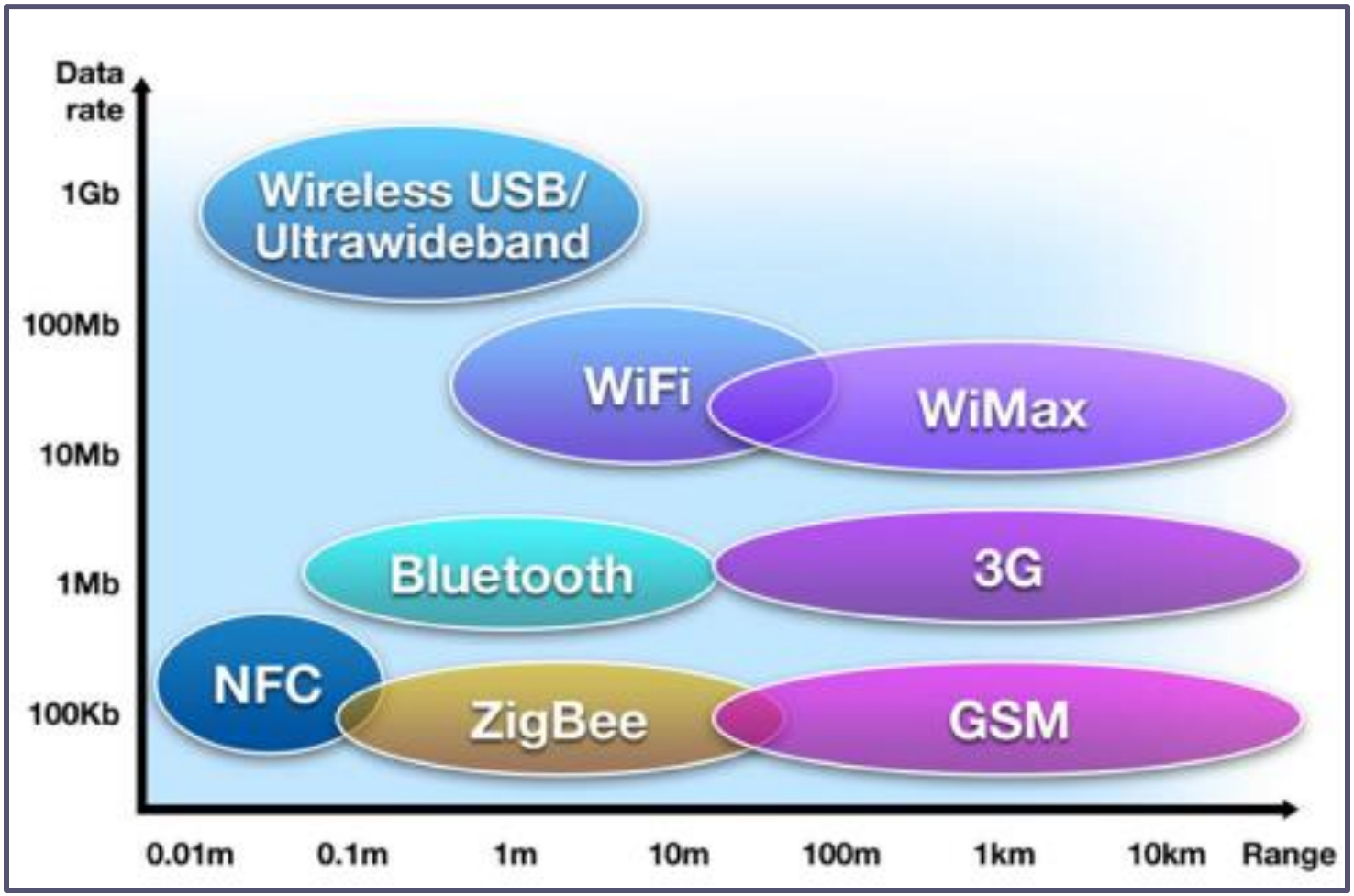
Wireless Personal Area Network

Outline

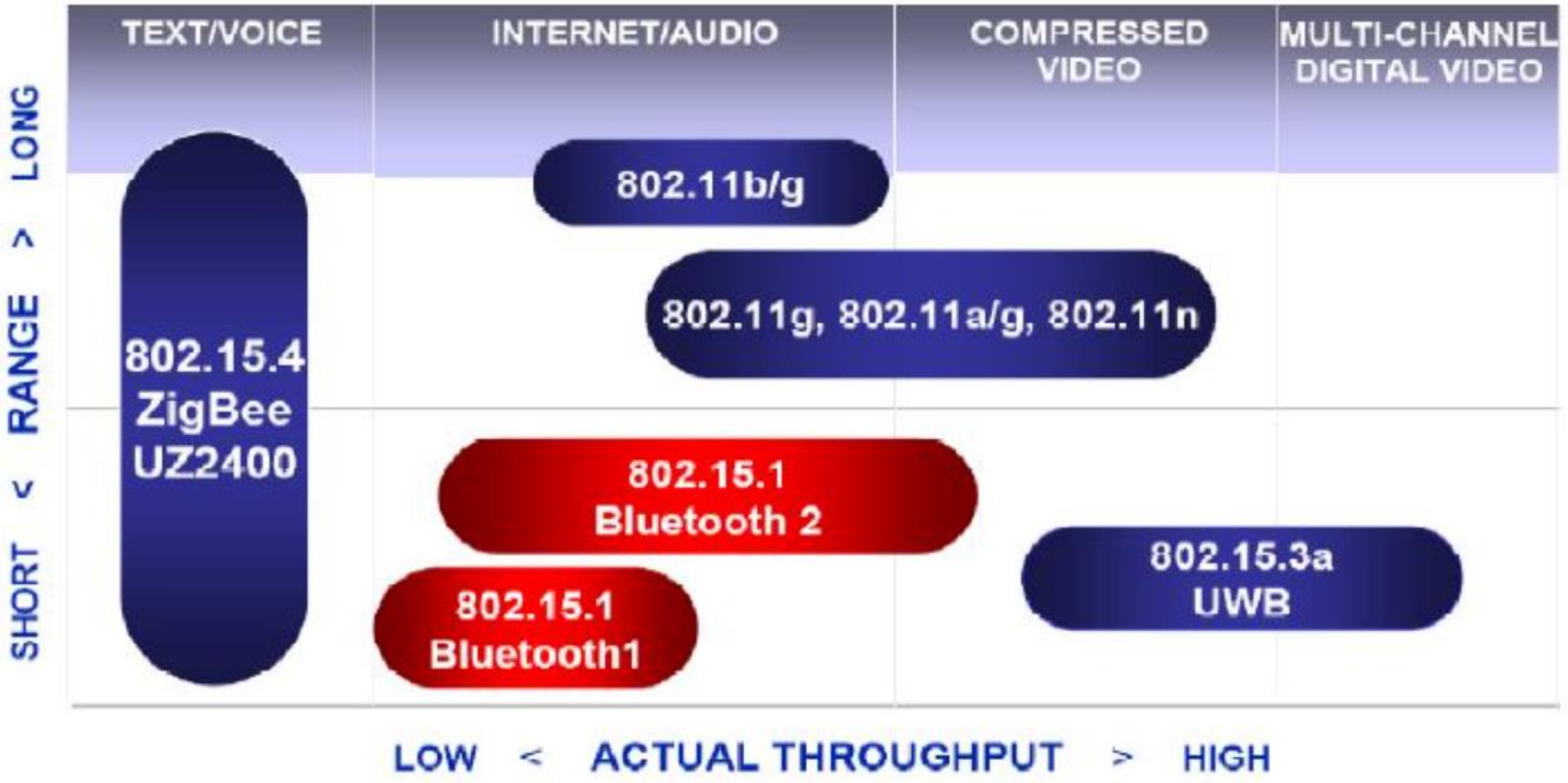
- **Introduction**
- **Technology**
  - Zigbee
  - Bluetooth
  - RFID
- **Industry Analysis**
- **Conclusion**
- **References**

