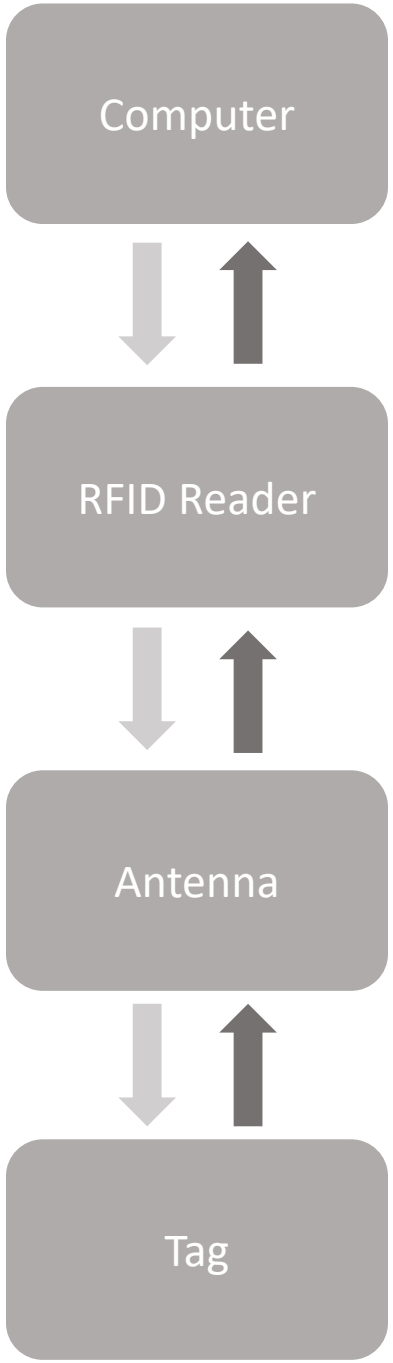
- RFID Technology
- RFID System
  - Types of RFIDs
  - Frequencies
  - RFID Communication
  - RFID Data
  - Security and Privacy
- Applications
- Distance
- Building an RFID System

RFID Technology

- Radio Frequency Identification
- Provides the ability to identify objects through radio waves
- Location: Line of Sight
- Optimal for Tracking

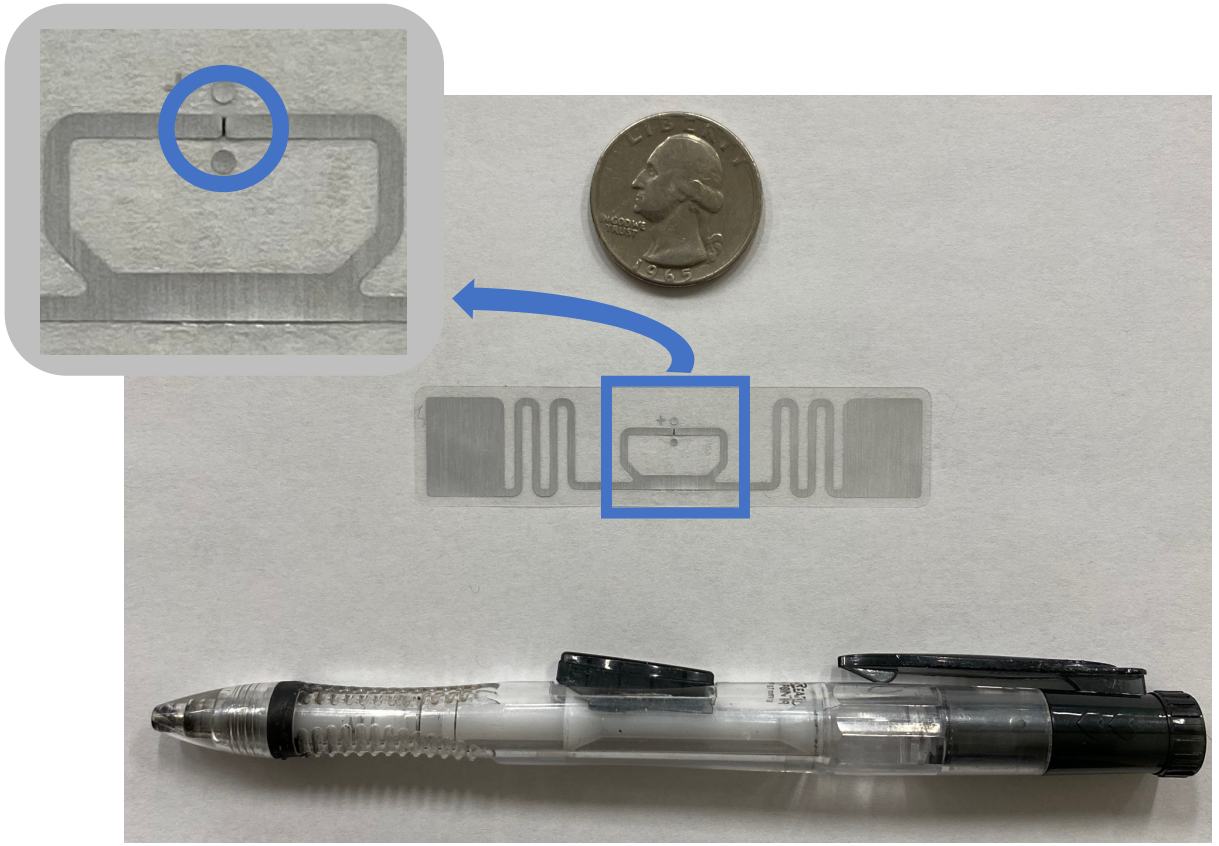
RFID System


Reader or
Interrogator
Antenna
Tag or
Transponder
Computer


Computer
RFID Reader
Antenna
Tag

Types of RFID Tags

- **Passive RFID Tags**
  - Antenna & Integrated Chip
- **Semi-Passive RFID Tags**
  - Battery, Antenna & Integrated Chip
- **Active RFID tags**
  - Battery, Antenna & Integrated Chip



