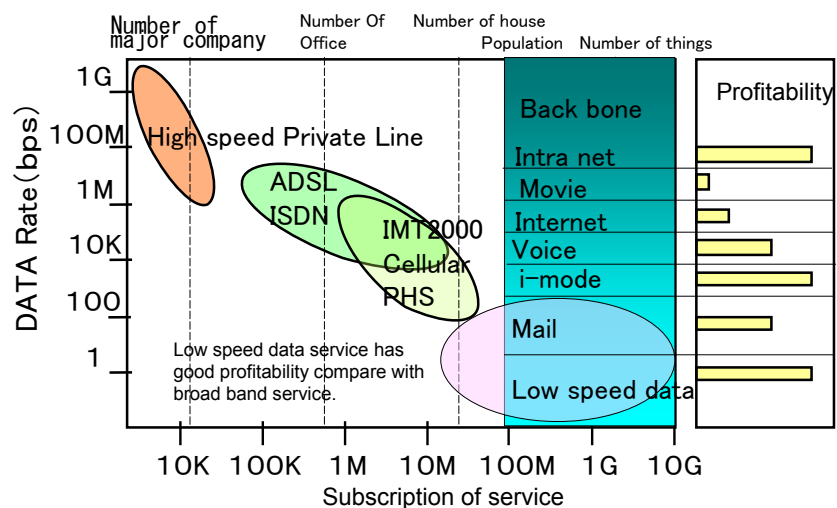


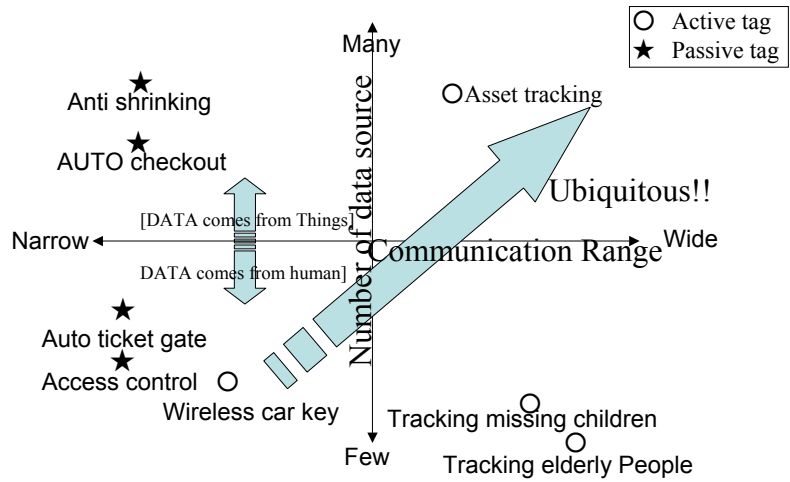
Overview of RFID Technologies for Ubiquitous Services