Comparison Between Similar Technologies[3]



Technology analysis

- 無線個人服務網路比較



Comparison Between Similar Technologies

	NFC	RFID	Bluetooth	Zigbee
Maximum Operating Range	10 cm	3 m	100 m	30-100 m
Operating Frequency	13.56 MHz	Varies[1]	2.4 GHz	Varies
Directional Communication	Two way	One way	Two way	Two way
Bit Rate	106/212/ 424 Kbps	Varies[13]	22 Mbps	250kbps
Potential Uses	e-Tickets, Credit card payment, Membership card	Tracking items, EZ-Pass	Communicate between phones, peripheral devices	Text/IoT

Zigbee

- Zigbee is a low-speed and short-range wireless network protocol
- Its MAC and PHY layer adopt IEEE 802.15.4-based specifications
- Developed by Zigbee Alliance since 1998
- Proposed to IEEE in 2001 to include it in the IEEE 802.15.4 specification
  - IEEE 802.15.4 = LR-WPAN (Low-rate wireless personal area network)
- Zigbee Alliance provides interoperability certification
- ZigBee features:
  - Low speed
  - Low power consumption
  - Low cost
  - Support a large number of network nodes

Zigbee Technical Specification

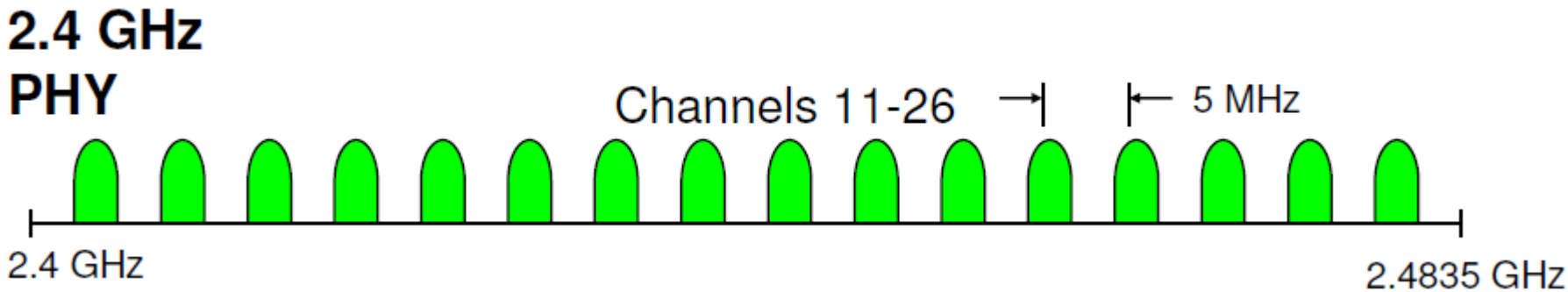
Solution	Description
Network Protocol	Zigbee PRO
Network Topology	Self-Forming, Self-Healing MESH
Network Device Types	Coordinator (routing capable), Router, End Device
Network Size	Up to 65,000 nodes
Radio Technology	IEEE 802.15.4
Frequency Band	2.4 GHz (ISM band), 16-channels (2 MHz wide)
Data Rate	250 Kbits/sec
Encryption Support	AES-128 at Network Layer
Communication Range (Average)	Up to 300+ meters (line of sight) Up to 75-100 meters indoor
Low Power Support	Sleeping End Devices Zigbee Gree Power Devices (energy harvesting)

Technology analysis

- Frequency band

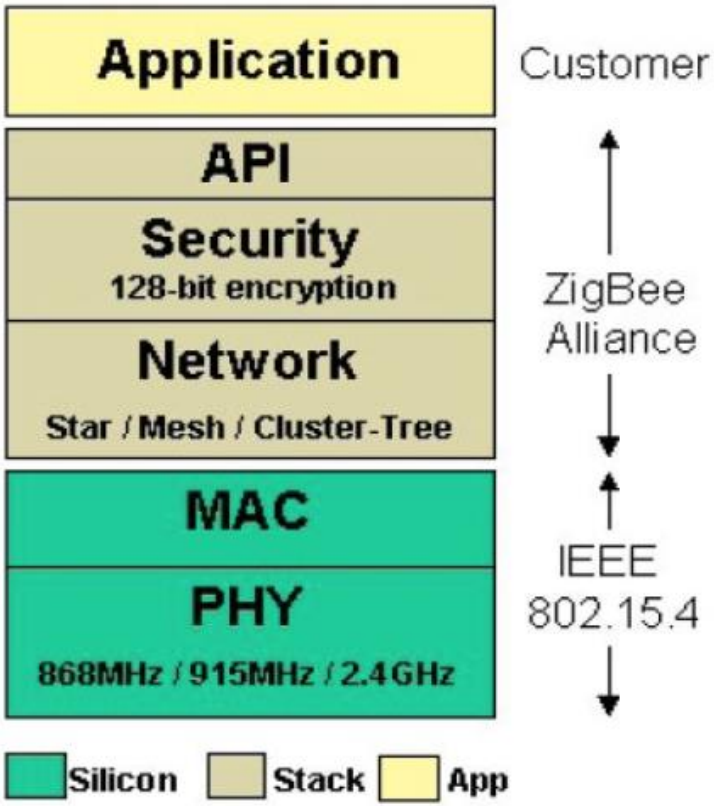
IEEE 802.15.4

- 16 channels in 2.4GHz ISM band
- Data rate: 250 kbps
- Modulation:
  - O-QPSK (offset quadrature phase-shift keying)
  - Direct Sequence Spread Spectrum