Frequencies

- Low Frequencies (LF): 125 kHz (30-300 kHz)
- High Frequencies (HF): 13.56 MHz (3-30MHz)
- Ultra High Frequencies (UHF): 866-960 MHz (300 MHz – 3 GHz)

Passive Tags

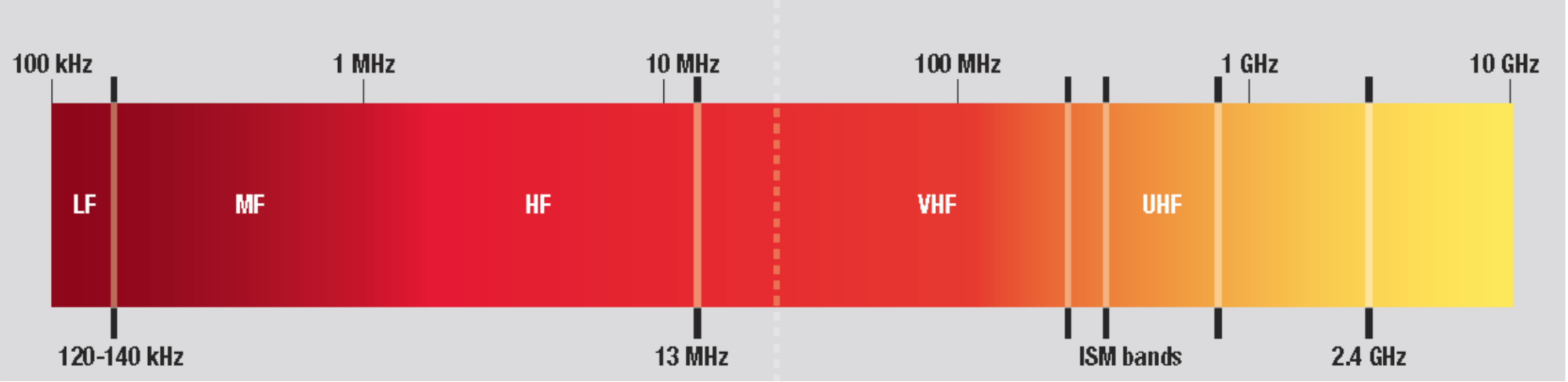
- LF, HF, & UHF
- Read Range: 10 m

Semi-Passive Tags

- LF, HF, & UHF
- Read Range: 100 m

Active Tags

