

Mobile Tagging

CSE 162 – Mobile Computing

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Mobile Tagging

Tagging the physical world

- When tags are attached to or linked to physical objects, they provide a way to audit physical spaces and processes.



History of Barcode

- 1920's most complex business existed in the grocery store.
- Herman Hollerith built the “Hollerith Machine.”



Groceries

- Consumers would get their cards punched depending on selected products.
- Pay for their selection at counter.
- Customer would receive groceries on a conveyor belt.
- Although the idea was ahead of time, it lead to the development of barcodes that are used in the modern supply chain.

Barcode

- UPC (Universal Product Code)



- broadly accepted.
- Succeeded well in the marketplace resulting in the creation of EAN(European Article Numbering) and JAN (Japanese Article Numbering).

QR Code for Mobile Tagging

- What is a QR (Quadratic) Code?
 - 2D barcode made of black/white modules in a square grid
 - “Quadratic” because data is laid out in two dimensions (x and y)
 - Easily scanned by smartphone cameras
- Why it works for Mobile Tagging
 - Encodes URLs, text, contacts, Wi-Fi configs, etc. in a tiny symbol
 - Users just point the phone camera → automatic decode → open app / webpage
 - Bridges physical objects (posters, products, tickets) to digital content
- Typical Mobile Tagging Use Cases
 - Advertising: posters → promo pages or videos
 - Payments and authentication (e.g., login via QR, pay-at-counter)
 - Ticketing and check-in: boarding passes, event tickets
 - Public info: museum exhibits, signage, transport schedules



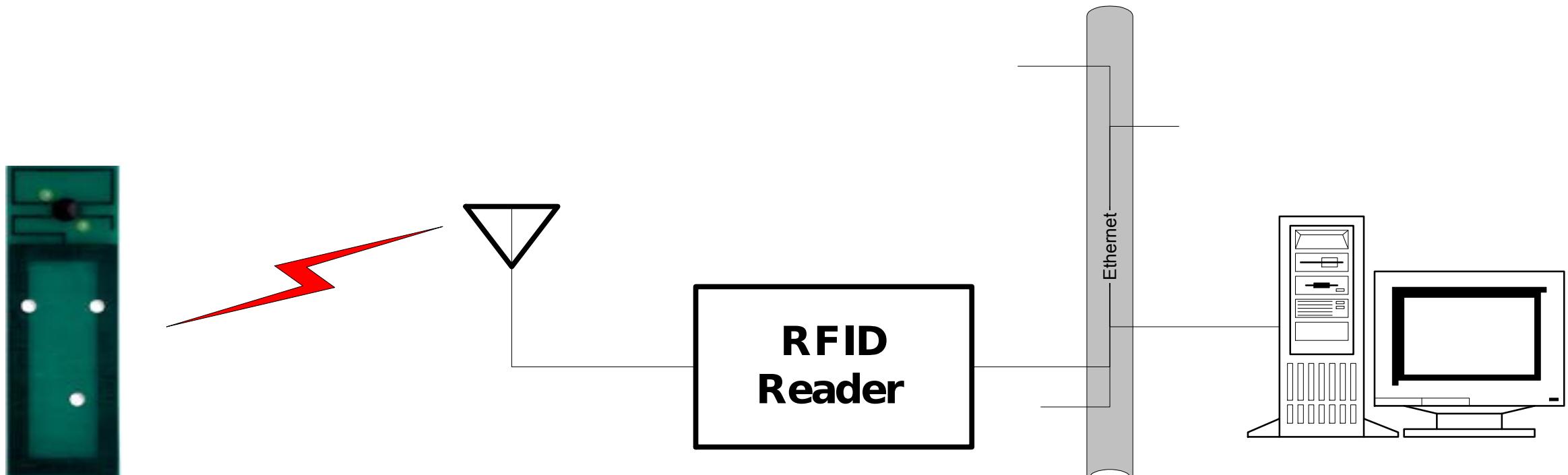
Drawbacks of QR code and Barcode

- Limited in terms of information capacity.
- Easily damaged or lost.
- Need for human in the loop

What is 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, categorize, 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.

RFID system components



RFID Tag

RF Antenna

Network

Workstation

RFID system components

- There are four parts to a RFID system:

RFID Tag

- Programmed with information

Antenna

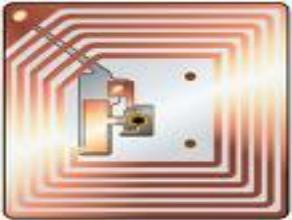
- Provides a means of communication and energy to communicate with RFID tag