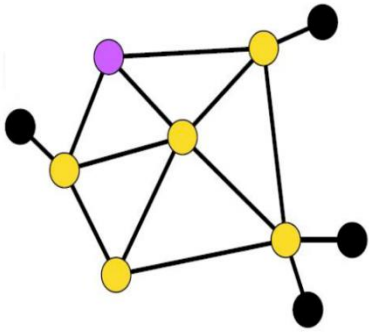


Technology analysis

- ZigBee

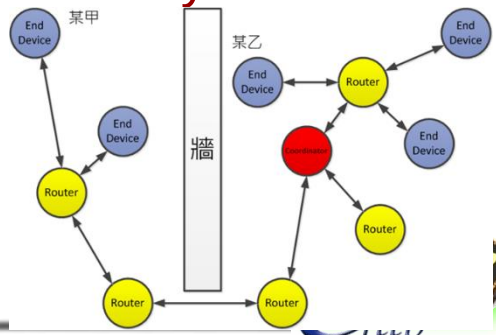


Zigbee Network

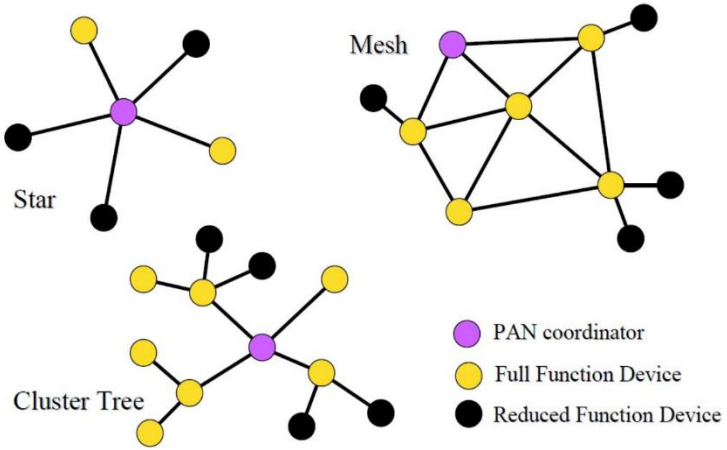


- 從網路架構層面來看
  - PAN coordinator (FFD)
    管理整個 ZigBee 網路的控制中心
    PAN ID , Security ,通道....
  - Network Router (FFD)
    負責延展整個網路的路由器
  - End Device (RFD)
    網路末端裝置(Sensor)

- **Coordinator**
  - The most capable device, the coordinator forms the root of the network tree and may bridge to other networks. It stores information about the network.
- **Router**
  - a router can act as an intermediate router, passing data on from other devices.
- **End Device**
  - Only communicate with Router, not with each other
  - The MAC layer function can be omitted, saving memory and power
  - Asleep most of the time