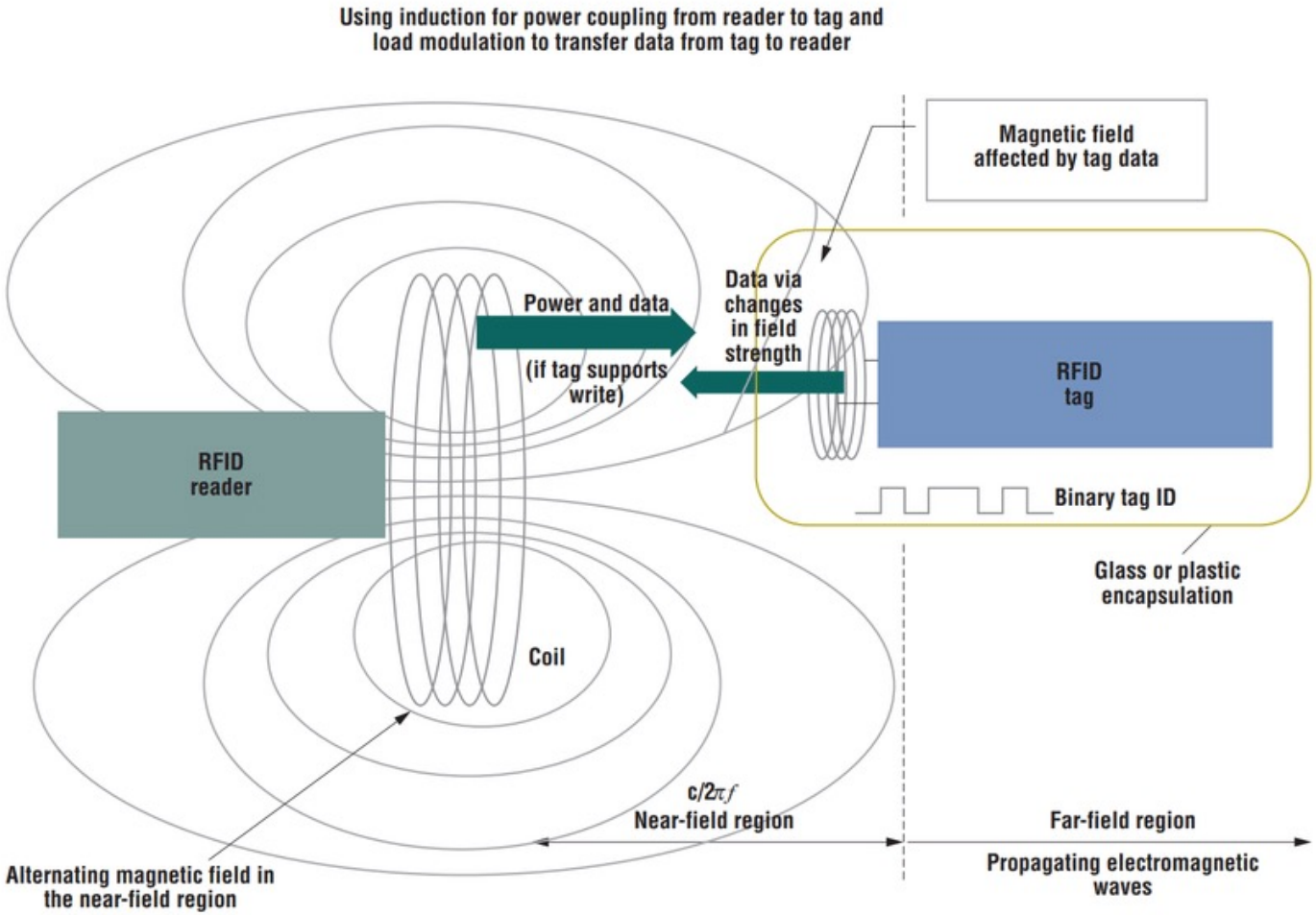
- HF & Larger
- Read Range: +100 m



RFID Communication (Near Field vs. Far Field)

Near Field Communication

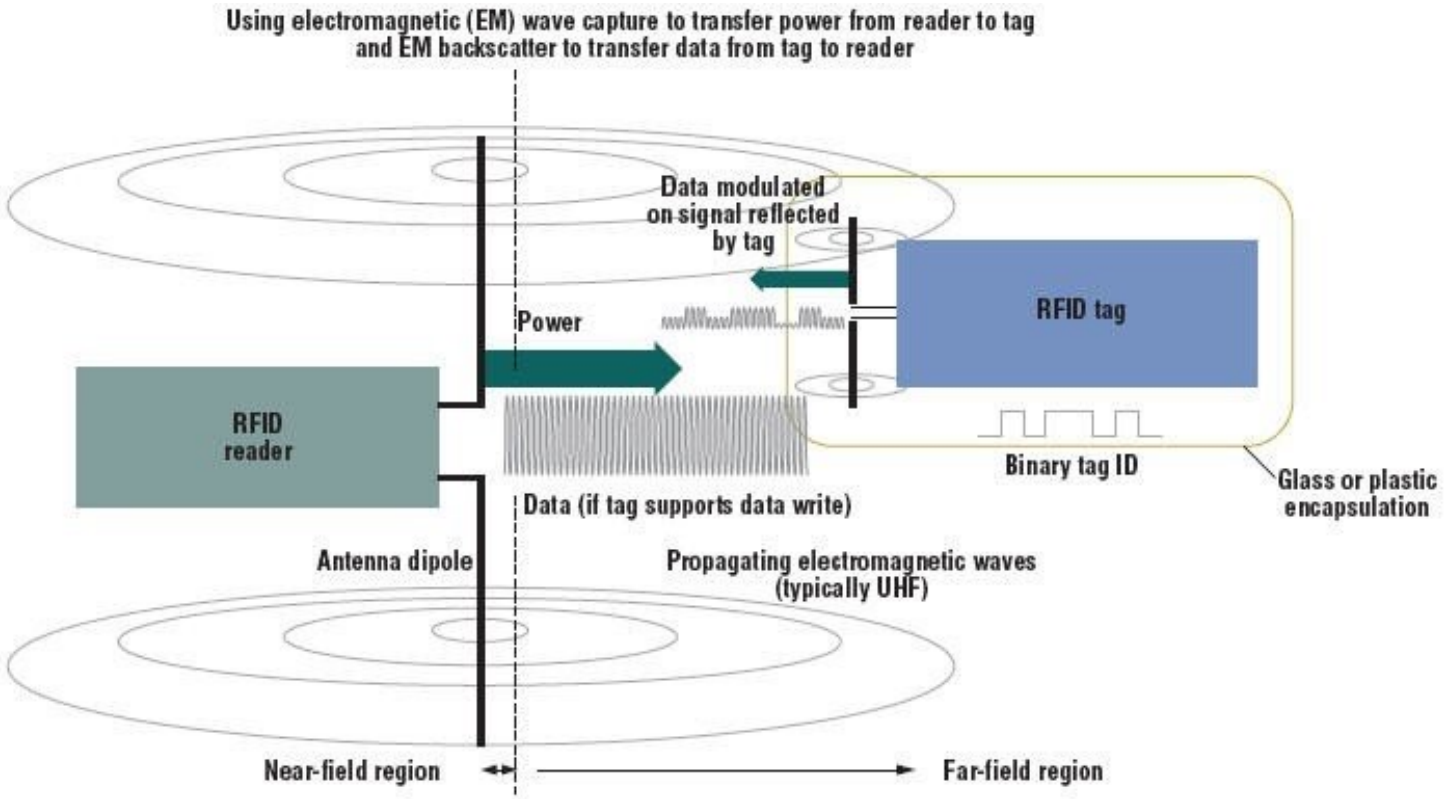
- Load Modulation
- Less than 100 MHz
  - LF & HF
- Orientation Independent



RFID Communication (Near Field vs. Far Field)