NTT Network Innovation Lab.
Masashi Shimizu

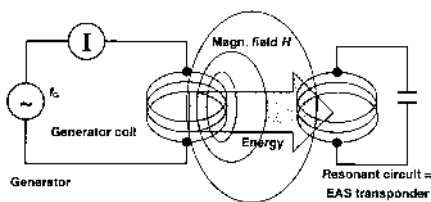
Data rate vs. subscription of service



RFID Service Mapping



Passive tag



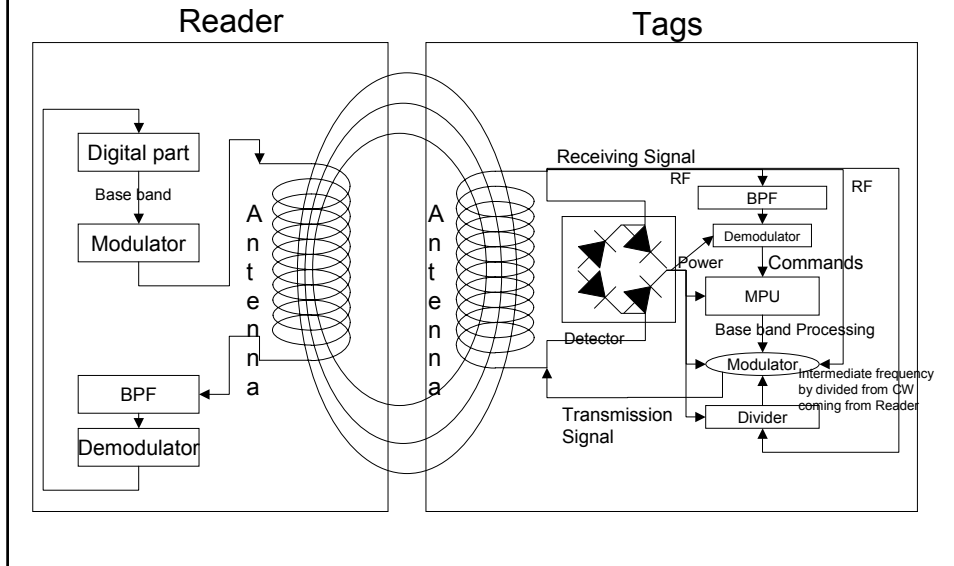
Good

- No Battery
- Long life time
- Cheap
- Thin (not small)

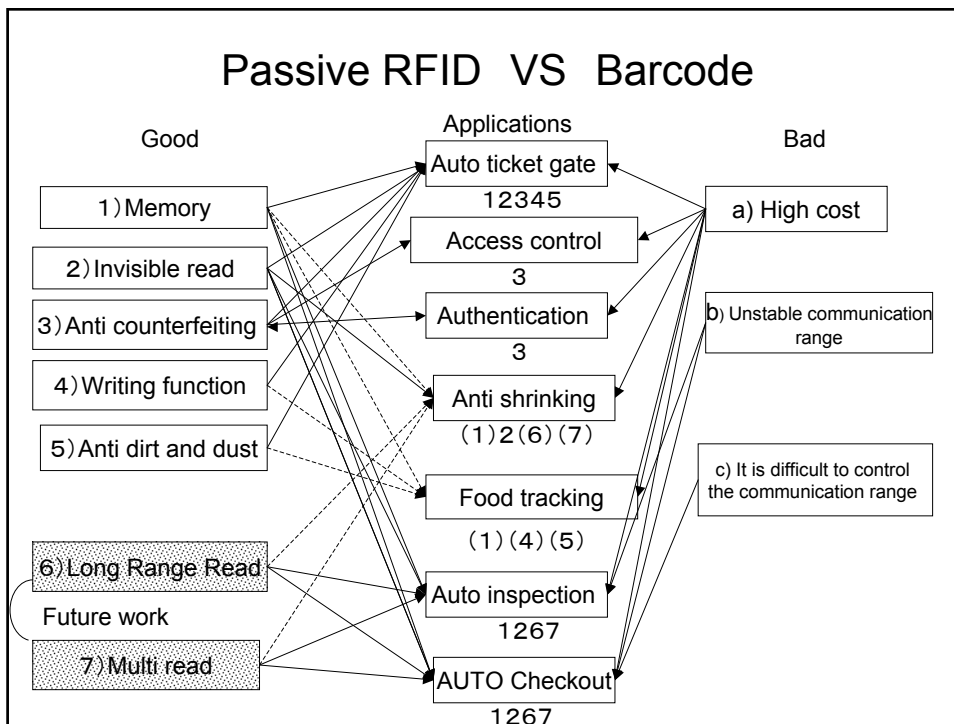
Bad

- Low communication readability
 - On-metal
 - Shadowing
 - Direction
- Sensor and Recorder can not work without reader
- Interference from other reader

Principal of the Passive RFID Systems



Passive RFID VS Barcode



Proving test using Passive RFID

- WAL☆MART
 - Total supply chain management
- AT book store
 - Anti shrinkage
- AT shoes store
 - Aid for finding the shoes of size fitting to customer.
- Food tracking
 - Identify the producer