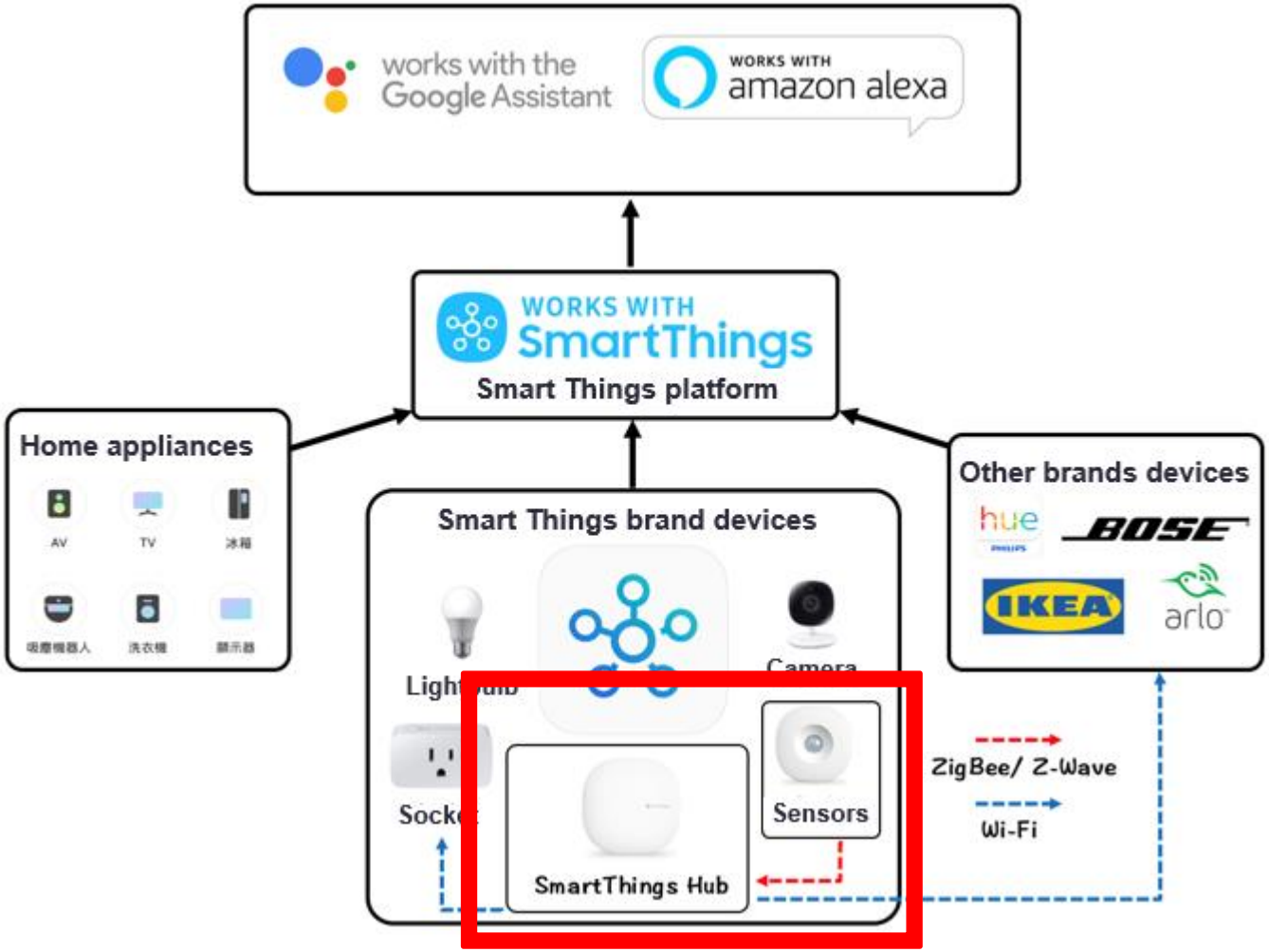
Technology analy



Comparison

	Pro	Con
Star	Easy to synchronize、No Router, power saving	Not scalable
Tree	multicast、Fixed Router path, low cost	Router high rebuild cost、Latency high due to long routing path
Mesh	multicast、scalable	Router discover cost high、Need to store routing table

Samsung SmartThings Platform



Applications: Samsung SmartThings

- SmartThings hub

SmartThings Hub

SmartThings Outlet

SmartThings Multipurpose Sensor

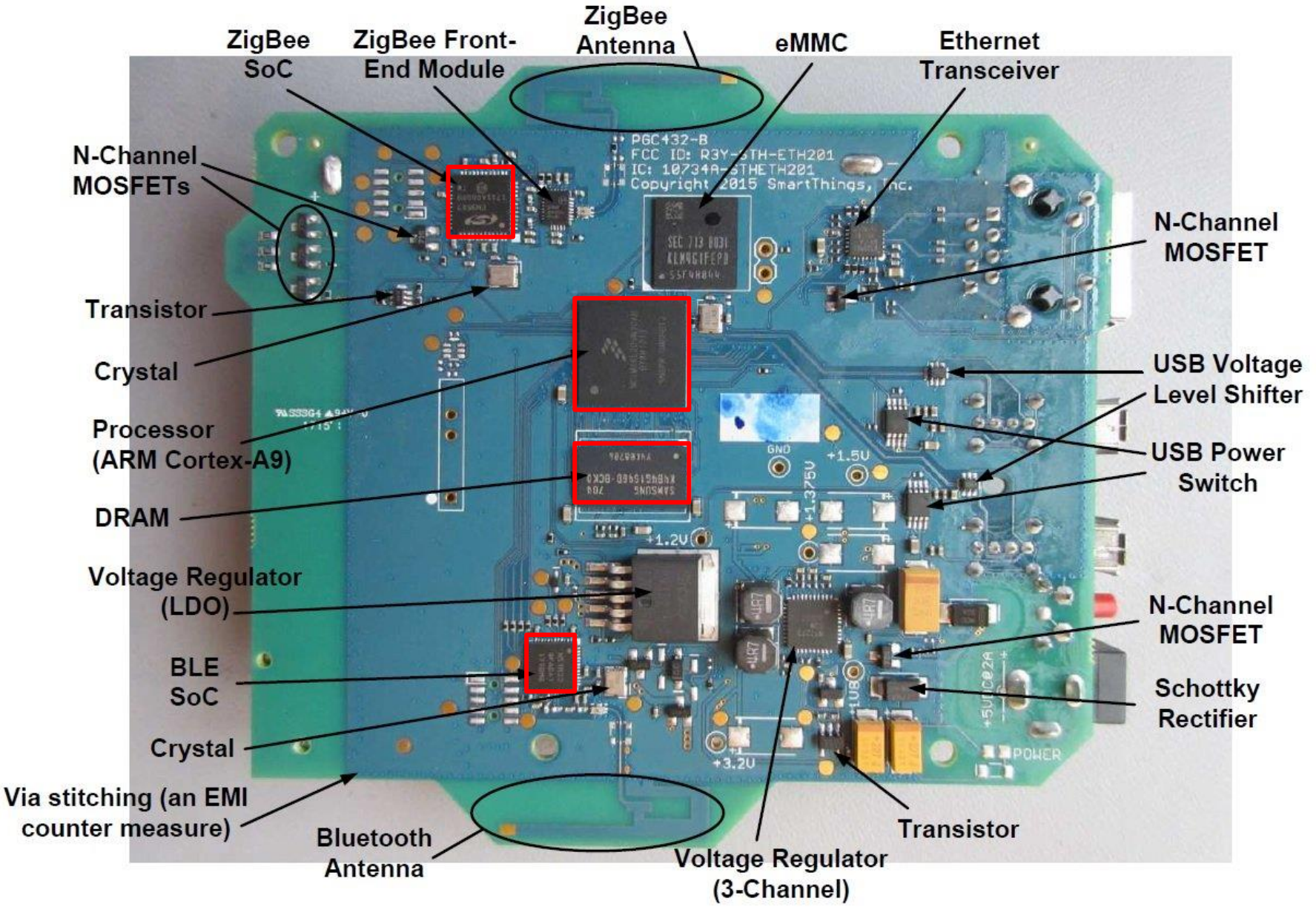
SmartThings Water Leak Sensor

SmartThings Motion Sensor

SmartThings Cam

SmartThings Smart Bulb

SmartThings Button


ZigBee SoC
ZigBee Front-End Module
ZigBee Antenna
eMMC
Ethernet Transceiver
N-Channel MOSFETs
N-Channel MOSFET
Transistor
Crystal
USB Voltage Level Shifter
Processor (ARM Cortex-A9)
USB Power Switch
DRAM
Voltage Regulator (LDO)
N-Channel MOSFET
BLE SoC
Schottky Rectifier
Crystal
Via stitching (an EMI counter measure)
Bluetooth Antenna
Voltage Regulator (3-Channel)
Transistor
PGC432-B
FCC ID: R3Y-STH-ETH201
IC: 10734A-STHETH201
Copyright 2015 SmartThings, Inc.
GND
+1.5U
+1.375U
+1.2U
+3.2U
POWER