Far Field Communication

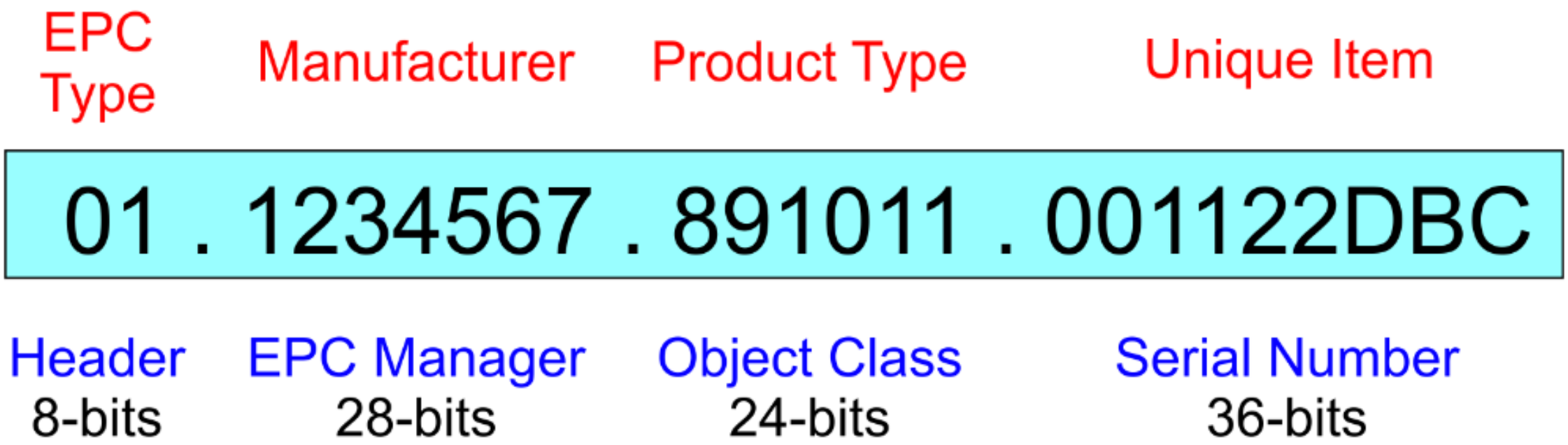
- Back Scatter
- Greater than 100 MHz
  - UHF & Larger Frequencies
- Orientation Dependent



RFID Data

Electronic Product Code (EPC)

- 96 Bits (24 Hexadecimal Characters)
  - 268 million companies with unique identifies
  - 16 million object classes
  - 68 billion serial number for objects.



Security and Privacy

Vulnerabilities

- Cloning/Spoofing
- Data Tampering
- Deactivation
- Eavesdropping

Security Methods

- Cryptography
  - Hashing
  - Elliptical Curve Cryptography
- Multiple ID’s
- Blocking Tags
- Two Factor Authentication

Application

- Supply Chain
  - Walmart
- Inventory Management
  - Hospitals
  - Livestock
  - Department of Defense
- Cashierless Grocery Stores
- Tolls
- Payment Methods
- Passports

Distance

- Approximate Distance
- Friis Equation

$$P_r = \frac{P_t G_t G_r \lambda^2}{(4\pi R)^2}$$

Where,

P_r = Power at the receiving antenna

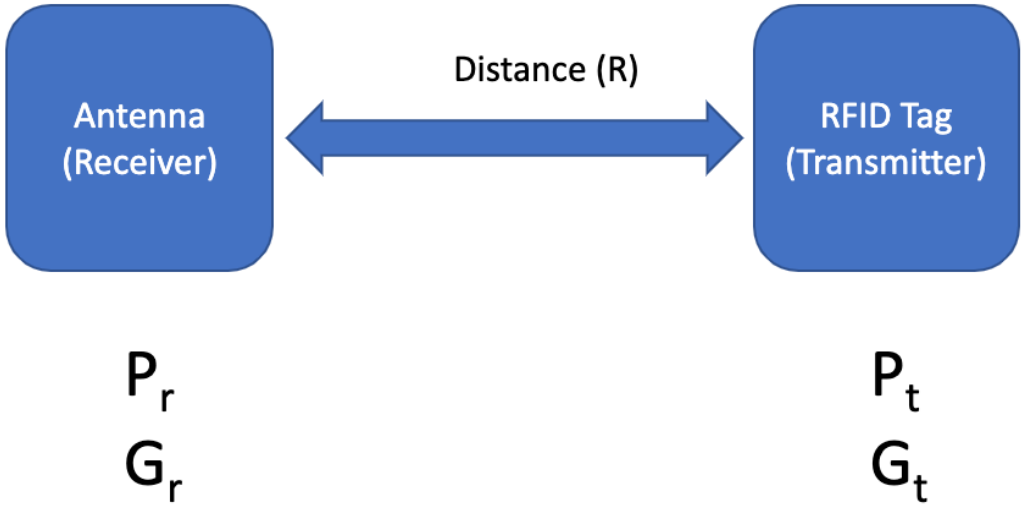
P_t = Output power of transmitting antenna

G_t = Gain of the transmitting antenna

G_r= Gain of the receiving antenna

λ = Wavelength

R = Distance between the antennas



Distance

- Received Signal Strength Indicator (RSSI)
- dBm (decibel milliwatt)