RFID Reader

- Has a decoder to interpret the data

Work station

- Data management



RFID vs. QR/Bar Codes

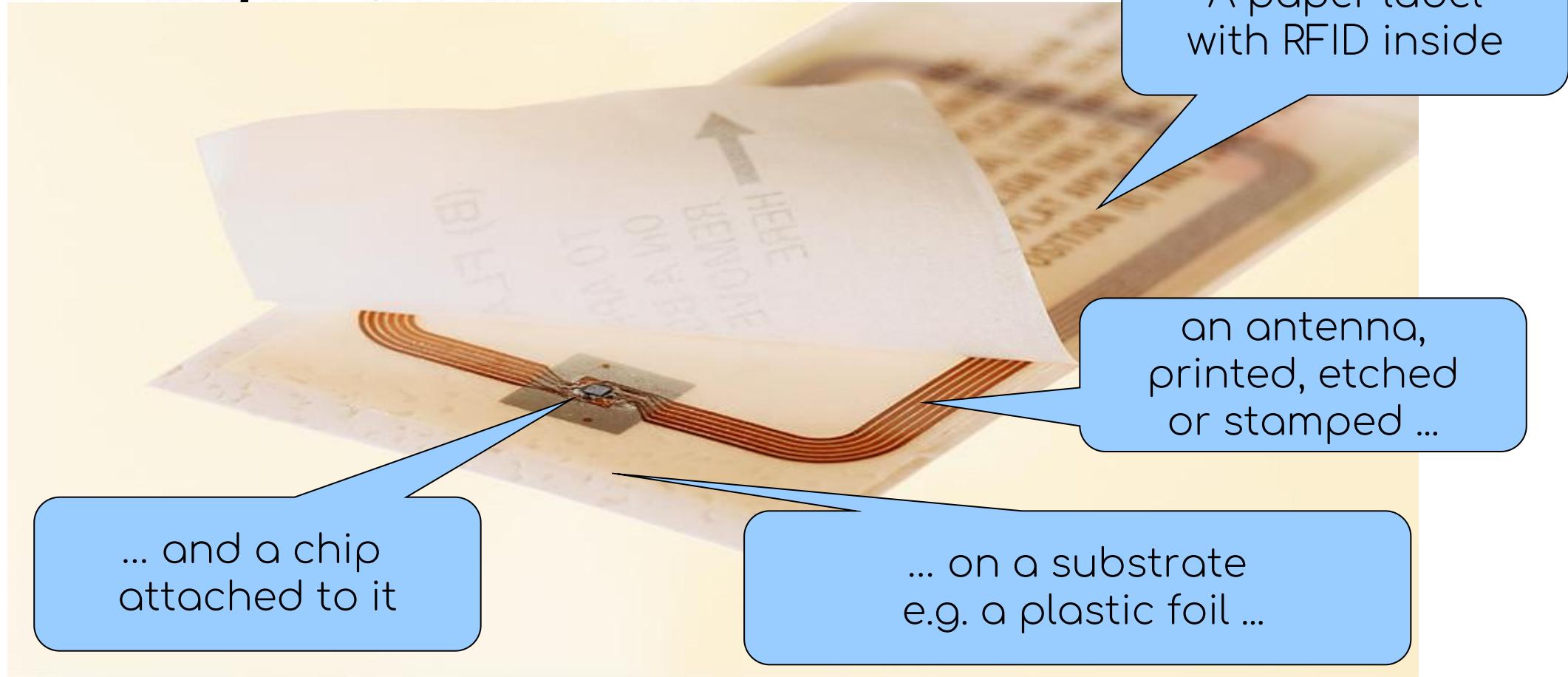


- How is RFID different from QR/Bar Codes?
 - Tag **does not need to be on the surface** of the object
 - No need for a direct line of sight, tags can be embedded or hidden.
 - Tags are **applicable in harsh environments**
 - e.g., outdoors, around chemicals, moisture and high temperatures.
 - **Faster:** RFID tags can be read at a rate of forty or more tags per second
 - Bar Codes: usually half a second or more per bar code.
 - **Longer Range:**
 - RFID tags can be read at distances up to 300 feet; Bar Codes no more than 15 feet.
 - **RFID Tags can be re-programmed;** Bar Codes do not have the read/write capability

RFID vs. Bar Codes

	Manual Process	Bar Code	RFID
Data Accuracy	Least Accurate	Most Accurate	More Accurate
Data Collection Time/Labor	Most Time/Labor	Some Time/Labor	Least Time/Labor
Data Input Time/Labor	Most Time/Labor	Some Time/Labor	Least Time/Labor
Equipment Costs (tags, readers/scanners)	N/A	Some	More
Can Track Assets Out of Line of Sight	No	No	Yes
Amount of Data Storage on Tag	N/A	Less	More
Two way communication	No	No	Yes
Ability to Reprogram Tags	N/A	No	Yes

RFID tags: Smart labels



Tag Attachments

- Embedded
 - Usually aimed for permanent or long-term implantation, such as animal traceability
- Attached
 - Designed to be attached on the surface of identified objects with permanent, semi-permanent or temporary attachment
- Injected
 - Small enough to be implanted by injection through large-gauge needles
- Digested
 - The tags would be covered with soft gelatin that takes a while to dissolve in the stomach. Stop working when exposed to gastric acid for a specific period of time



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

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
 - Point of sale
- Readers can also be mobile/hand-held



Types of Readers



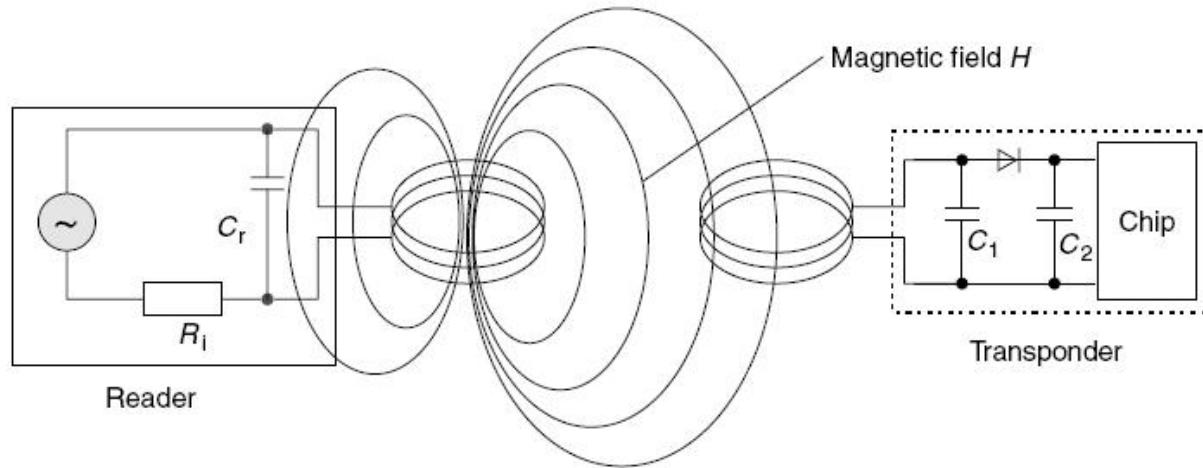
- Dumb
 - Can read only one type of tag using one frequency and one protocol
- Agile
 - can read tags at different frequencies or using different methods of communication
- Intelligent
 - Agile reader+ applications such as data filtering