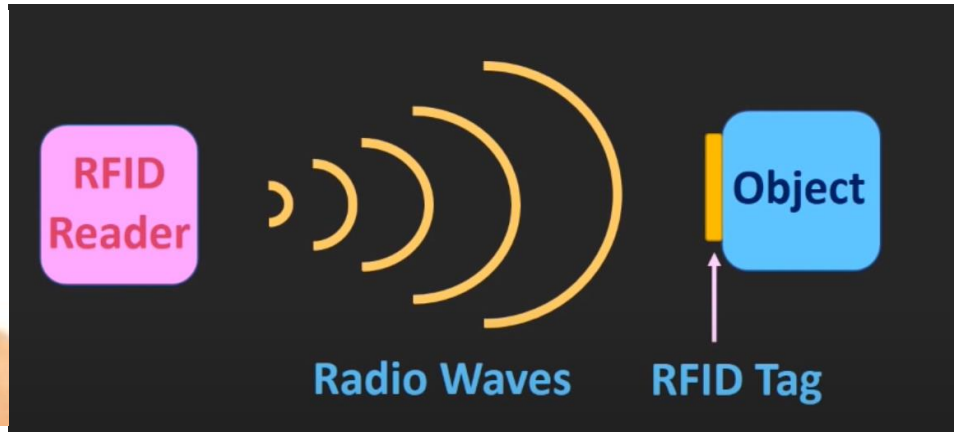
SmartThings Hub

- **Processor:**
  - 32-Bit ARM Cortex-A9 core
  - 1GHz
  - 128KB RAM + 256KB L2 Cache
- **SDRAM**
  - DDR3-1600
  - 4Gb
- ZigBee SoC
  - 32-Bit ARM Cortex-M3 Core
  - 512KB Flash + 64KB RAM
  - 2.4GHz IEEE802.15.4-2003 Transceiver
- Bluetooth Low Energy SoC
  - 2.4GHz

RFID

What is RFID ?

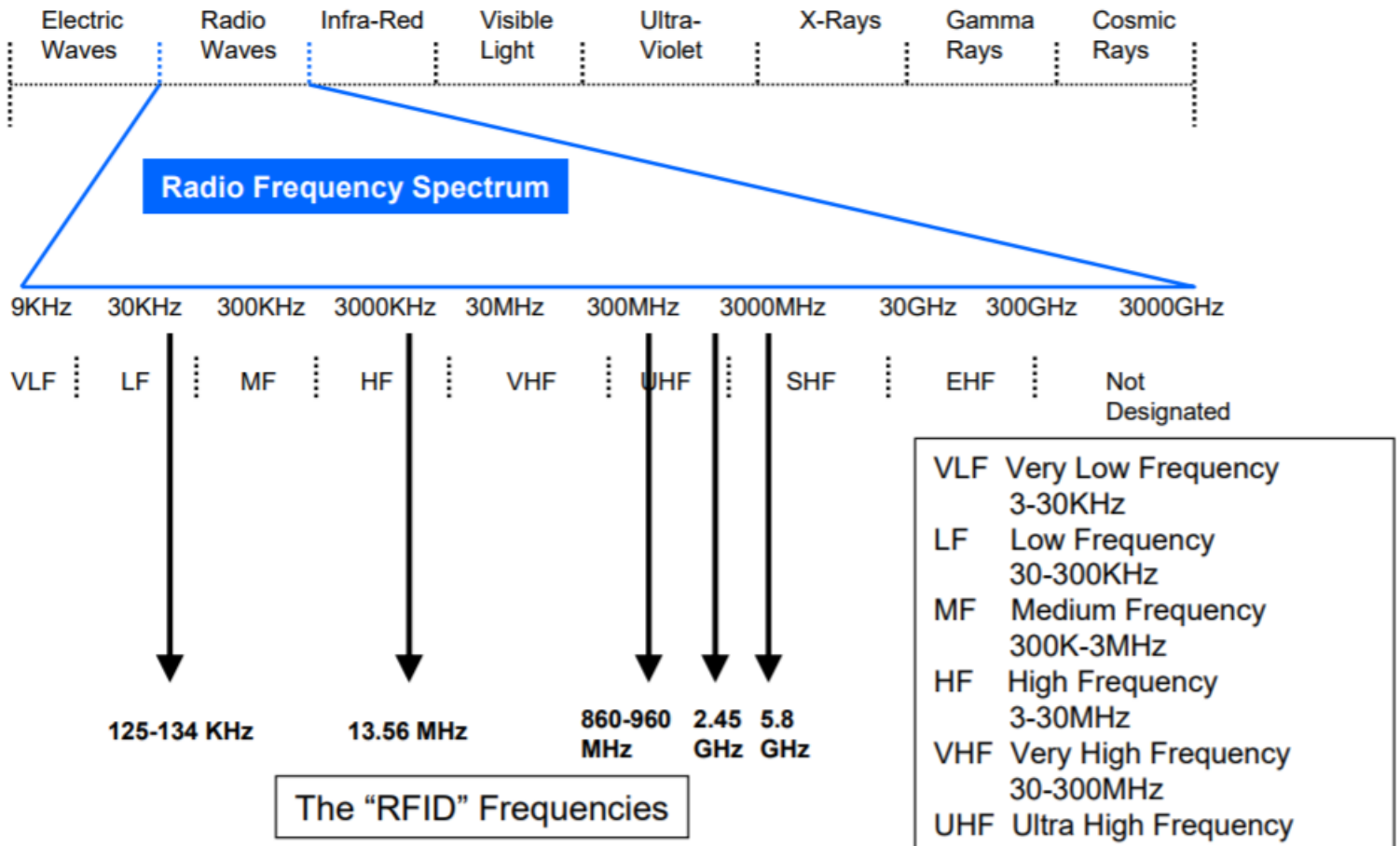
- RFID = Radio Frequency Identification
- Contactless and wireless communication between objects.
- identify and transmit data via radio waves.
- RFID system composed of a reader and a Tag like barcode.



Introduction

- **What is RFID (Radio Frequency Identification) ?**
  - Eliminates the universal issues of bar code
    - Not require physical sight between reader and tagged item.
    - Can read several tags at a same time
    - Rewritable, reusable, larger storage
  - RFID is used to automatically identifying or tracking object.