$$R_x = R_0(10^{\frac{Pr(R_0)-Pr(R_x)}{10N}})$$

$R_x = Estimated\ Distance\ of\ Tag$

$R_0 = Initial\ Distance\ of\ Tag$

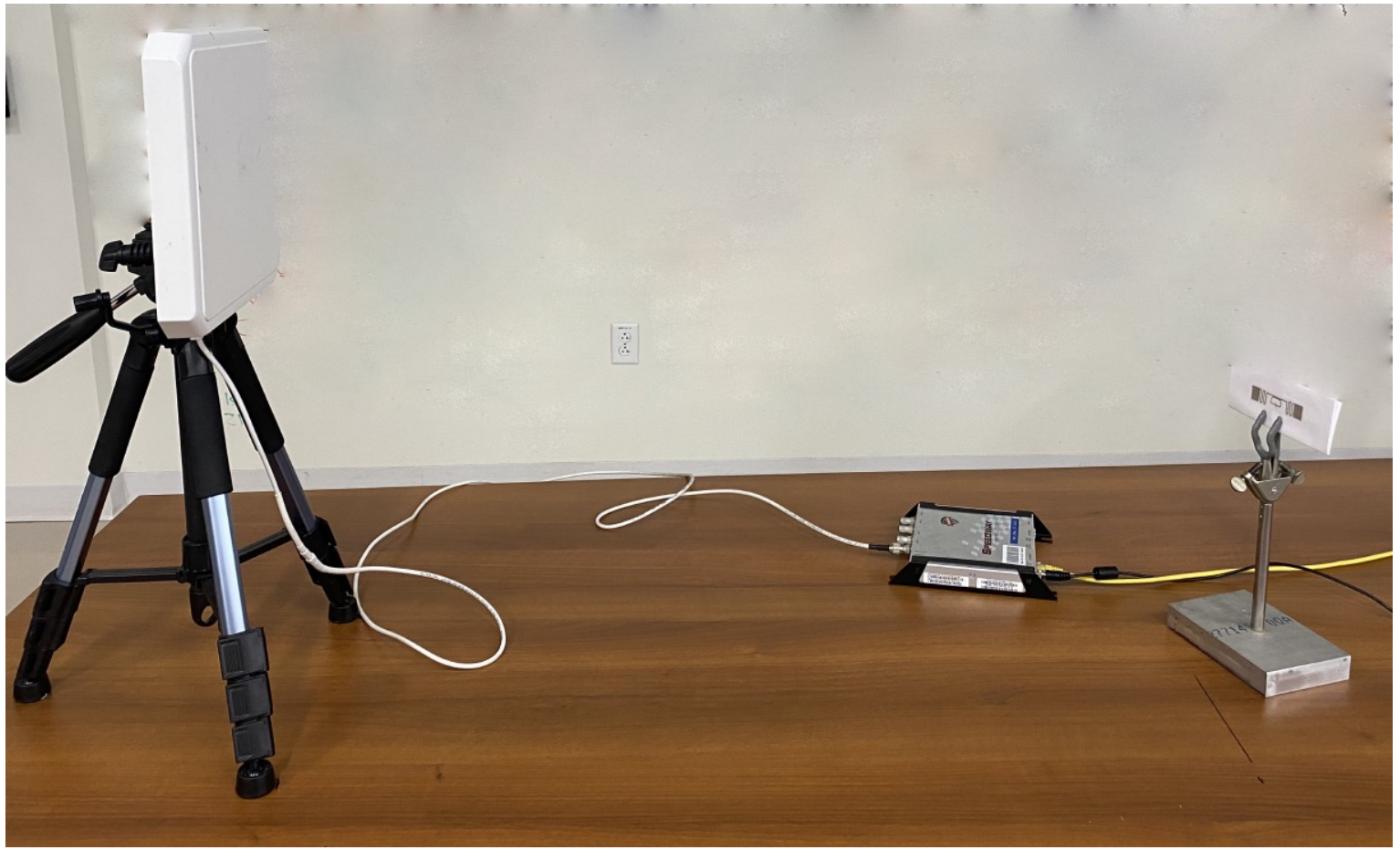
$P_r(R_0) = RSSI\ Value\ for\ a\ Tag\ at\ the\ Initial\ Distance$

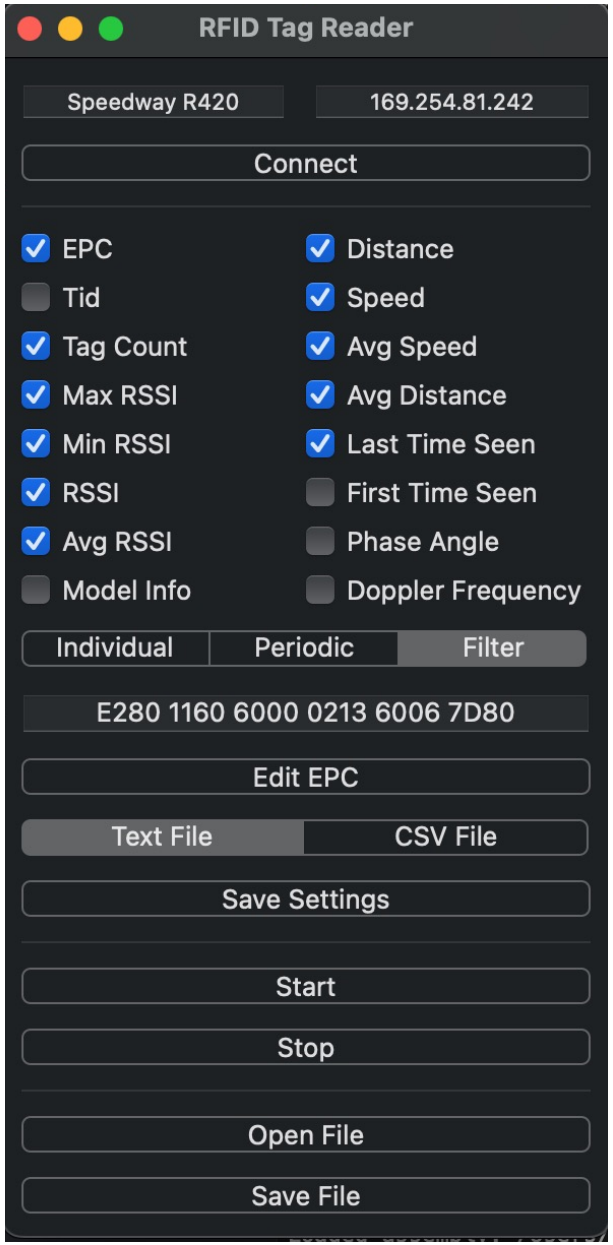
$P_r(R_x) = RSSI\ Value\ for\ a\ Tag\ at\ the\ new\ Distance$