Some RFID readers



Working of Passive RFID

Inductive Coupling

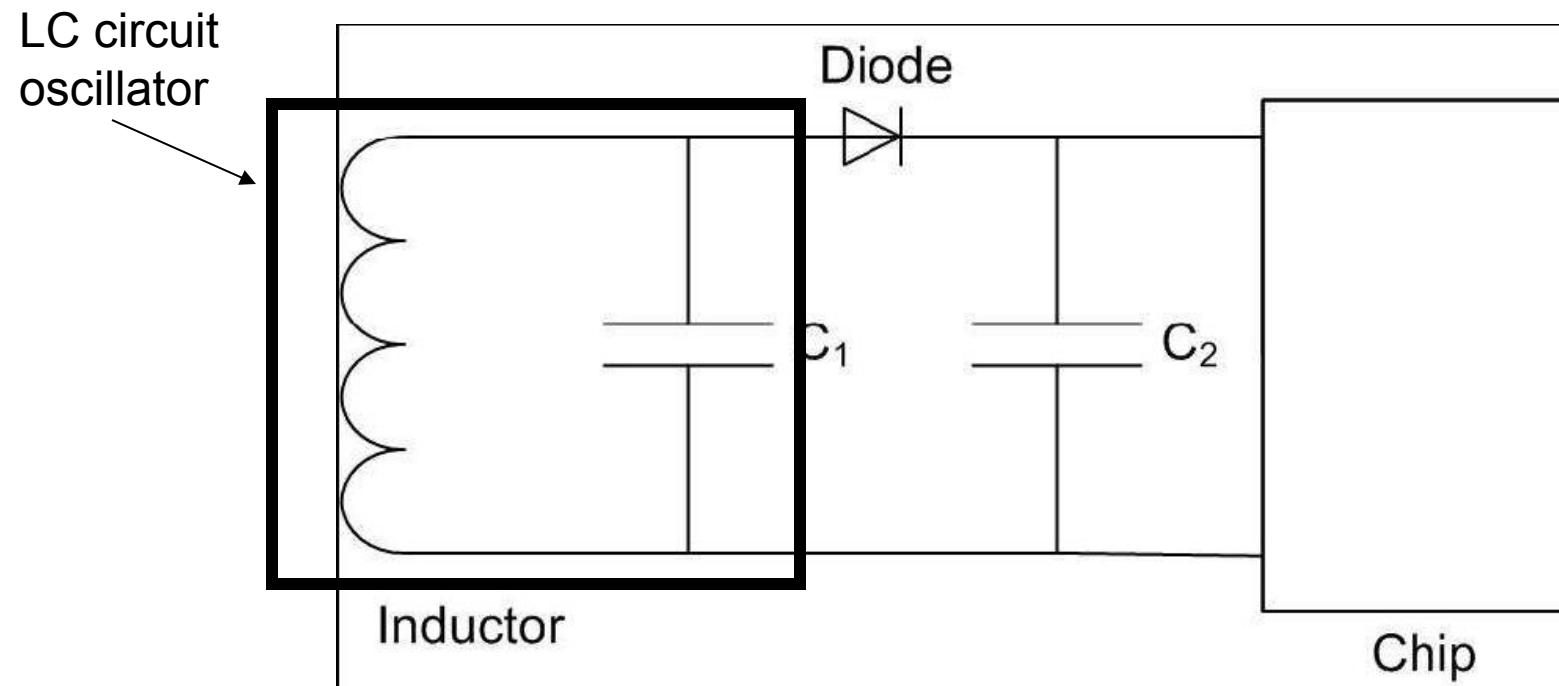


Inductive coupling means that the transponder and the antenna are coupled by the magnetic flux through both coils, much like a transformer.

All the energy used in the tag is drawn from the primary coil of the antenna.

The rest of the picture

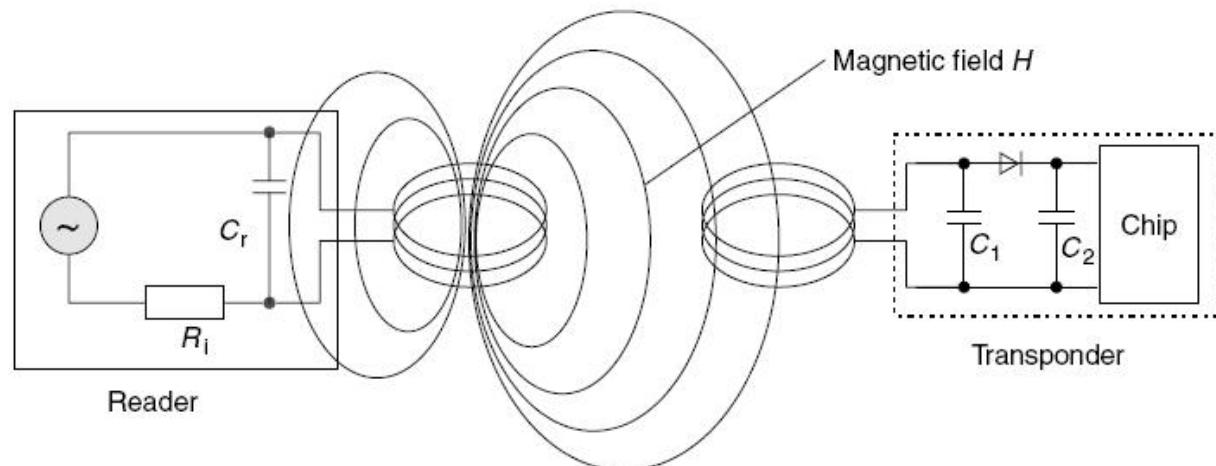
- The energy in the coil can be harvested using diodes and capacitors (C_2) to rectify the current.



Introduction

- For low frequency systems (100kHz-30MHz) the tag is typically read in the near field of the reader

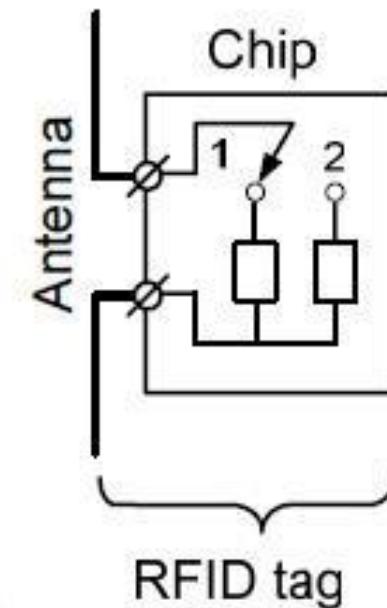
$$Z_1 = Z_{11} - \frac{Z_{12}^2}{Z_{22} + Z_{TAG}}$$



Digital Modulation

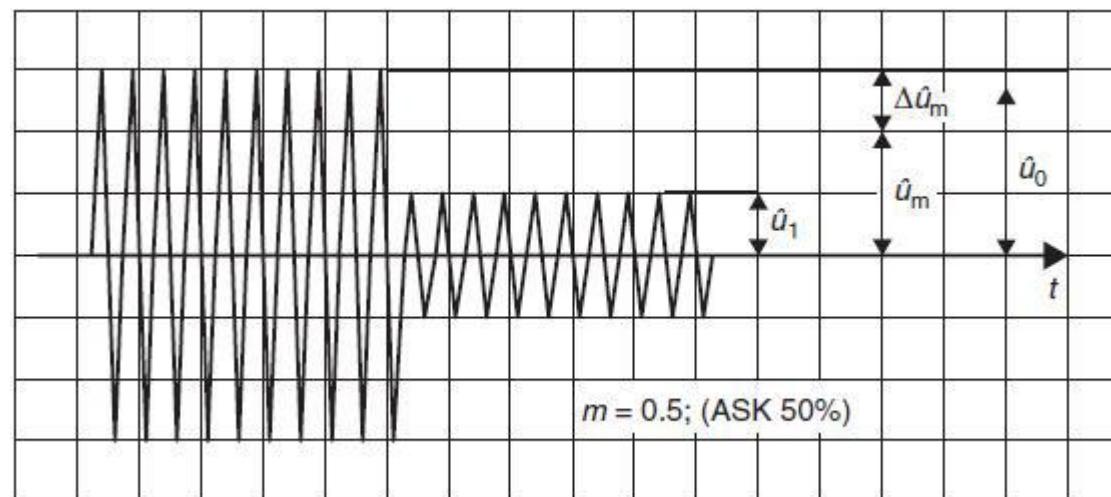
- Circuit in the tag
- The inductance load, Z_{tag} , is electronically adjusted by switching 1 or 2.

$$Z_1 = Z_{11} - \frac{Z_{12}^2}{Z_{22} + Z_{TAG}}$$



Digital Modulation

- As the load Z_{tag} is adjusted, in the reader side, the current amplitude will change accordingly.