RFID Frequency



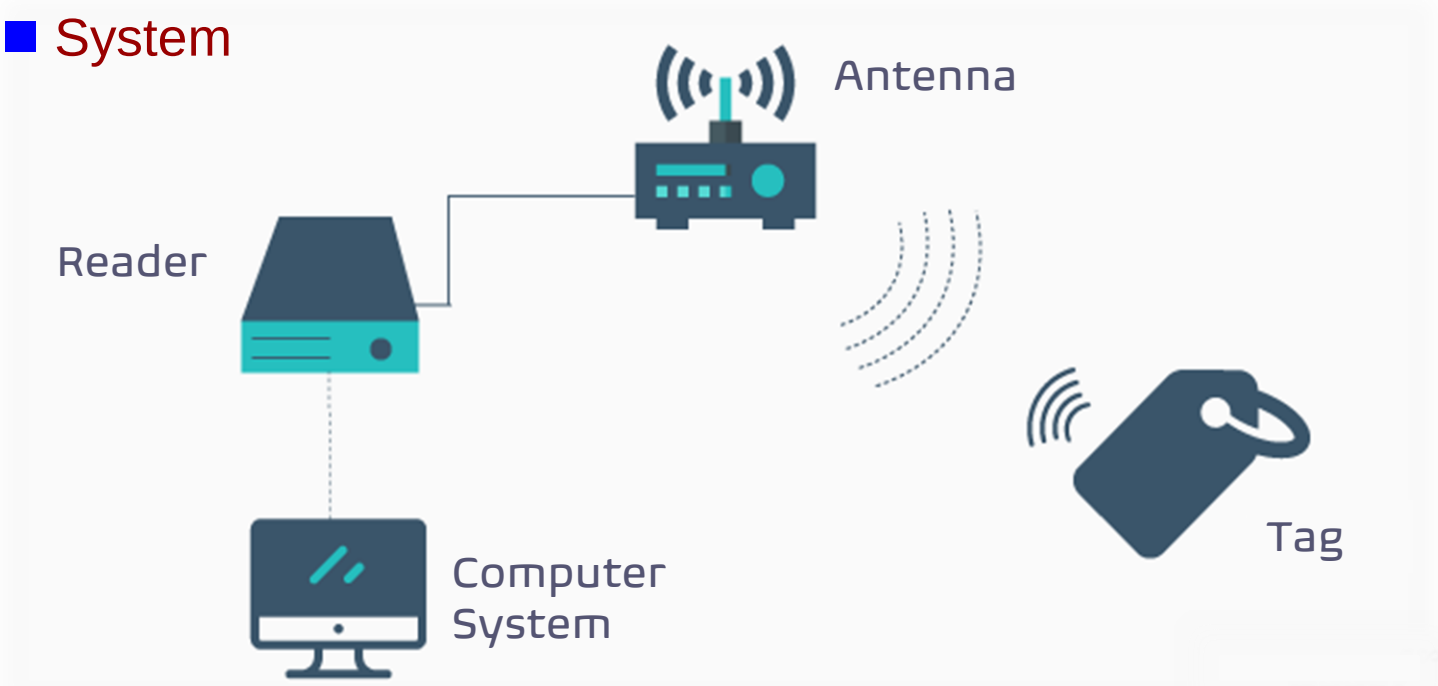
RFID Frequency

	LF	HF	UHF	Microwave
Frequency Bands	125 kHz – 134 kHz	13.56 MHz	860 MHz – 960 MHz	2.45 GHz & 5.4 GHz
Type	Passive	Passive/ Active	Passive/ Active	Passive/ Active
Data Passing	Electromagnetic induction	Electromagnetic induction	Microwave resonance	Microwave resonance
Read Range	Short to Medium ~10 cm	Short ~10 cm	Medium ~several meters	High ~ 3 meters
Restrict	short distance	Metal	Moisture	Moisture
Usage	- Access Control - Animal Tagging - Inventory Control - Car Immobilizer	- Smart Cards - Items level tagging - Proximity Cards	- Pallet level tagging - DOD & Walmart Mandates	- Container Rail Car - Auto Toil Roads - Pallet level tracking

https://www.impinj.com/about-rfid/types-of-rfid-systems/

System Description

- **RFID components**
  - Transponder (RFID Tags)
  - Transceiver (Tag Reader)
  - Antenna
  - System



