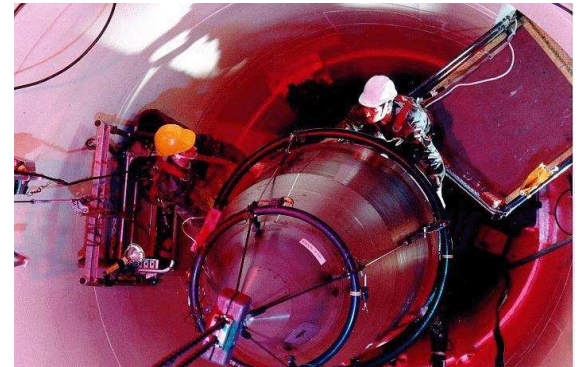# RFID
Radio Frequency IDentification

By: Jeremy Yager

RFID - Overview

- RFID, as the name suggests, uses RF devices to communicate identification information.

- This is achieved by using small devices known as tags to carry unique identification for the object, person, or animal carrying the tag.

- In most applications, a second device, known as a reader, polls the RFID tag for its identification information.

History of RFID

l *IFF: Identification, Friend or Foe.* Developed in WWII by British to distinguish returning Allied aircraft from invading German bombers.

l In 60's and 70's RFID gained usage in inventory and access control of radioactive/nuclear materials.

Private Sector and Research

ℓ In 1977, RFID technology was transferred to the private sector. The first applications were cattle identification and monitoring--to replace branding--and in railroad car inventory management.

ℓ RFID also began to see use in wildlife monitoring and research. RFID tags can be used to monitor animal movement without adversely affecting the animal, giving researchers more data to understand behaviors that may be difficult to observe directly.

Uses of RFID Today

- Inventory tags: Small size and low cost of tags allows widespread usage in inventory control. For example, Walmart now requires top 100 suppliers to include RFID tags on all merchandise.

- Shipping containers: In addition to inventory, tags can be used to monitor history, condition and security of container.

Uses in Manufacturing

ℓ Manufacturing: RFID tags are used to track material and processes on shop floors.

ℓ In a newer application, tags embedded in the floor give location information to mobile equipment (i.e. forklifts) to navigate autonomously around the shop.

ℓ These uses in industry center around the management buzzword 'Supply Chain Visibility'

Other Uses of RFID

- ⌐ No-stop toll booths to improve traffic flow
- ⌐ Cashless payment
- ⌐ Security/Access Control
- ⌐ Supermarkets
- ⌐ Medical monitoring
- ⌐ Theft deterrent, e.g car-key RFID tags
- ⌐ Any application requiring unique identification of objects in an inexpensive and unobtrusive way…

Types of RFID Tags

There are three types of RFID Tags:

- Active Tags
- Passive Tags
- Semi-Passive Tags (actually, technically a subset of passive)

Active RFID Tags

Active RFID Tags use a radio transceiver to communicate with tracking system. This requires the inclusion of a battery with the unit.

l Pros: Longer range than passive. Battery allows much more sophisticated control logic.

l Cons: Larger and heavier due to battery. Currently more expensive than passive tags.

Passive RFID Tags

Passive tags use backscatter modulation of reader field to communicate with reader. Purely passive tags use the reader's field to power onboard logic through power scavenging techniques.

- Pros: Very small. Can be millimetric in dimension. Does not require a battery. Can be very inexpensive (<$0.25 each in large quantities)

- Cons: Antenna system used for power scavenging and communication is difficult to design and to attach to the device. Readable range is very limited. Onboard logic capability is very limited.

Backscatter Modulation?!

l Antenna theory: A tuned receiving antenna retransmits a portion of incident RF energy. This retransmission is known as scattering-- backscattering if it is in the direction of the original transmitter. This backscattering can be detected by another antenna.

l By continuously tuning and detuning an antenna element, the amount of backscattering can be controlled.

Backscatter Modulation, Continued

l By changing the antenna element tuning in a well-defined manner, backscattering from antenna can be modulated to transmit information. The signal is actually the amplitude of the backscattering from the tag antenna. This method is used by all passive tags.

l Care must be taken with design, however. When antenna is detuned, the tag is no longer receiving power from the reader's field. If the antenna spends too much time in the detuned state, the tag will exhaust its energy storage and lose power without a battery backup.

Semi-Passive RFID Tags

Semi-passive tags use battery power for logic like an active tag, and backscatter modulation for communication like a passive tag.

ꞁ Pros: Antenna design can be optimized for communication, as in active tags, rather than compromise design for both power scavenging and communication. Can have more sophisticated onboard logic. No radio transceiver required, as in passive.

ꞁ Cons: Readable range is still quite limited. Size and weight of battery.

Communication Protocol

Design Decision: Who starts communication, the reader or the tag? Be careful, this has known to degenerate into somewhat of a religious war!

l   Tag Talks First: Tag communicates as soon as it detects reader field. Simplifies tag logic, but less secure because tag doesn't care what it is communicating with, as long as sufficient field strength is available.

l   Reader Talks First: Tag waits for interrogation by reader before transmitting information. Opposite pros and cons versus 'Tag Talks First'.

Frequency Bands of RFID

- LF band: 125 and 135 kHz
- HF band 13.56 MHz

  These frequency bands can be used freely worldwide. The low frequencies here optimize transmission distance by minimizing free-space losses.

- UHF band: 915 MHz
- MW band: 2.4 GHz

  These frequency specifications are for the US only, Europe and Japan have different frequency specifications for UHF/MW.

Issues in RFID

l Tag Security: On-tag encryption can defend against eavesdropping, but this increases size and power requirement of tag logic.

l Illegal/unethical monitoring of RFID tags: This is a major controversy surrounding RFID right now.

l Embedding of RFID tags in humans: This has been proven to work, but should it be done?

Tag Security/Tag Lifetime

- Tags can remain functional long after original intent (inventory) is no longer needed-- especially passive tags that can essentially work forever.

- Tags often use Tag-Talks-First model, allowing anyone with the correct tag frequency and a high-gain antenna to eavesdrop on unsuspecting tag carriers.

Ethical Issues in RFID Tagging

- Passive RFID tags could conceivably used for surveillance of unsuspecting tag carriers
- More than ten states have passed legislation limiting and/or requiring conspicuous notice of the use of an RFID tag.
- "How would you like it if, for instance, one day you realized your underwear was reporting on your whereabouts?" — California State Senator Debra Bowen, at a 2003 hearing
- "Spychips" -- Katherine Albrecht, founder of CASPIAN, a consumer privacy group

RFID Tags in Humans

- Successful embedding of passive RFID tags in/under the skin has taken place.
- Applications include high-level security, and location monitoring of mental patients.
- Skin-embedded RFID can lead to ultimate in privacy intrusion. (Big Brother, realized?!)
- As RFID becomes more popular, this issue must be addressed.

Conclusion

- RFID, like any technology, has a variety of different uses for which it is well suited.

- RFID tags will only become cheaper and more powerful with improving technology and design experience

- However, the potential for abuse of this technology is vast and requires careful consideration to avoid.

Questions?

Credits

- Picture credits:

  http://www.b17sam.com/

  http://www.globalsecurity.org/

- Wikipedia

- Larry Martin, "The $1 Wireless Interface", Circuit Cellar, Issue 163, February 2004