Privacy Challenges in RFID-Systems

RESEARCH GROUP FOR

Distributed Systems

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The Ubicomp Vision

„The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it.“

Mark Weiser (1952 – 1999), Xerox PARC

- The computer as an everyday tool
- Networking all things
- Embedding computers into intuitive UI's

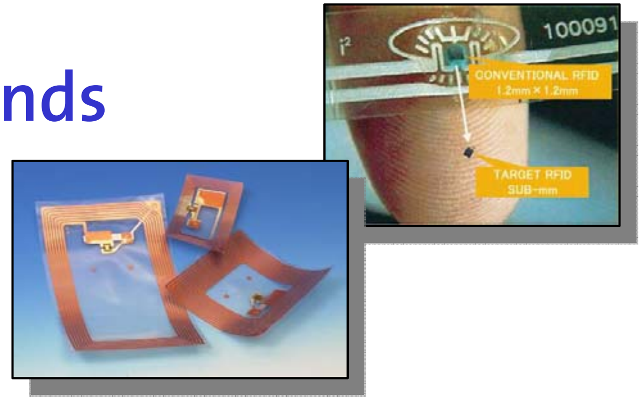
Data Collection in Ubicomp

- High Potential for…
  - Unprecedented collection size
  - Unprecedented collection detail
  - Large public unawareness

What?	How?
Coll. Scale	Everywhere, Anytime
Coll. Manner	Unobtrusive, Invisible
Data Types	Detailed, Mundane, Close-Up & Personal
Motivation	Everything is Important (Context!)
Accessibility	Machine-to-Machine Interactions

Radio Frequency Identification

- "Barcode++"
  - Stores (potentially very detailed) IDs
  - Provides link between real and virtual
- Unobtrusive
  - Tags can be read without line-of-sight
  - Tags need no batteries (reader provides power)
- Efficient
  - Dozens of tags can be read in seconds
- Cheap
  - Price range: 5-10 Cents



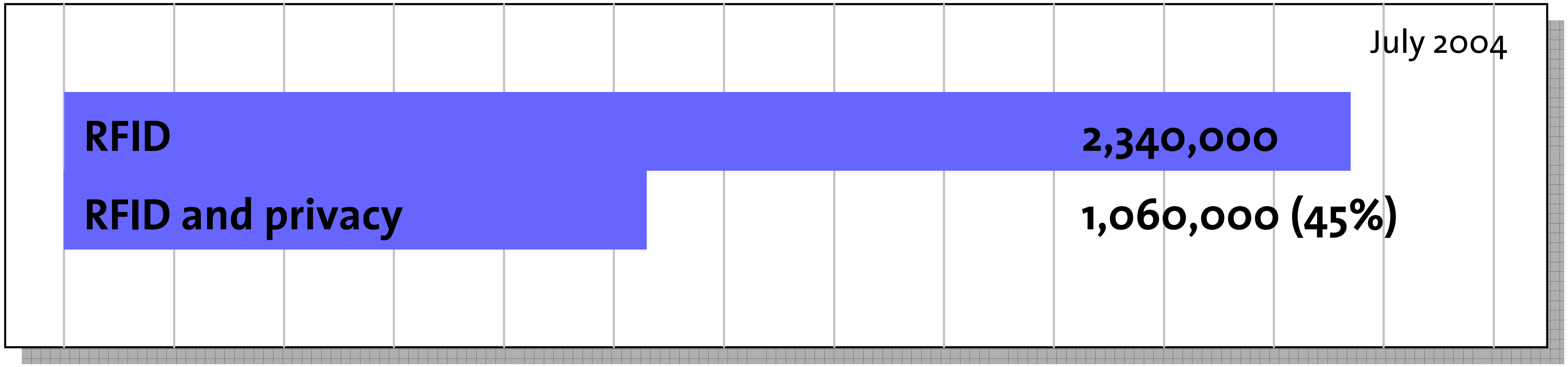
RFID Privacy

WAL★MART ALWAYS LOW PRICES. Always

UNITED COLORS OF BENETTON.

- Ubiquitous Technology?
  - WalMart, US DoD, Benetton, Metro, ...
- Ubiquitous Reading?
  - Anything, anytime, anywhere?
- Public Concern (measured by Google*)

C.A.S.P.I.A.N.
Consumers Against Supermarket Privacy Invasion and Numbering

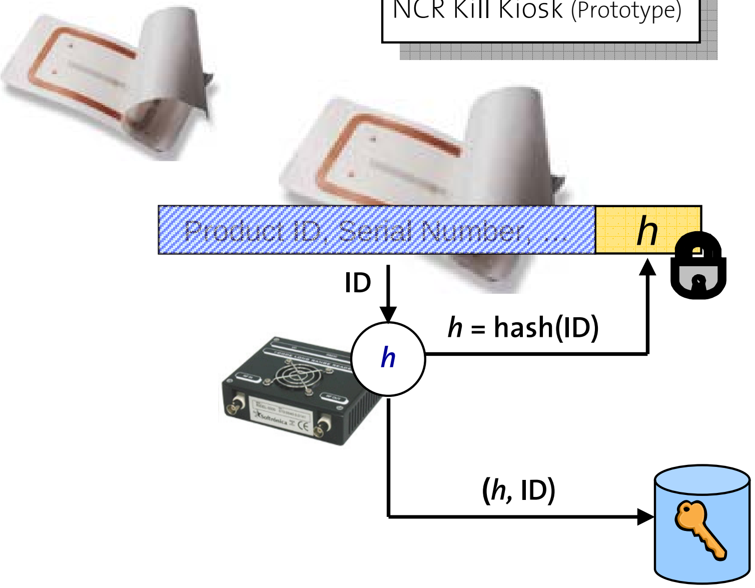


* Original numbers by Ravi Pappu, RFID Privacy Workshop @ MIT: November 15, 2003

Current Solutions

- Tag Deactivation (Kill Tag)
  - Cumbersome
  - Expensive training / equipment
  - Prevents post point-of-sales applications
- Communication Block (Blocker Tag)
  - Unreliable
  - Interferes with 3rd party tags
- Access Control (Hash Locks)
  - Expensive chip design
  - Impractical key management