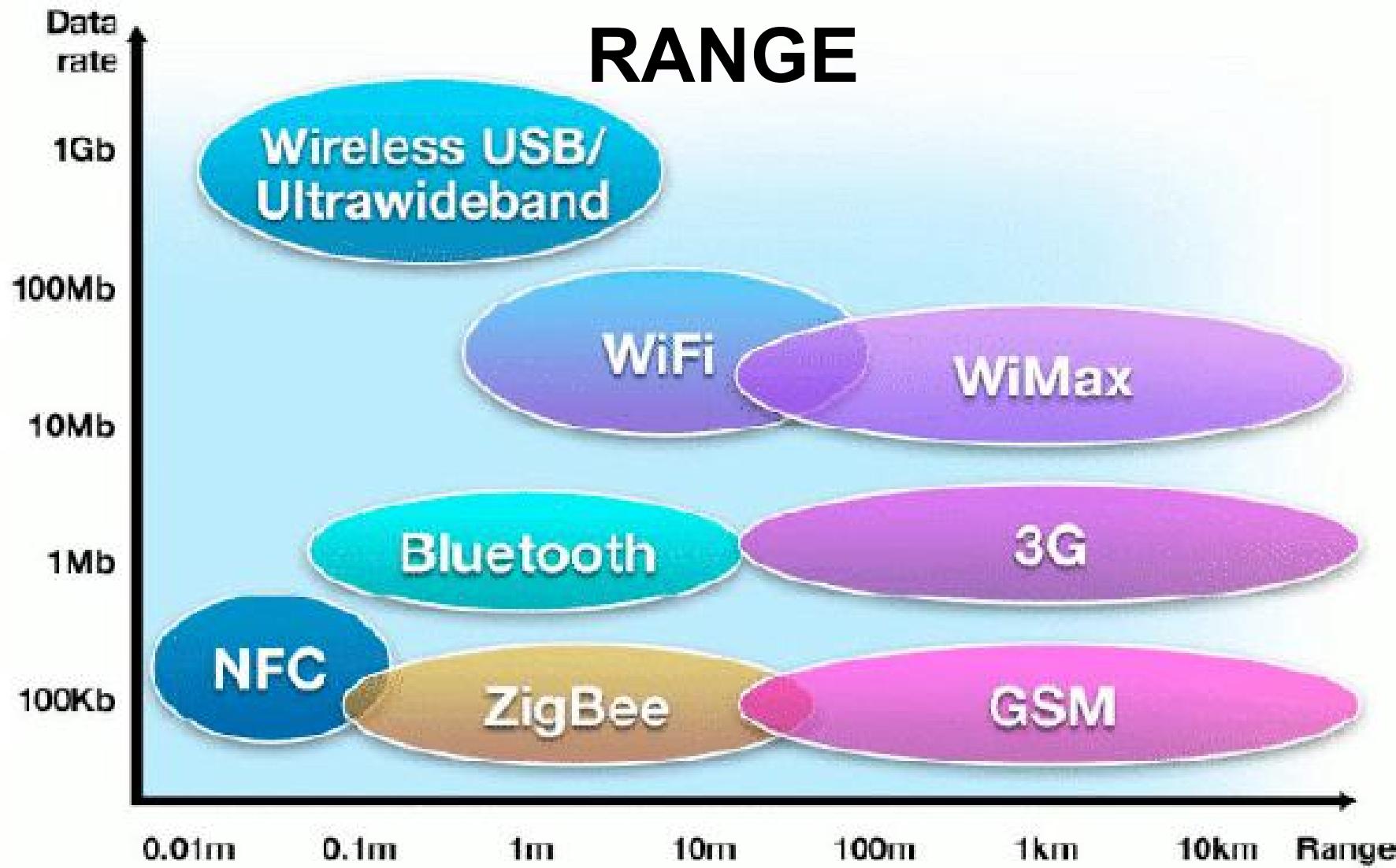


Near Field Communication (NFC)

What is NFC?

- NFC or Near Field Communication is a type of High frequency RFID
- NFC is mainly aimed for mobile or handheld devices.
- It allows for simplified transactions, data exchange, and wireless connections between two devices.
- Allows communication between
 - Two powered (active) devices
 - Powered and non self-powered (passive) devices

DATA RATE & RANGE

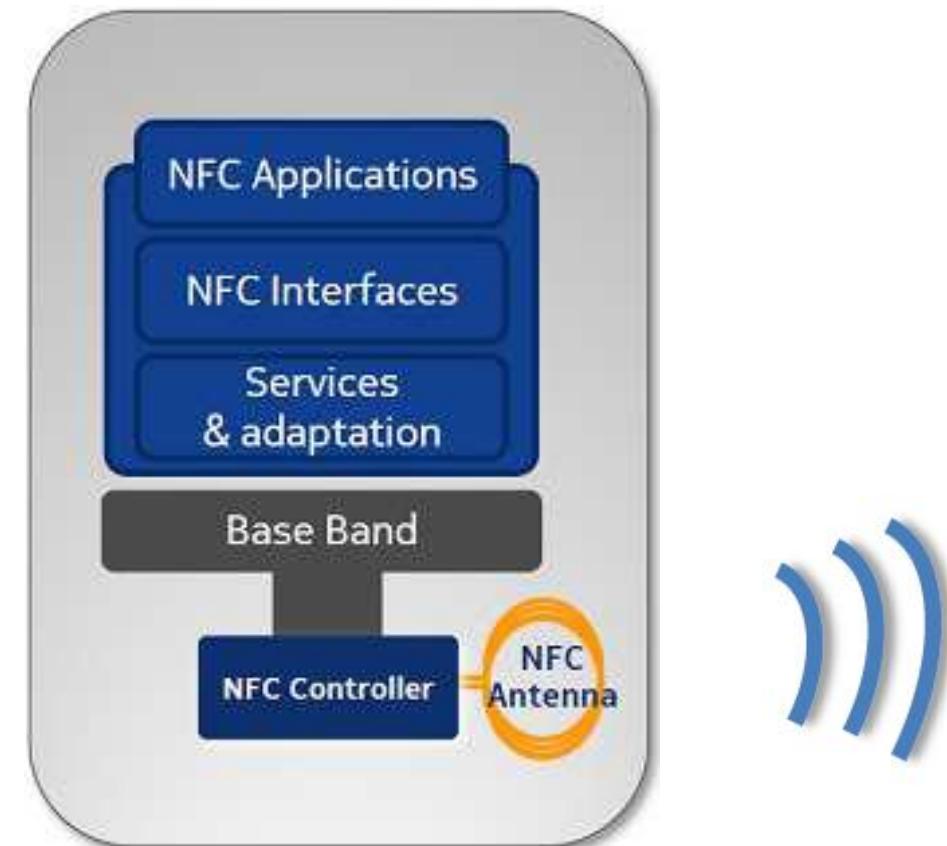


Features

- NFC is an extension of **Radio frequency identification (RFID)** technology
- It operates within the globally available and unlicensed radio frequency band of **13.56 MHz**, with a bandwidth of **14 kHz**.
- Working distance with compact standard antennas: up to **10 cm (mostly)**
- Supported data rates: **106, 212 and 424 Kbit/s**