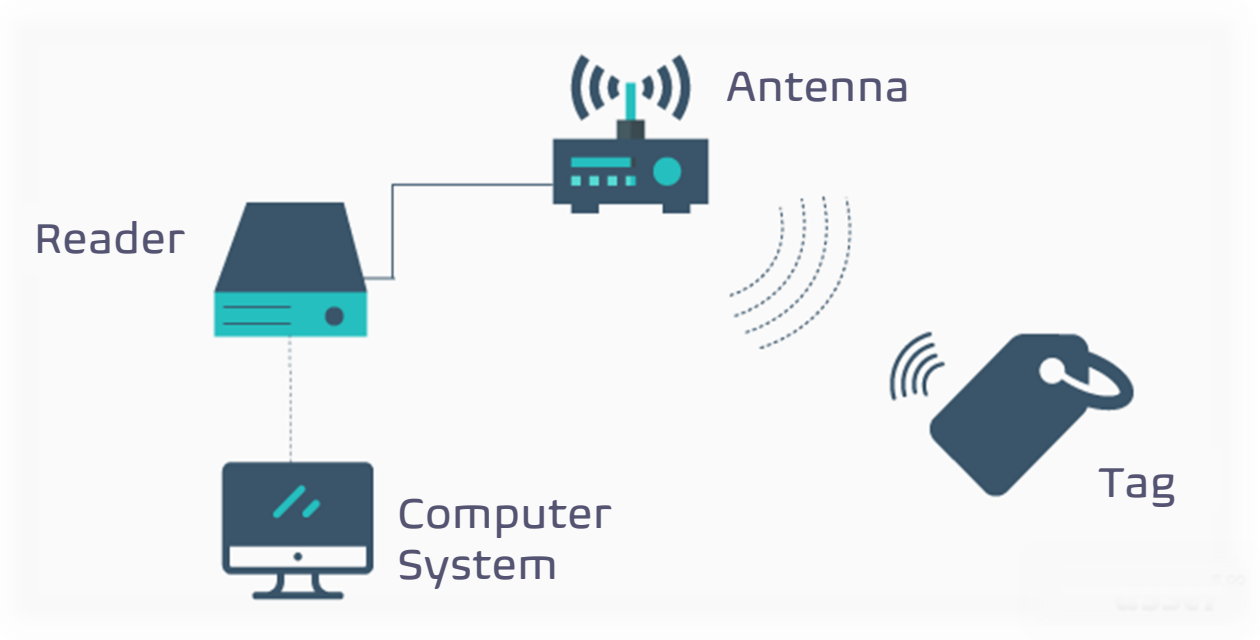
System Description

- **How it works?**

  RFID reader is continuously sending radio waves via Antenna

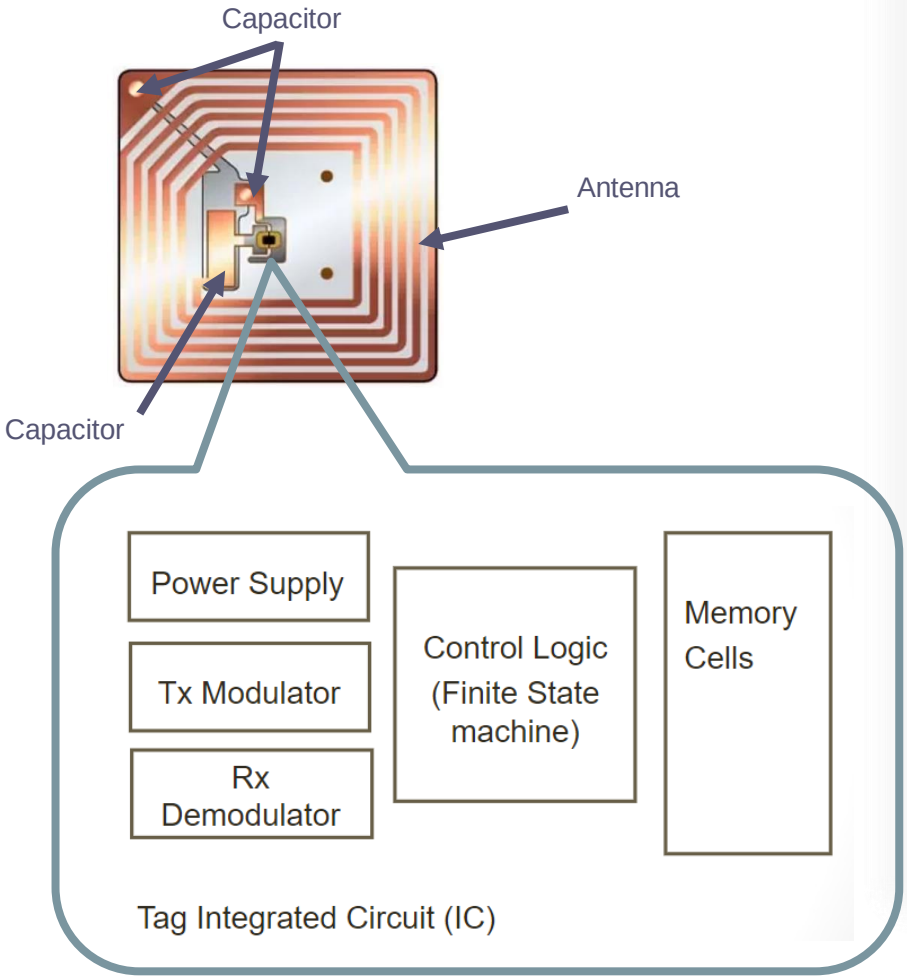
  Whenever the RFID tag is in the range of the reader,

  Tag transmit feedback to reader.



Components

Transponder (Tags)



https://blog.atlasrfidstore.com/a-tag-a-label-an-inlay

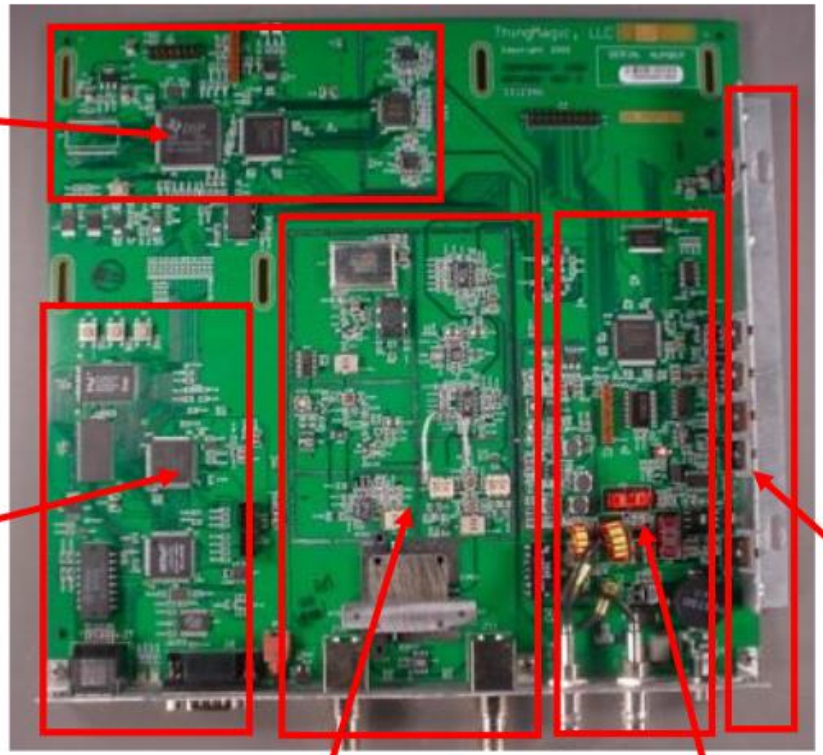
Components – types of Tag

Semi-Active

	Active RFID Tag	Passive RFID Tag
Power Source	Internal Battery	Transferred from Reader
Availability of Power	Continuous	Only within range of reader
Required Signal Strength	Weak	Strong
Range	305 meters up	6 meters around
Multi-Tag reading	1000's of tags	100 around (within reader range)
Cost	High (Most at 450~600 NTD)	Low (1.65~6 NTD)