Active tag



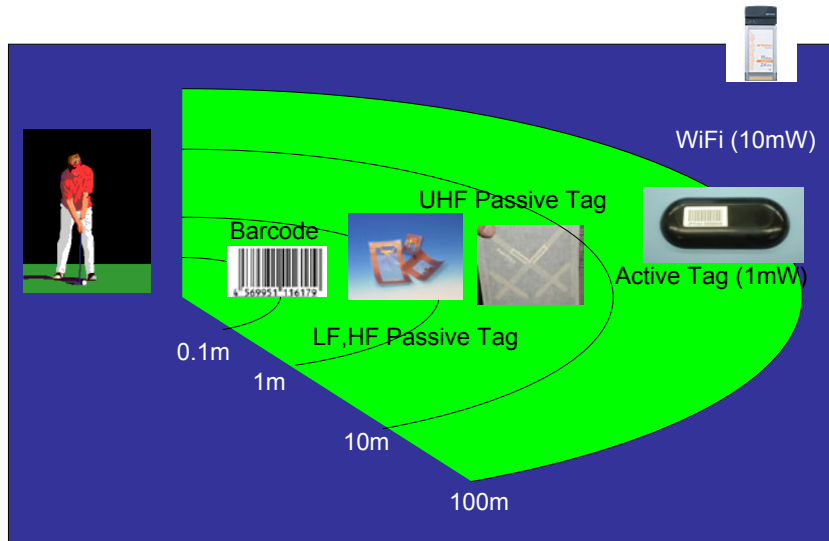
Good

- Sensor/ Recorder capability
- Long Range
 - Reliable communication
- Positioning
- Recycle use

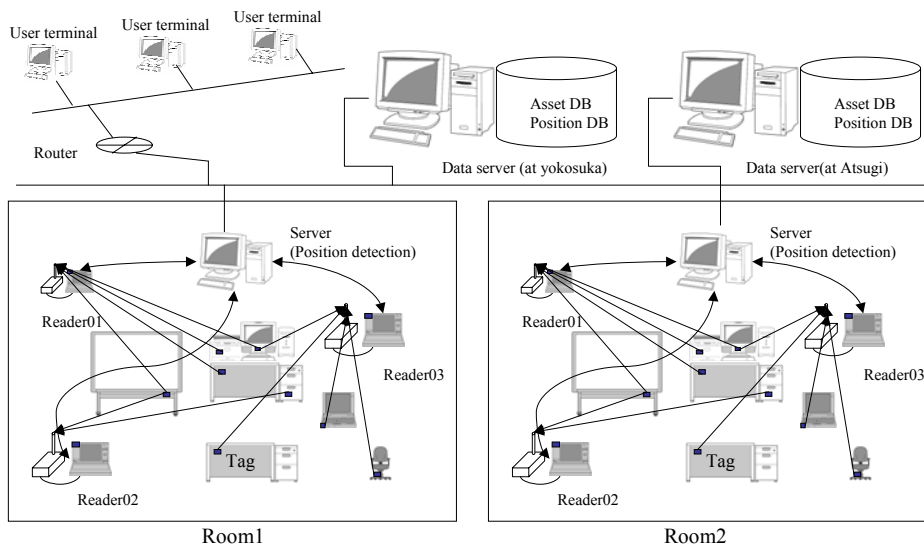
Bad

- Expensive
- Thick
- Too mach long range
- Life time

Communication Range



Asset tracking system



Asset tracking result

History of my PC

Room	Reader	Time	Status
Y-903A	YR0029	2005/7/8 15:02	Motion
Y-901A	YR0011	2005/7/8 13:34	Motion
Y-1008A	YR0035	2005/7/8 8:47	Normal
Security Center	YR0043	2005/7/7 18:21	Motion
Y-912C	YR0032	2005/7/7 10:16	Motion
Y-807C	Post Stack	2005/7/1 16:03	Motion
Y-807A	Post Stack	2005/7/1 16:02	Motion
Y-812A	Post Stack	2005/7/1 16:01	Motion
M1-2F西	MR0023	2005/6/27 19:32	Motion
M5-1F西	MR0029	2005/6/27 16:38	Motion



In door positioning

□: Estimated position * : Real position

Size of grid: 1.35 m x 1.35 m

Maximum error: about 4.5 m

Minimum error: about 0.13 m

RMS for 16 random points: 2.3 m

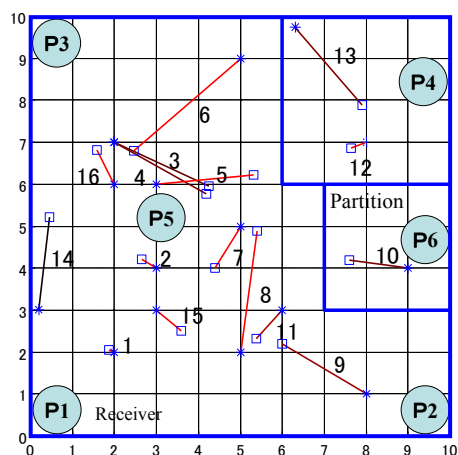
Annotation:

Real position includes an 1.35 m error caused by roughness of line of sight estimation (a rough estimate by sight).