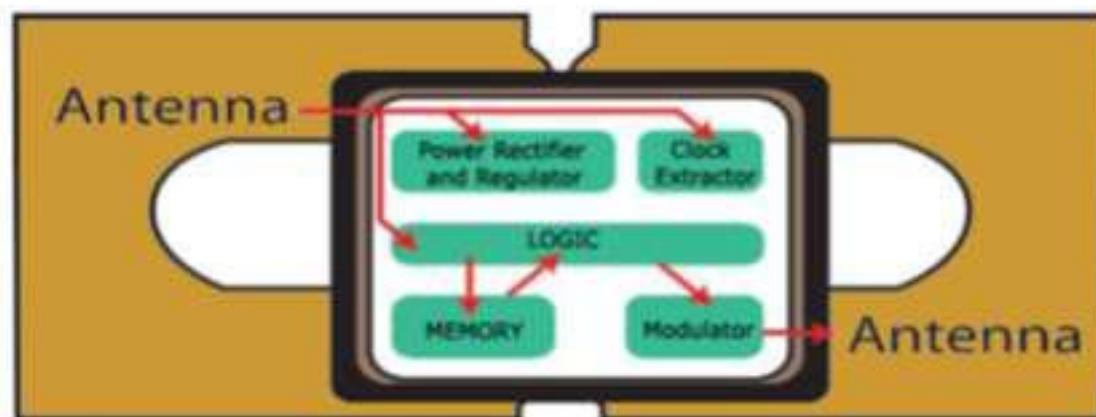
NFC Reader

- Usually a microcontroller-based (e.g., smartphones) with an integrated NFC circuits
- The reader continuously emits RF carrier signals, and keeps observing the received RF signals for data



NFC Tag

- The passive tag absorbs a small portion of the energy emitted by the reader (phone), and starts sending modulated information when sufficient energy is acquired from the RF field generated by the reader.



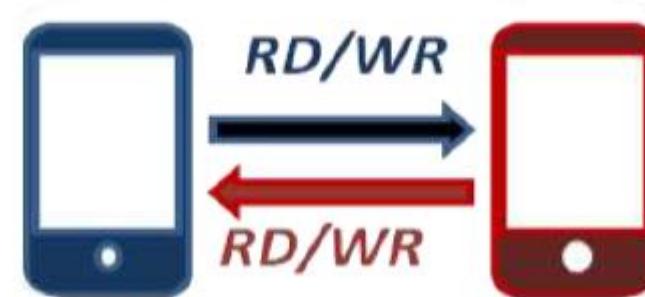
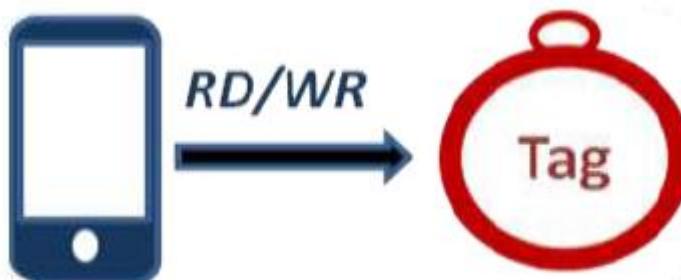
Operation Of NFC

- NFC has two communicative terminals
 - The **INITIATOR** is the one who wishes to communicate and starts the communication.
 - The **TARGET** receives the initiator's communication request and sends back a reply



Communication modes Of NFC

- **Passive Communication Mode**
- The Initiator device provides a carrier field and the target device answers by modulating existing field.
- **Active Communication Mode**
- Both Initiator and Target device communicate by alternately generating their own field.



Operating Modes of NFC devices

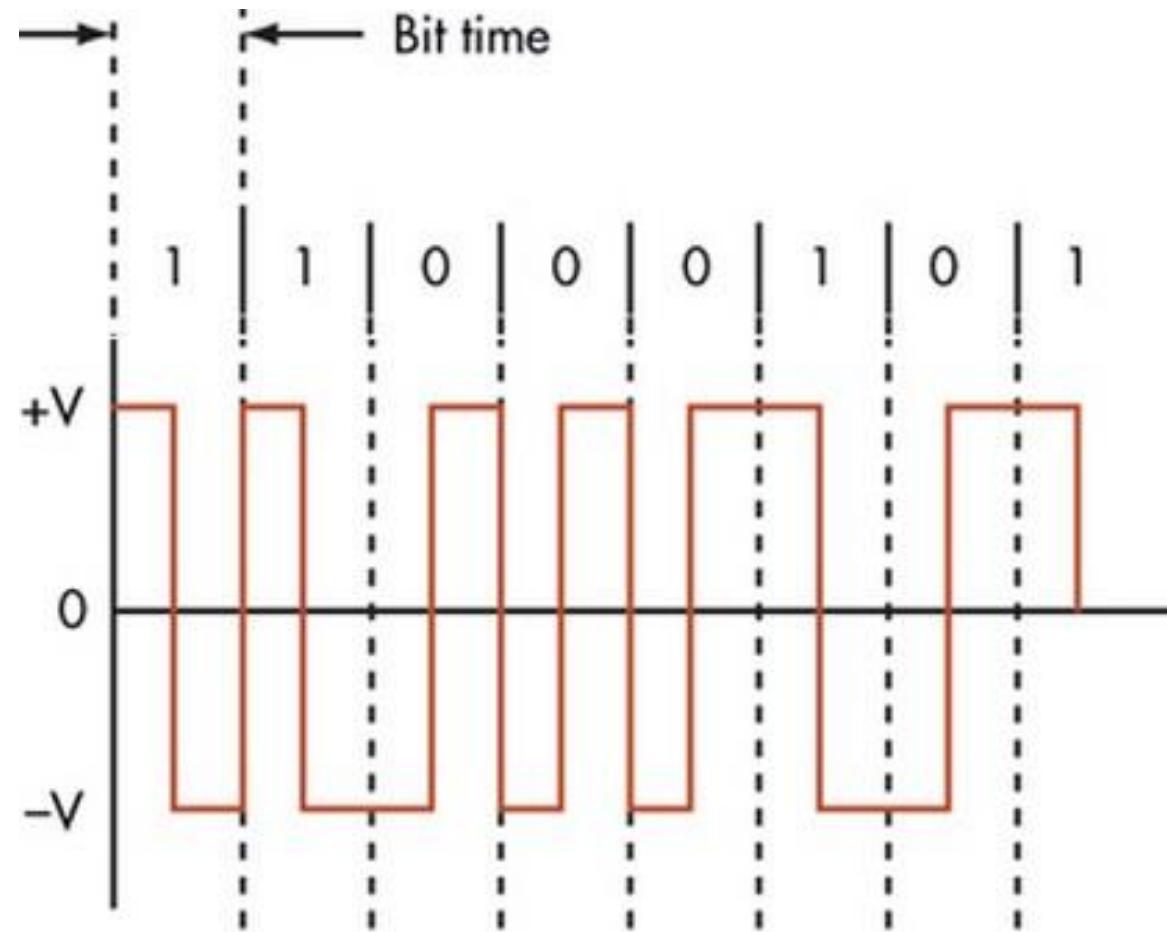
- **Reader/writer mode**, allowing the NFC device to read and/or write passive NFC tags and stickers.
- **P2P mode**, allowing the NFC device to exchange data with other NFC peers;
 - this operation mode is used by Android Beam.
- **Card emulation mode**, allowing the NFC device itself to act as an NFC card.
 - The emulated NFC card can then be accessed by an external NFC reader, such as an NFC point-of-sale terminal.