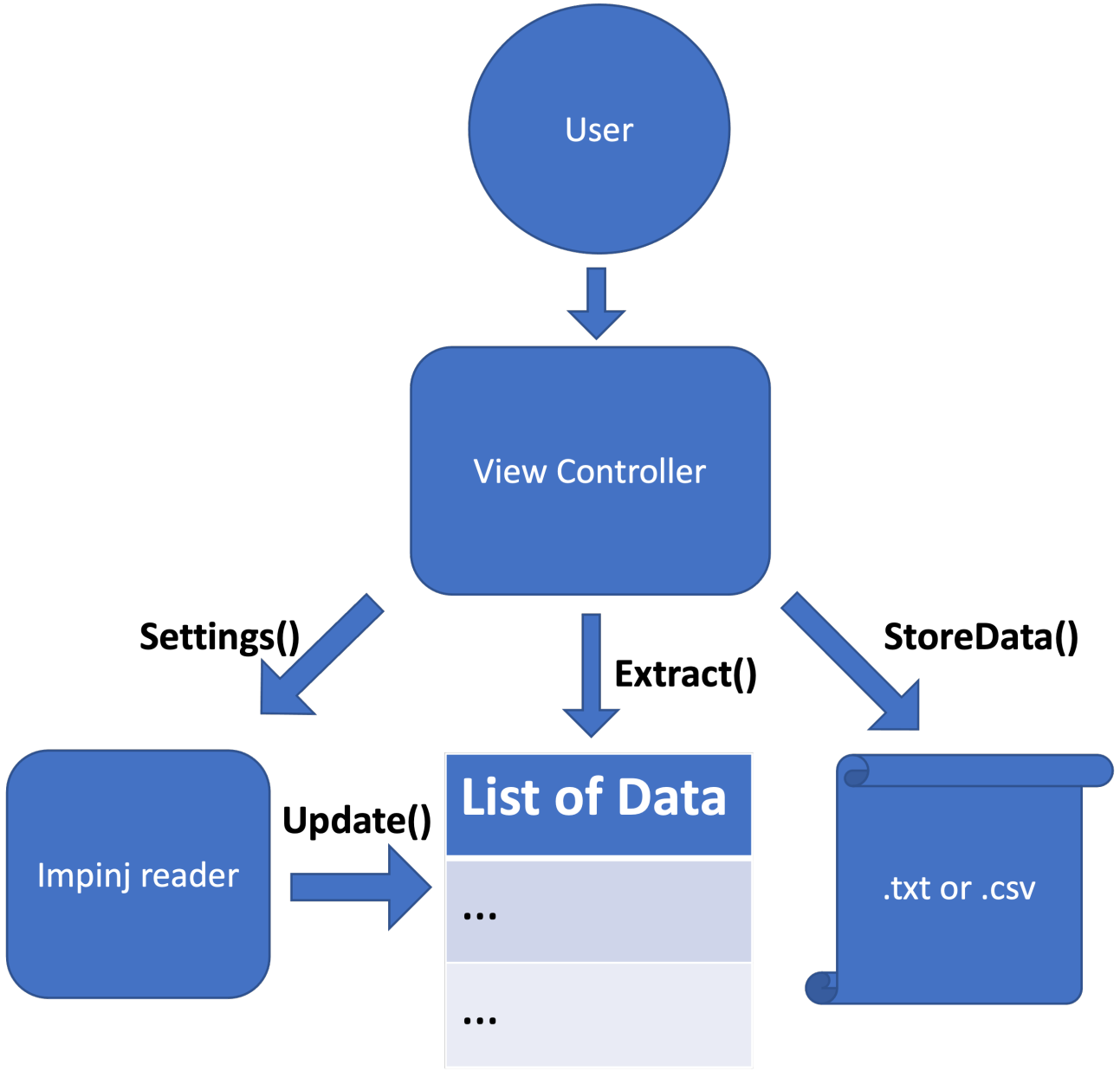
$N = Path\ loss\ factor\ for\ waves\ in\ the\ environment$

Building RFID System

- macOS Application: C# - Visual Studio for Mac
- Impinj RFID Reader and Antenna
- UHF RFID Tags

