CSE 303
Concepts and Tools for Software Development

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Impact of Computer Engineering Solutions: RFID

RFID

Radio Frequency IDentification (RFID)

Using radio frequency (RF) signals

To identify (ID) objects

Does not require line-of-sight

Can serve for location tracking

Existing RFID Applications

- Supply-chain management
- Package tracking
- Airline tickets, luggage
- Pharmaceuticals
- Medical: patient id
- Asset tagging, archiving
- Identifying pets
- Tracking library books
- RFID tags inside passports
- Enhanced driver's license
- Toll collection (highways)

- 6 of top 7 retailers worldwide support RFID
  - > $1 trillion revenue
- 100s of manufacturers and retailers

Other Useful Applications?

- Elder care (UW & Intel Seattle)
  - What objects people use is a good indicator of what they are doing
- Study human social dynamics (UW & Intel Seattle)
  - How social groups form and evolve with time
- Woodland Park Zoo: track visitors
- Speed pass at gas stations (Exxon Mobile)
- Help people monitor their outdoor workout
  - iPod with reader
  - Nike shoes with active RFID tags

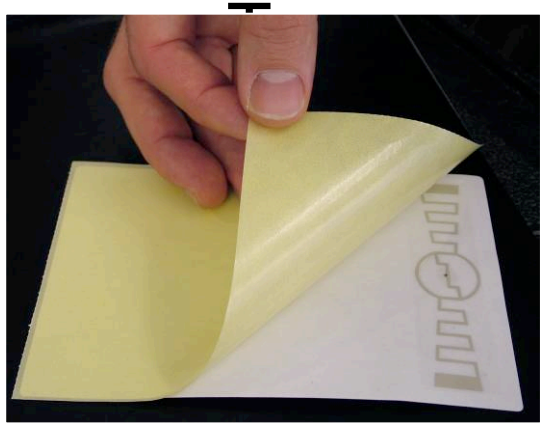
RFID Components

RFID Reader

RFID Antennas

Active Tag

Passive



RFID Basics

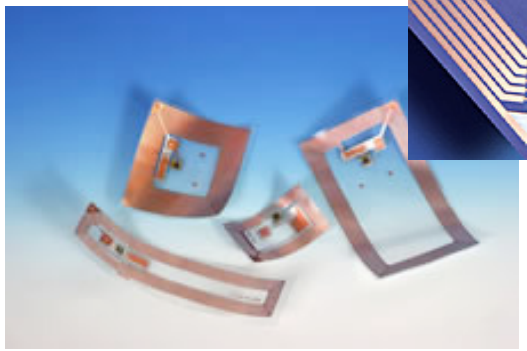
RFID systems comprise tags and readers

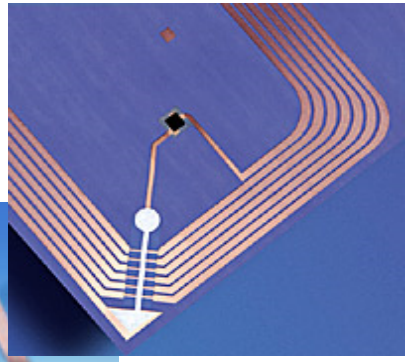
- Tags are placed on objects
- Readers placed in the environment interrogate tags