Signal Encoding in NFC

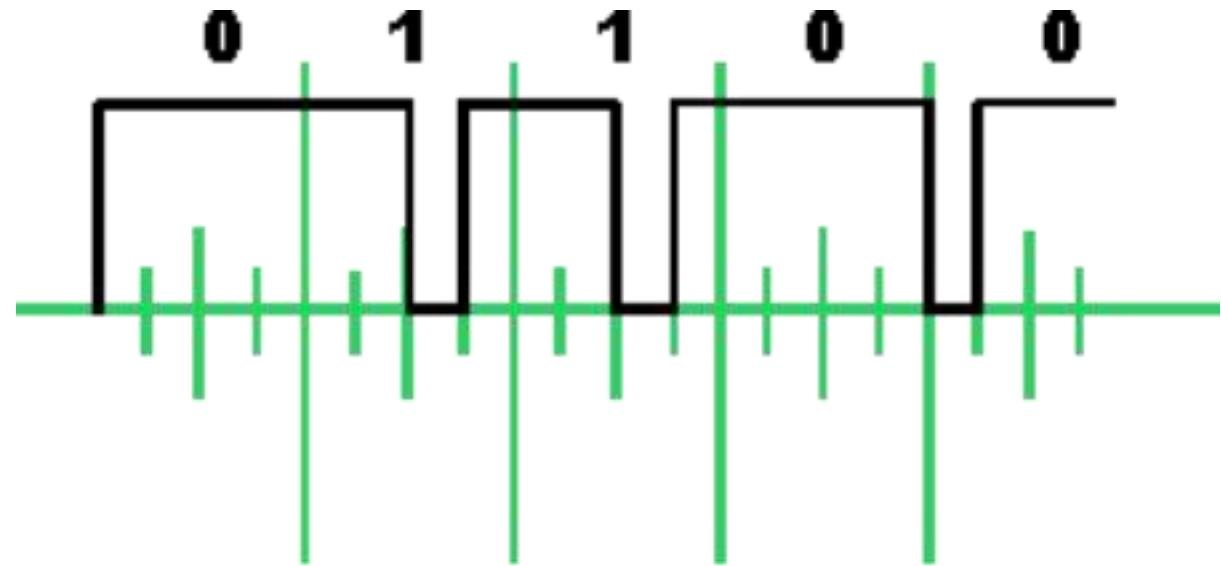
NFC Manchester Coding

- High to Low transition is mapped as binary logic-1
- Low to High transition is mapped as binary logic-0
- Transition occurs exactly in the middle of bit period.



Modified Miller Coding

- A high or "1" is always encoded in the same way, but a low or "0" is encoded differently dependent upon what preceded it.
- Pros
 - Has fewer transitions. This characteristic saves bandwidth



Key:

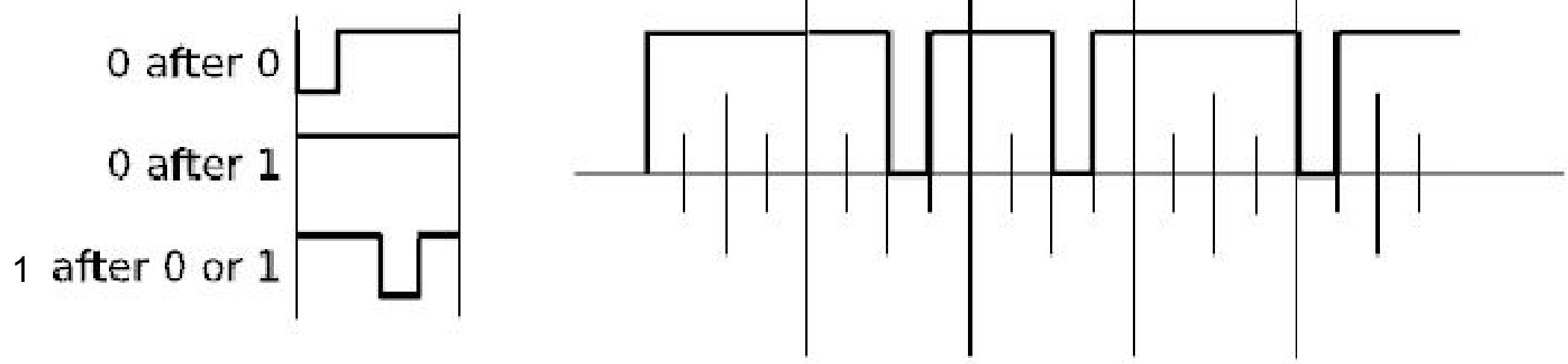
0 after 0

0 after 1

1 after 0 or 1

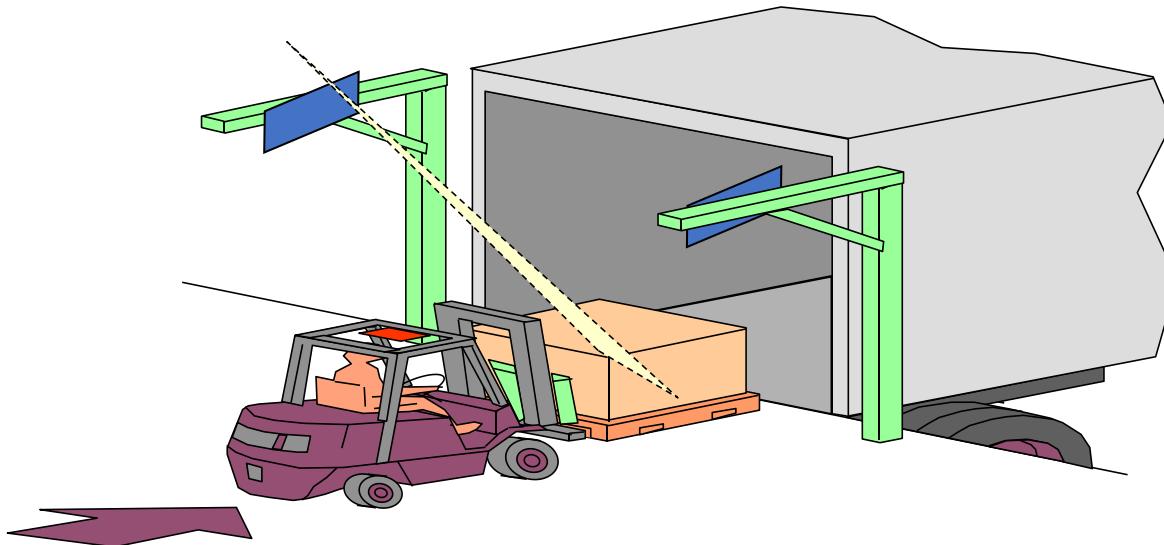
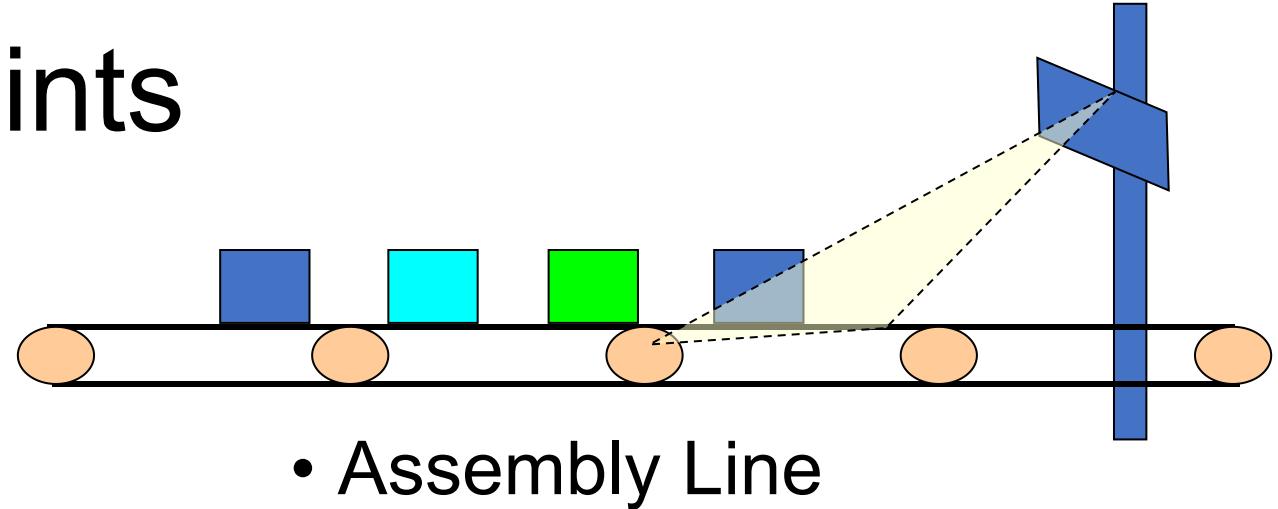
Exercise