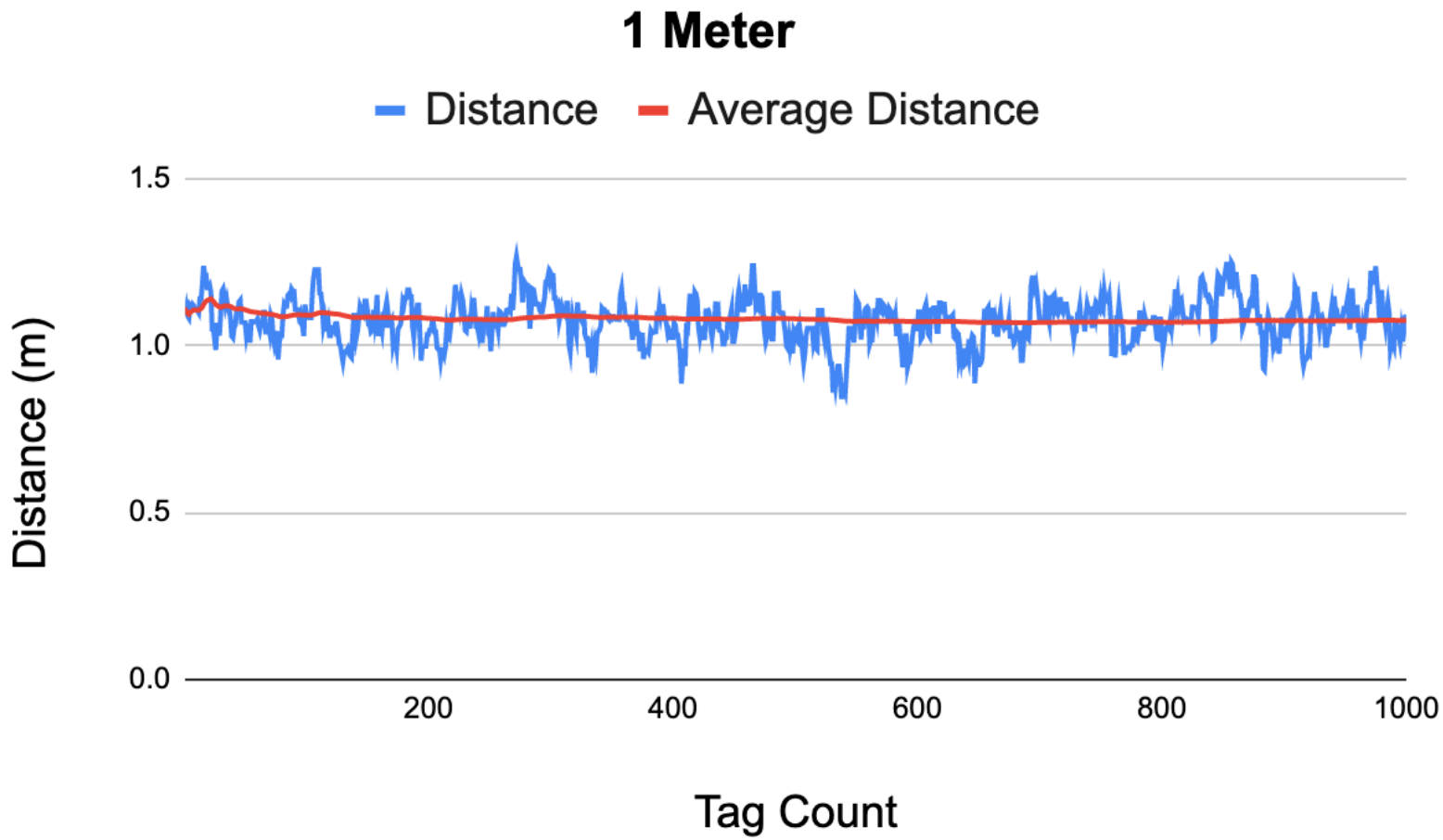



RFID Tag Reader
Speedway R420
169.254.81.242
Connect
EPC
Tid
Tag Count
Max RSSI
Min RSSI
RSSI
Avg RSSI
Model Info
Distance
Speed
Avg Speed
Avg Distance
Last Time Seen
First Time Seen
Phase Angle
Doppler Frequency
Individual
Periodic
Filter
E280 1160 6000 0213 6006 7D80
Edit EPC
Text File
CSV File
Save Settings
Start
Stop
Open File
Save File


User
View Controller
Settings()
Extract()
StoreData()
Impinj reader
Update()
List of Data
...
...
.txt or .csv