Tags can be active or passive

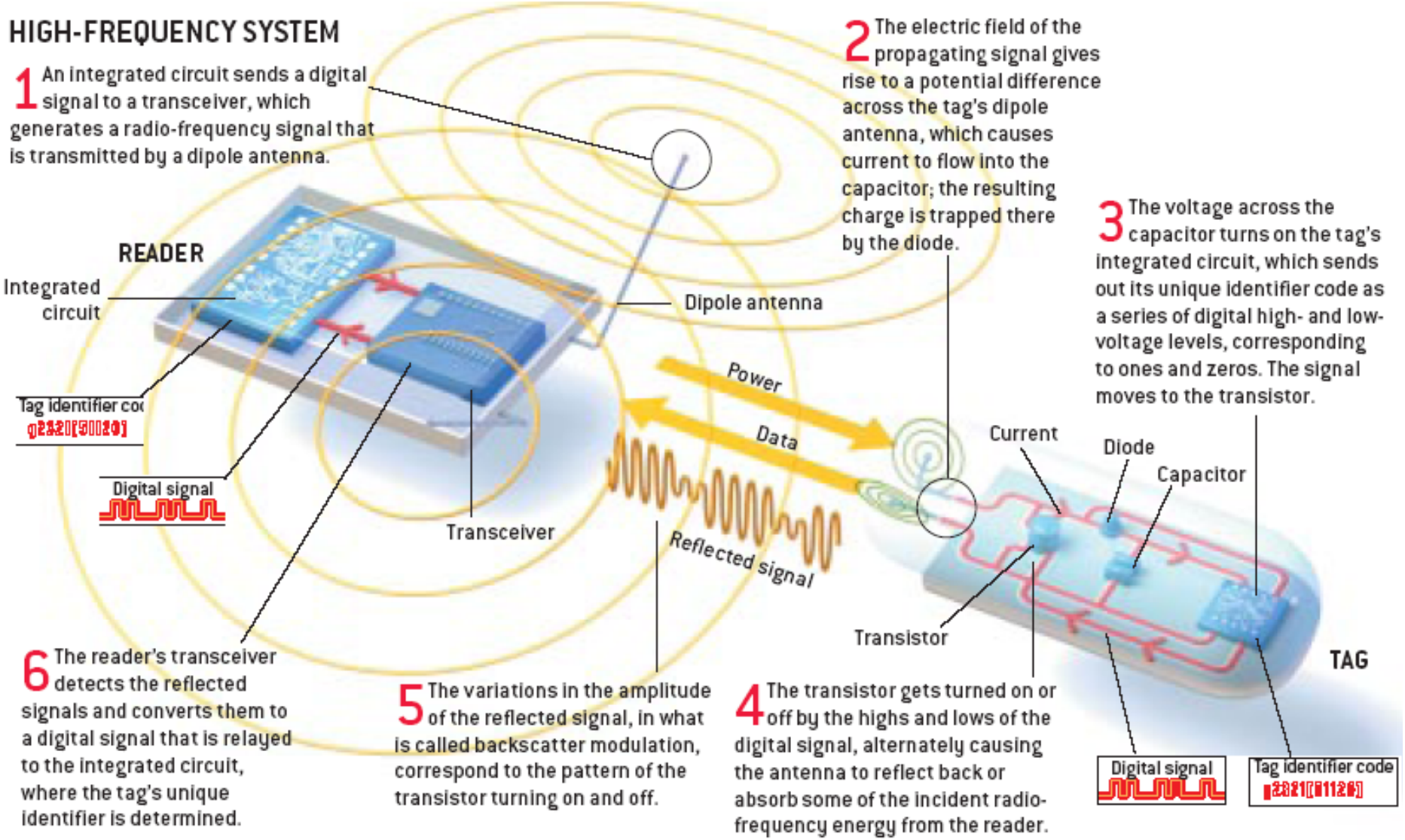
- Active tags: longer read-range (up to 300 feet)
  - Battery powered, expanded capability, expensive
- Passive tags: shorter read-range (1 foot to a few meters)
  - Receive power from RF field, limited capability, cheap
- Each tag has a unique ID (typically 64 to 128 bits)
- Tags can include other information besides ID (< 2KB)