- Decode the signal modulated in modified miller code



Applications

RFID application points



§ Shipping Portals

§ Handheld Applications

Smart groceries

- Add an RFID tag to all items in the grocery.
- As the cart leaves the store, it passes through an RFID transceiver.
- Check out in seconds.

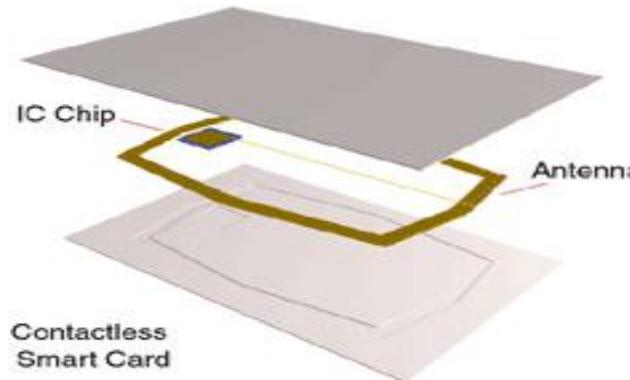


Smart fridge

- 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

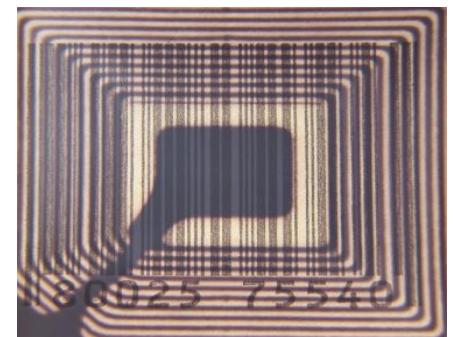
Access control and identification

- Cards for access to secure areas.
- Wristbands to provide access to unattended buildings.



Tracking people and objects

- Children in theme parks
- Protection of expensive objects
- Personnel activities inside a facility
- Inmates identification and tracking



Ticketing

- Trains, subways, buses, concerts, amusement parks, fitness facilities, ski resorts.
- Reduces counterfeit
- RFID tickets used in the Soccer World Cup in Germany in 2006. 4.8 millions Tickets sold with no counterfeiting problems.



Libraries

- From barcodes to RFID tags.
- Faster and automatic checkout and return.
- Faster inventory process.

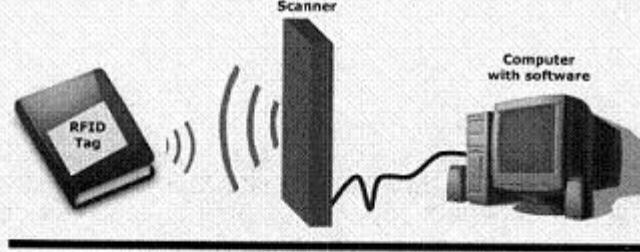


Figure 1. Components of an RFID system

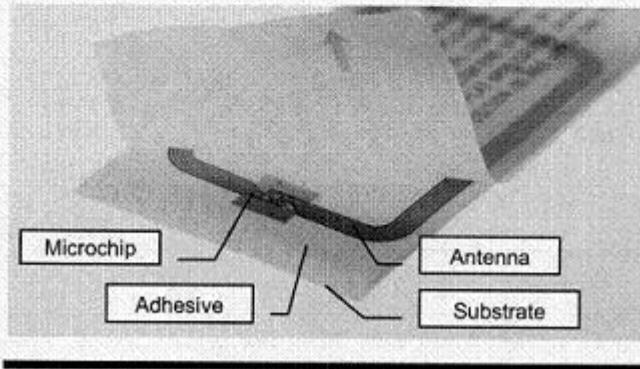


Figure 2. Typical RFID tag

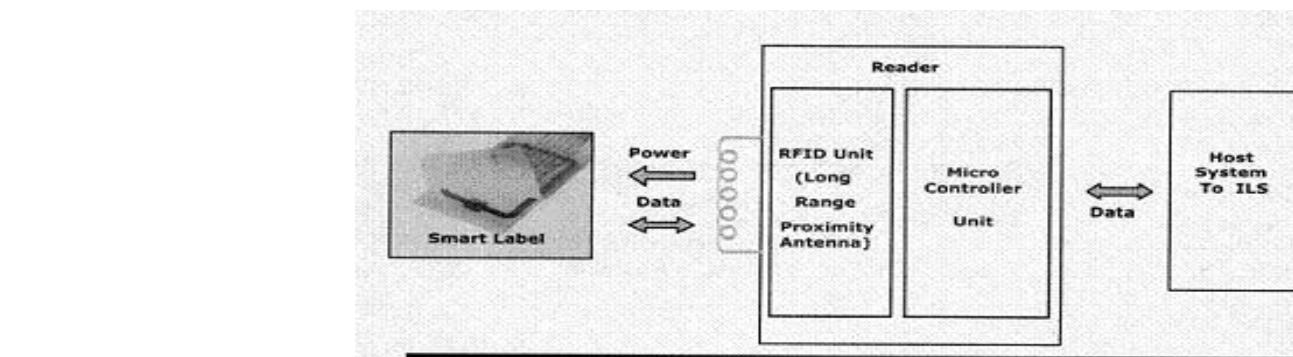
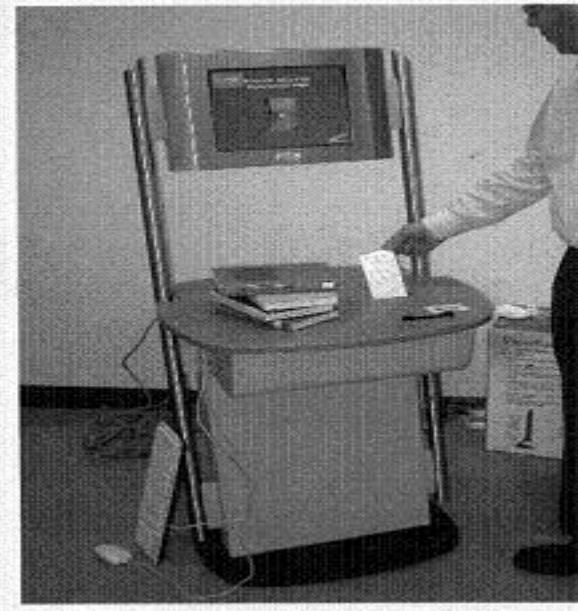