P1-P6 indicate the positions of the receivers.

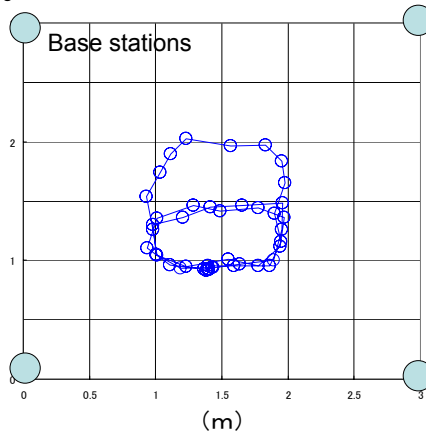
radio propagation is

- : good condition
- : normal condition
- : bad condition

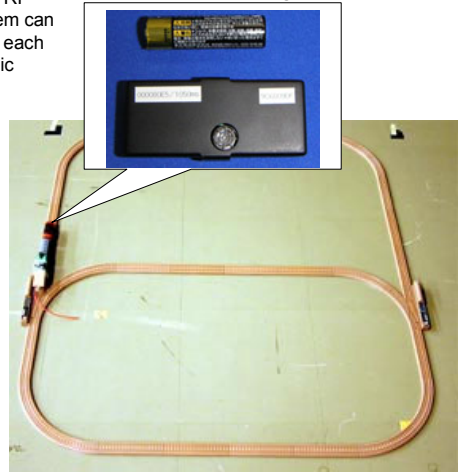


Accurate positioning

Ultrasonic tags are activated by ultrasonic from base stations located known positions. Tags simultaneously transmit RF signals after receiving the ultrasonic signal. This system can know the tag position after analyzing the distance from each base stations to tags by measuring trip time of ultrasonic signals.



Ultrasonic Tag



Transportation quality monitor

Sensor tags record the quality from origin to terminal. Retailer can show customers the real quality.



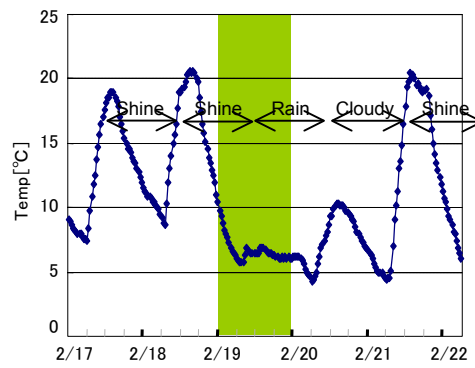
Fake Squid



Crystal Apple



Temperature Monitor Tag for Container

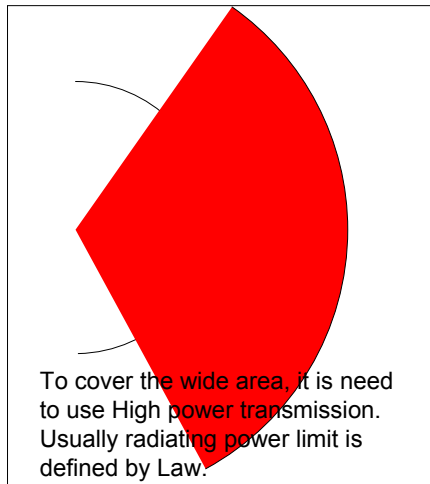


The purpose of Multi Hopping

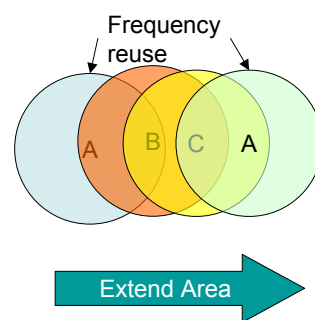
- Extend communication area
- Effective utilization of Frequency
- Save total power consumption
- High communication readability