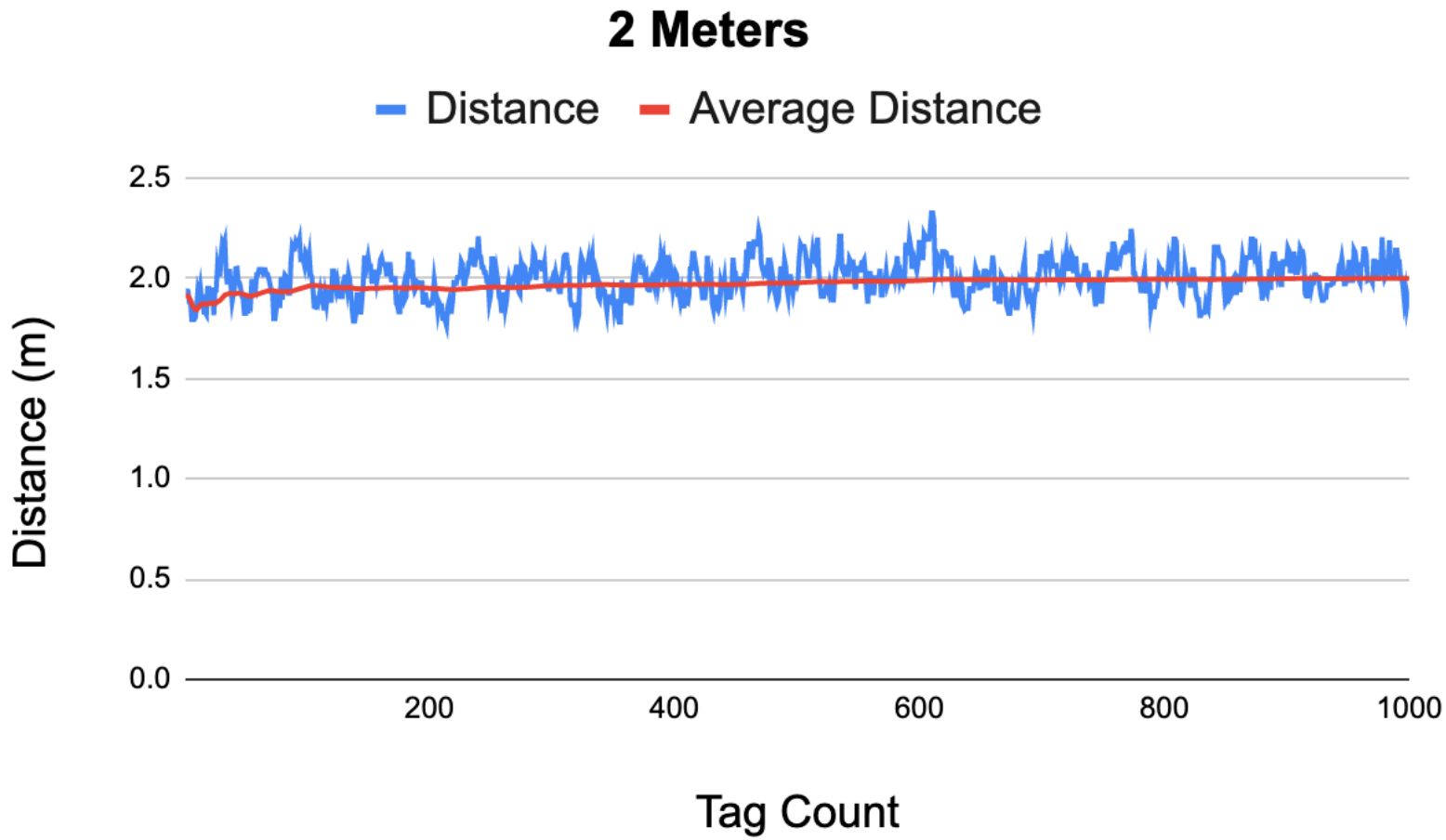
Estimating Distance

- Average Distance: 1.079 m



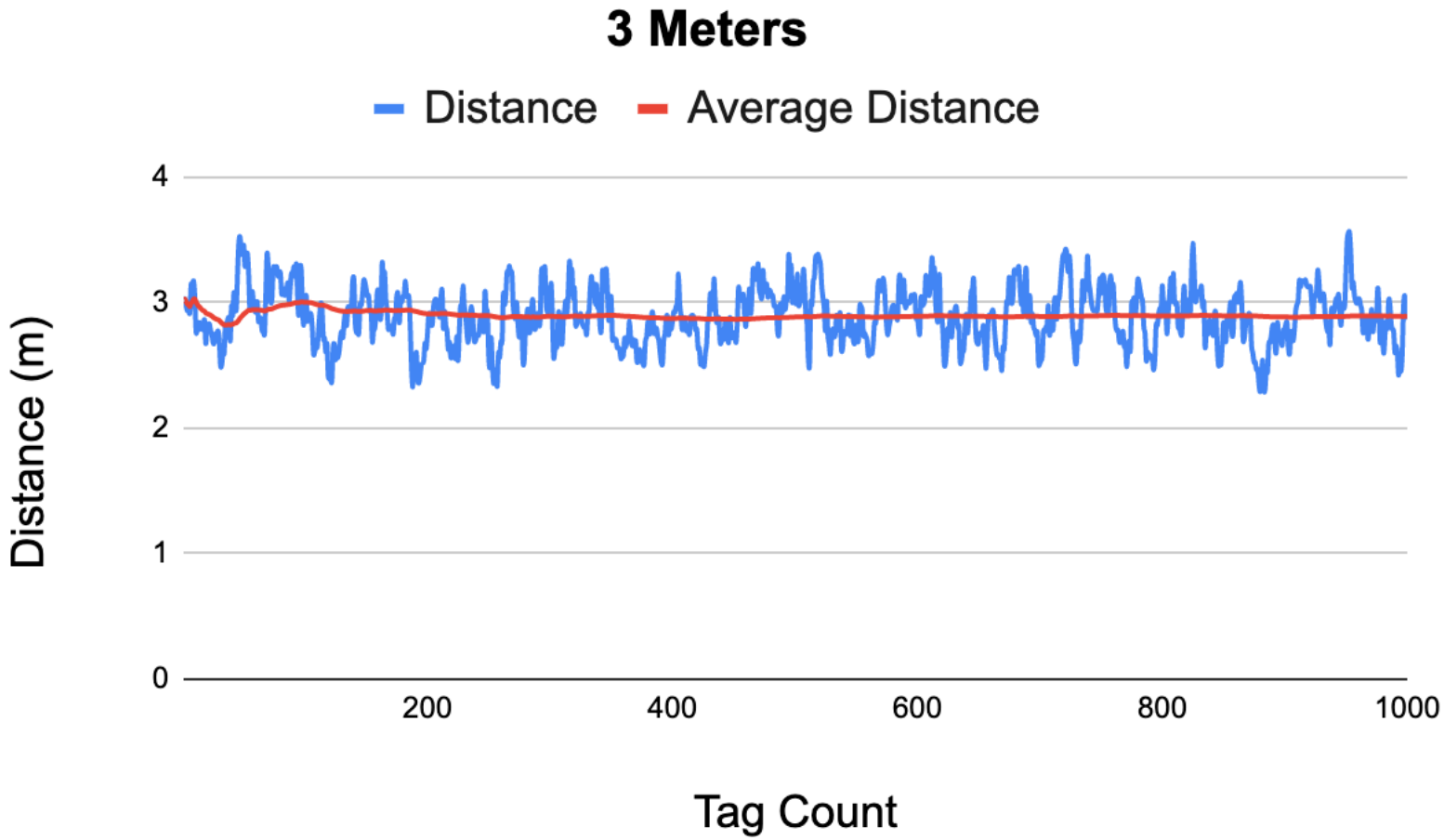
Estimating Distance

- Average Distance: 1.971 m



Estimating Distance

- Average Distance: 2.889 m



Analysis of Experiment

- Accuracy
- Limitations
  - RFID Reader
  - RSSI Value Step Size
  - Antenna
  - Environmental Factors
- Improve algorithms for calculating distance
  - Error Estimations

Future of RFID

SPORTS

PAYMENT METHODS

SECURITY

Questions