Figure 3. Information exchange for a typical RFID-based library (source: Libramation Library Systems)

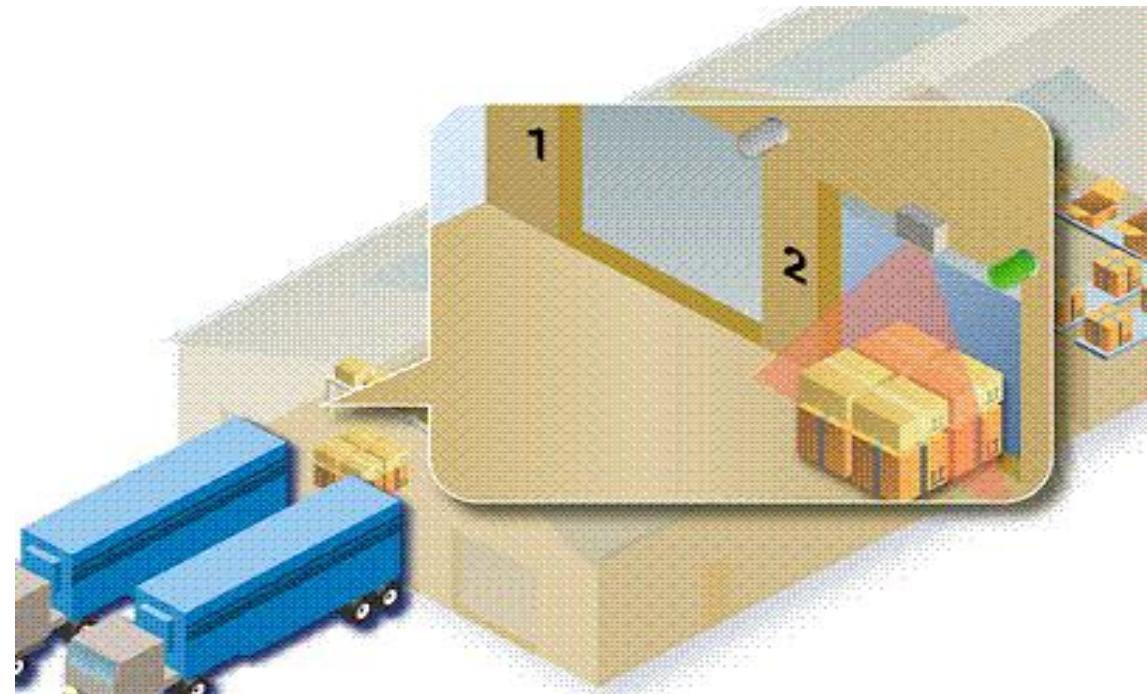
Production Line Control and Monitoring

- Car Body Production: Flow of information along the assembly line for process verification.
- Identify vehicles through assembly line prior to the execution of a given assembly task.



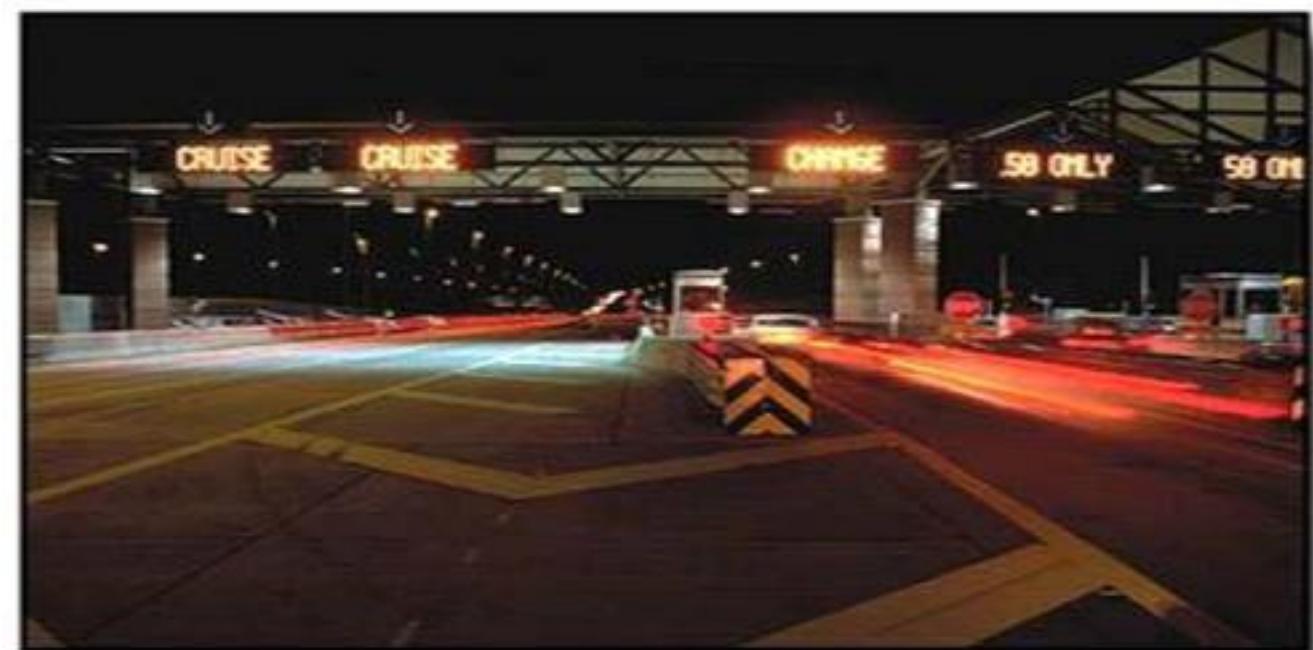
Distribution and transportation

- Receiving and check-in
- Put away and replenishment
- Order Filling
- Shipping
- Product and asset tracking



Vehicle Identification

- Fleet management
- Access to parking lots
- Railway industry
- Electronic toll collection



Baggage handling

- Replace bar code stick labels with RFID inlay stick labels.
- Many tags can be read at one time.
- Read-write capability is used to record information along the way as the bag makes its way through the handling system.



Animal Identification

- Livestock tracking
- Data critical for the safety of food supply
- Can also be used on pets.
- Ear tags, injectable tags, RFID tattoos