Extend Area and frequency reuse

Direct

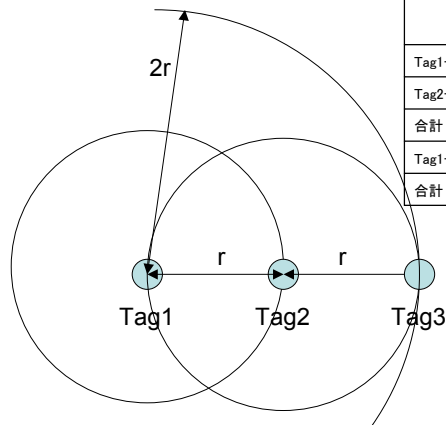


Mhop



It is possible to realize wide communication area with low power transmission and high frequency efficiency.

Power saving



	Required Transmission Power	Required Transmission and processing Power
Tag1→Tag2	kr	P
Tag2→Tag3	kr	P
合計		$2kr+2P$
Tag1→Tag3	$4kr$	P
合計		$4kr+P$

Total Power
 $2kr+2P < 4kr+P$
 MHhop Direct

If $P < 2Kr$
 Multi hopping can save the total power

Auto Routing (using Ir Nodes)

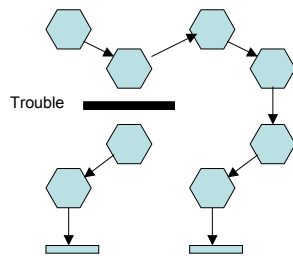
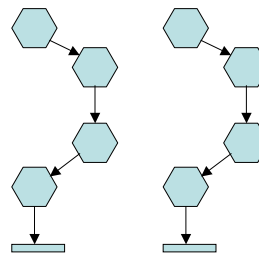


Table1 Feature of Wireless Tags

Type of Tag	Range	Worldwide use	Encryption	Anti-Collision	Multi-Tag	Battery Life	Receiver	Sensor	Memory	Maker
RFID Class0 (13.56MHz)	<1m	Yes	x	Δ	x	∞	Yes	None	None	Phillips
RFID Class0 (915MHz)	<10m	No	Δ	O	x	∞	Yes	None	Yes	Matrix
RFID Class1 (915MHz)	<10m	No	x	Δ	x	∞	Yes	None	None	Alien
RFID Class2 (2.45GHz)	<1m	Yes	O	O	x	∞	Yes	None	None	Alien
RFID Class3	<30m	No	O	O	x	<3Year	Yes	Yes	Yes	Unknown
RFID Class4	<30m	No	O	O	x	<few Month	Yes	Yes	Yes	Unknown
RFID Class5	<30m	No	O	O	O	<few Month	Yes	Tag Reader	Yes	Unknown
Smart Dust	<300m	No	Δ	O	O	<2Year	Yes	Temp/Light	Yes	Dust
ZigBee	<75m	*Yes/No	Δ	O	Δ	<2Year	Yes	None	Yes	Many
Bluetooth	<100m	Yes	Δ	Δ	O	< half_year	Yes	none	Yes	Many
IC Card	<10Cm	Yes	⊗	NA	NA	∞	Yes	None	Yes	Many
μ Chip	<10Cm	Yes	x	x	x	∞	Yes	None	None	Hitachi
Simple Active Tag	<30m	No	x	x	x	<10Year	None	Motion	None	Many
Tire Pressure Monitor	<30m	No	x	x	x	<3Year	Yes	Pressure/Temp	None	Many
Food Tracking	<30m	No	x	x	x	<few Month	Yes	Temp/Motion	Yes	Many
Infrared	<10m	Yes	x	Δ	x	<few Month	Yes	None	None	Many
Bar Code	<10Cm	Yes	x	x	x	∞	None	None	None	Many

*ZigBee defines 3 frequency bands, 2.45GHz band is Worldwide 800and 900MHz band is EURO and US respectively.

Green low mean our prediction

Bluetooth usually used as embedded divide. There is few case use for Active Tag.