A Wide Variety of Tags





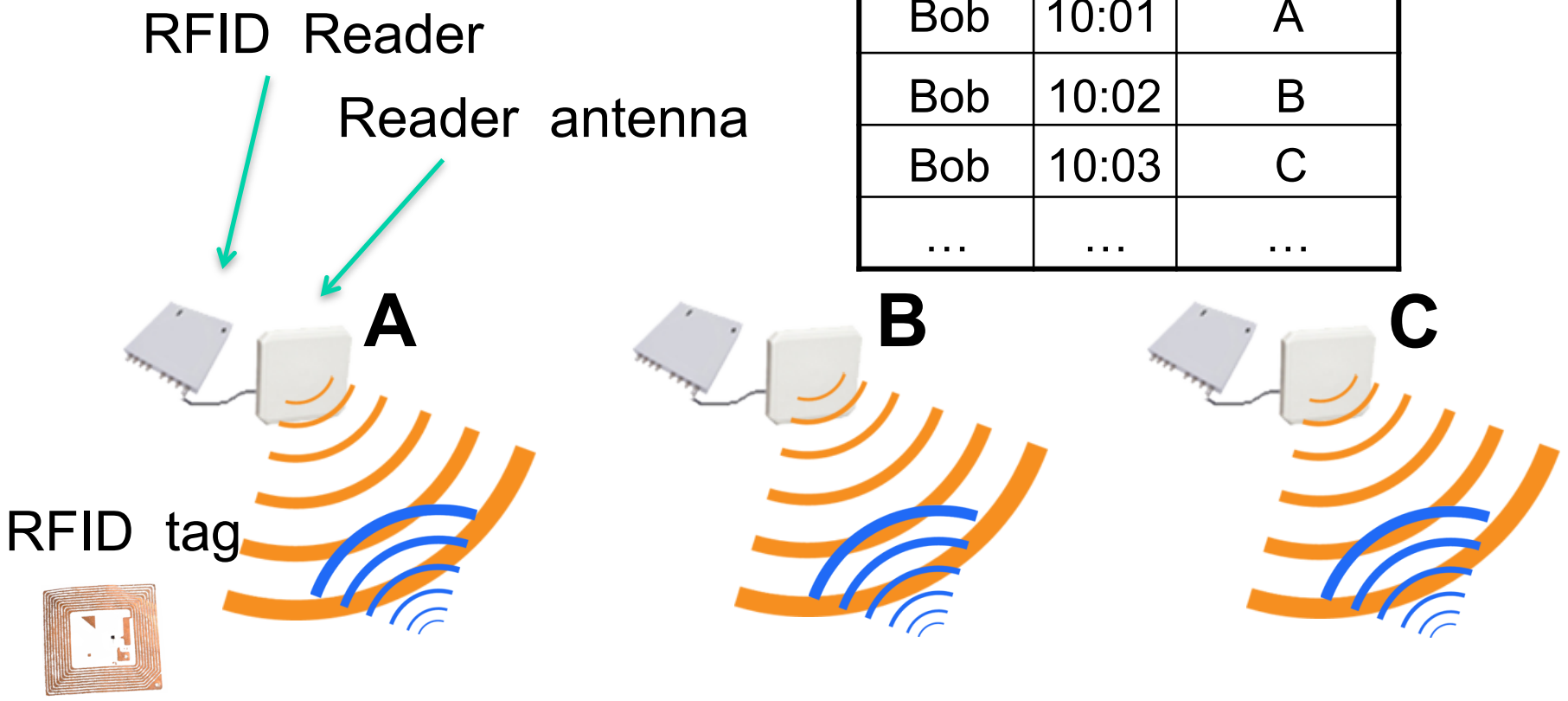
Communication Between Reader and Tag



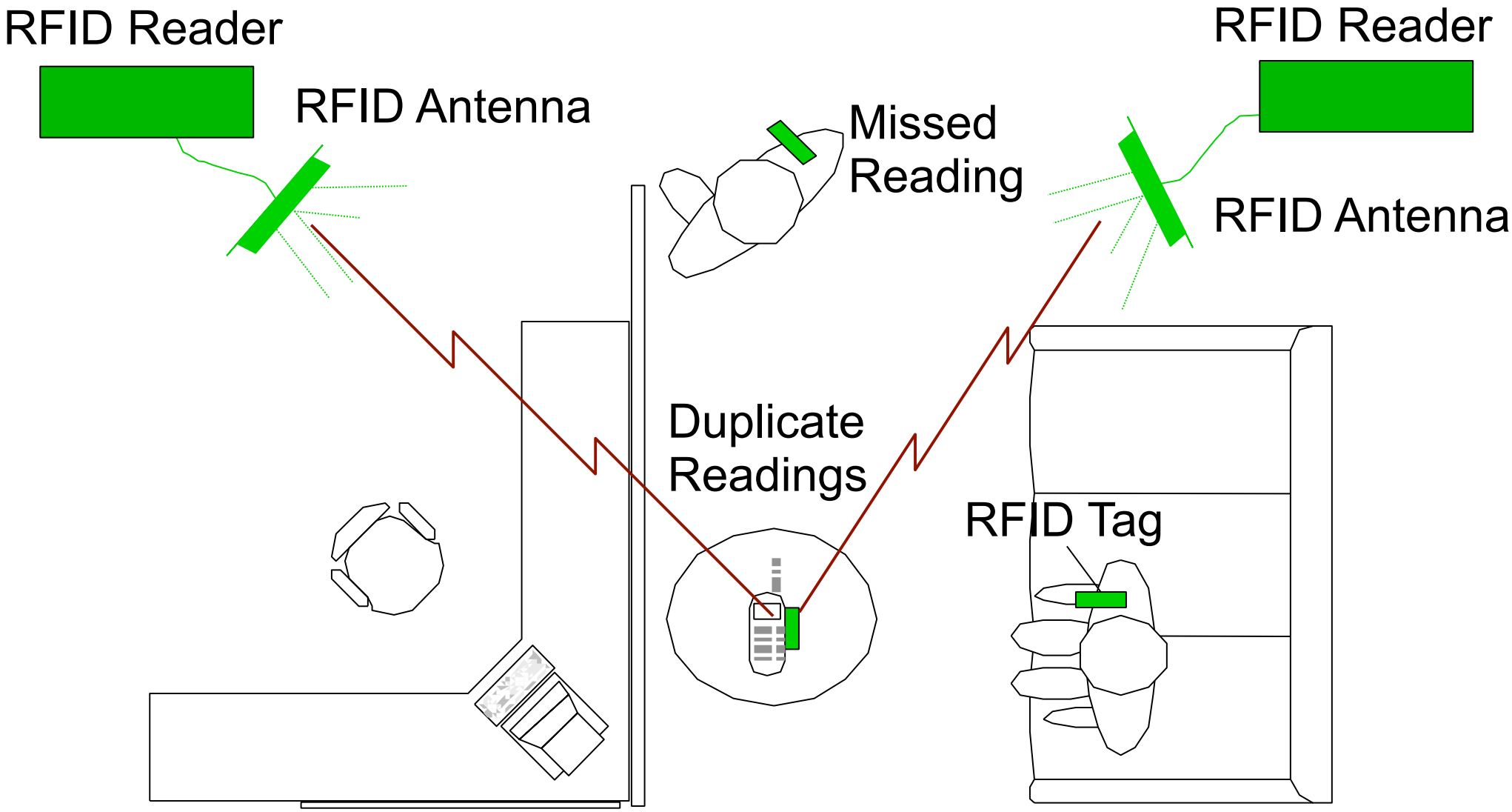
Communication Between Reader and Tag

Location Tracking

tag	time	location
Bob	10:01	A
Bob	10:02	B
Bob	10:03	C
…	…	…



Example of RFID Deployment



Elements of an RFID System

- Tags: carry unique identifiers
- Readers: detect tags in their vicinity
- Networking infrastructure
  - Reader is connected to a network and communicates tag IDs to interested parties
- Databases
  - Collect the “read events” and log them with time/place
- Applications and their user interfaces
  - Use the data in various ways