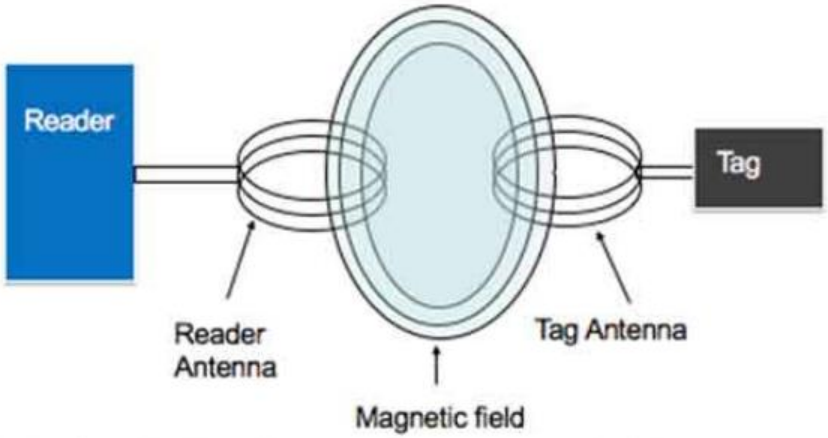
Components

- **Transceiver (Reader)**



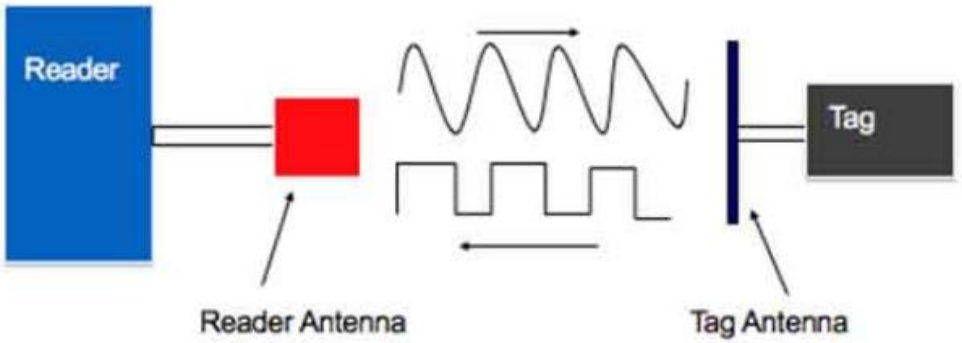
RFID Communication Principle

- Electromagnetic induction Coupling(d = 1cm~at most 1m)



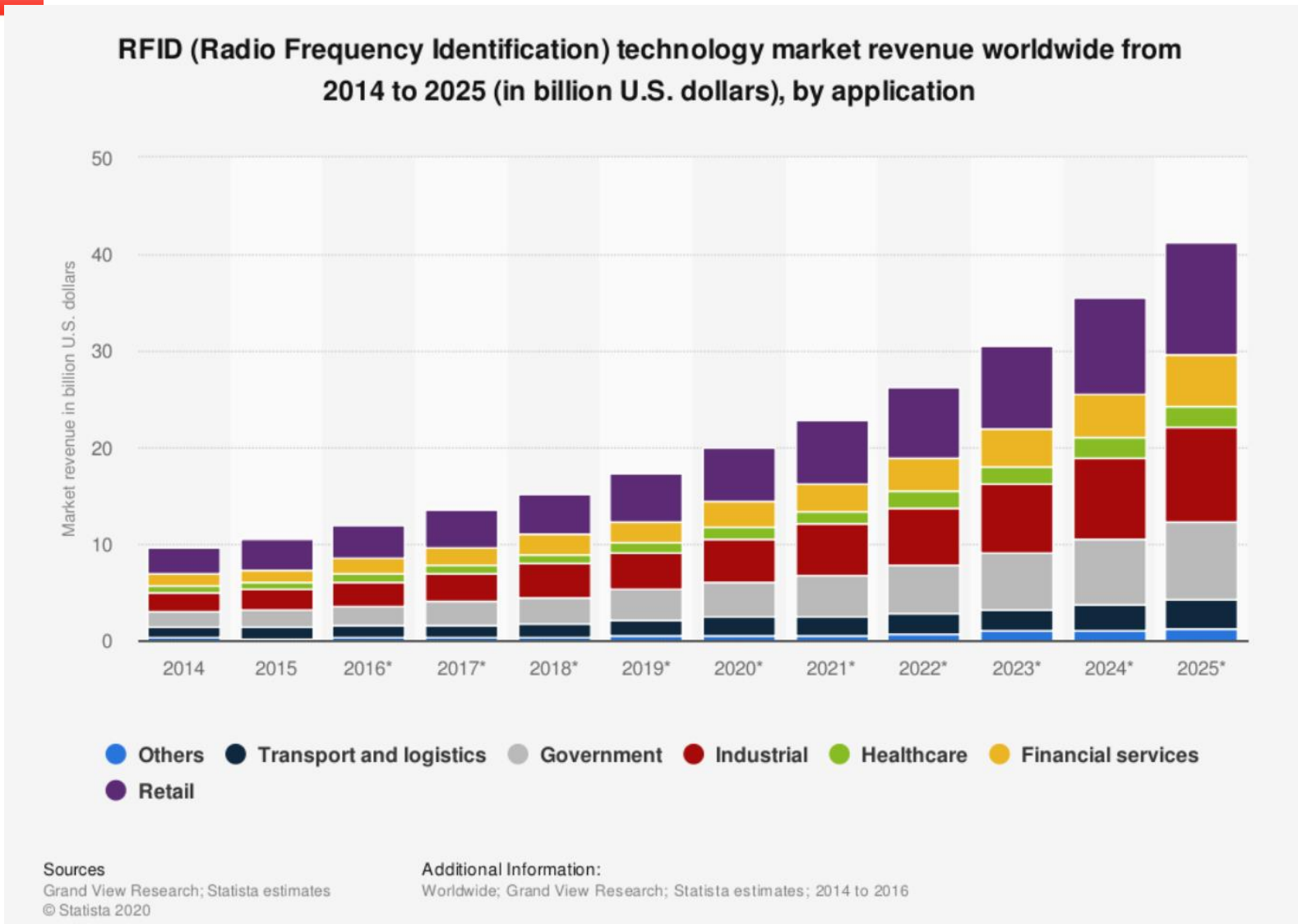
Power at tag Ptag ∝ 1/d6 Preader d = tag – reader distance

- Microwave resonance Coupling(Backscatter, d =1m~4m)



• UHF (915MHz) : Far field propagation : Pt ∝ 1/d2

Market Size (by types)



https://www.statista.com/statistics/781314/global-rfid-technology-market-revenue-by-application/

Competitor

- **NFC (Near Field Communication)**

	RFID	NFC
Frequency	LF(125~134 kHZ) **HF(13.56 MHz)** UHF(860~960 MHz) MW(2.45, 5.4 GHz)	13.56 MHz
Data Transfer	One direction	Bidirectional
Range	10~100 cm (Based on Frequency)	5 cm or closer
Security	Low	High
Multi Reading	Yes	Once a time
Popular Uses	Asset Tracking Inventory Tracking Smart cards	E-wallet Mobile pay

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