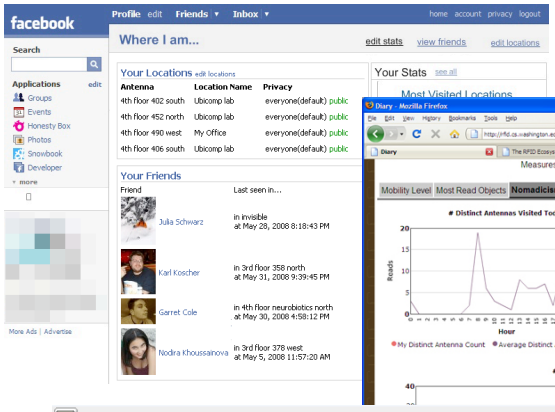
RFID Ecosystem

- Building-scale deployment
  - 7 floors and 8,000 square feet
  - 47 readers and 160 antennas
  - 67 participants and > 300 tags
- Study technology but also societal and business issues

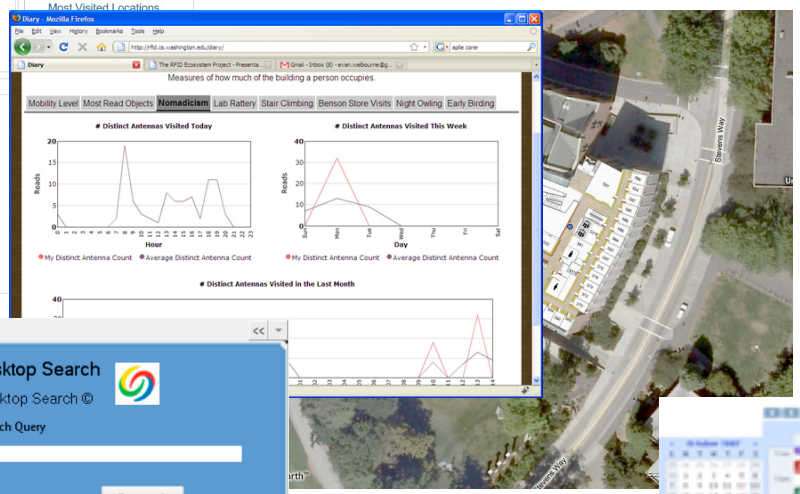
- In particular, RFID data management challenges
  - Lahar query engine
  - Scenic event specification system

RFID Ecosystem Applications

Facebook



Event notification



Friend finder

Digital diary

Enhanced desktop search

Implications of RFID

- As previous examples show, RFID enables many apps that can make our lives better
- But, there are serious security problems
  - Possible to intercept communication between reader and tag (need cryptography)
- There are very serious privacy problems
  - Opportunities for mining and surveillance
  - Example: Nike+iPod story
- There are also great reliability problems
  - What are the implications of wrong information?

Many Privacy Challenges

Other Implications of RFID

- Health considerations
  - Must stay at least 9" away from an RFID antenna
- What are the implications
  - For technology, business and society
  - Of having a “number on everything”?
- RFID Enables
  - Merging physical and virtual worlds
  - Every object is an index into a world-wide database
  - Every object has its own history
  - Tracking objects over their entire lifetime
  - Analyzing trends in user habits

Extra Information

- Google for: RFID
- RFID Ecosystem project: http://rfid.cs.washington.edu/
- **Security Analysis of a Cryptographically-Enabled RFID Device.** S. Bono, M. Green, A. Stubblefield, A. Juels, A. Rubin, and M. Szydlo. Usenix Security. 2005
- iPod + Nike security analysis project

  http://www.cs.washington.edu/homes/yoshi/papers/
- EPCGlobal http://www.epcglobalinc.org/home
- RFID ConsortiUm for Security and Privacy

  http://www.rfid-cusp.org/