NCR Kill Kiosk (Prototype)



Threat Models

- What are We Trying to Protect?
  - ~~Secret surveillance networks?~~
  - ~~Pickpockets and burglars?~~
  - Staying in control of personal data flows!

unlikely (expensive, unreliable)

impractical (expensive, unreliable)

ubiquitous! (everywhere, anytime, unnoticed)

- Goal: Transparency Protocols
  - Use machines to monitor plethora of interactions
  - Support for privacy laws & regulation (see P3P)
- RFID Approach
  - Embed support for the *Fair Information Principles* in RFID-protocols (reader-to-tag communication)

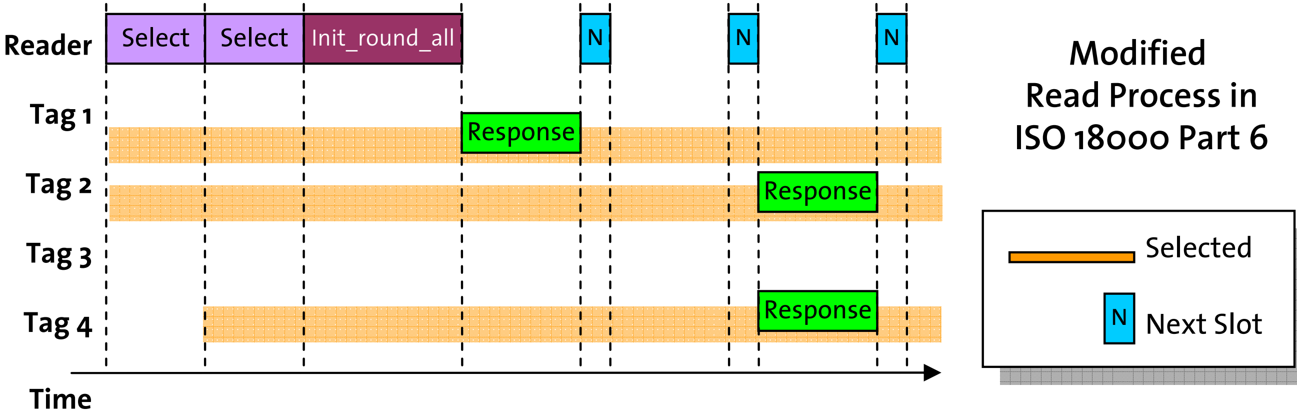
RFID FIP-Support

Principle	Support through...
Collection Limitation	Tag Selection Mask
Consent	Watchdog-Tag (optional)
Data Quality	n/a (with „privacy-aware database/PawDB“)
Purpose Specification	Purpose Declaration, Collection Type
Use Limitation	n/a (Leveraging from Purpose Specification)
Security Safeguards	Encryption/Authentication (?)
Openness	Reader-Policy ID
Participation	n/a (using PawDB)
Accountability	Reader-Policy ID

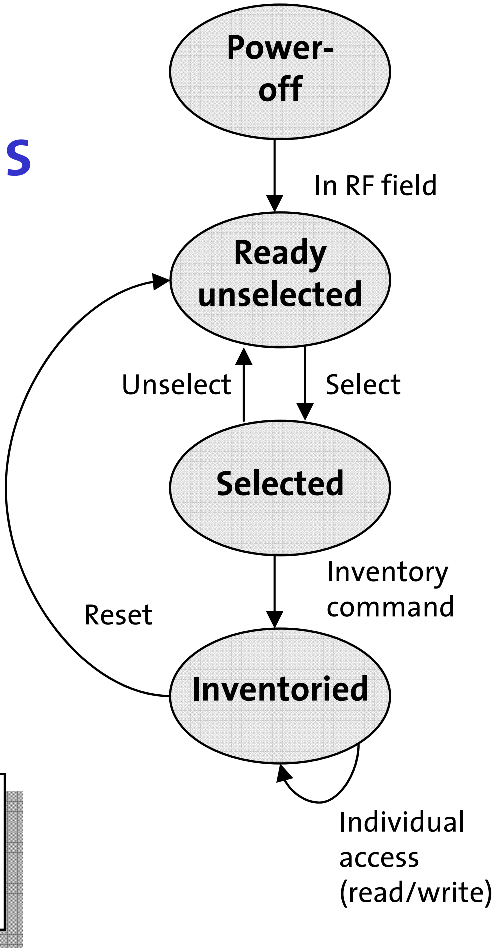
Fair Information Practices, OECD 1980

Collection Limitation

- Targeted Read Commands
  - Smart shelf only reads razorblades
  - Smart checkout reads only store items
- Selection Mask (e.g., “*.E32B*.*”)
  - Only selected tags reply
  - Requires hierarchical IDs (e.g., EPC)



Modified Read Process in ISO 18000 Part 6

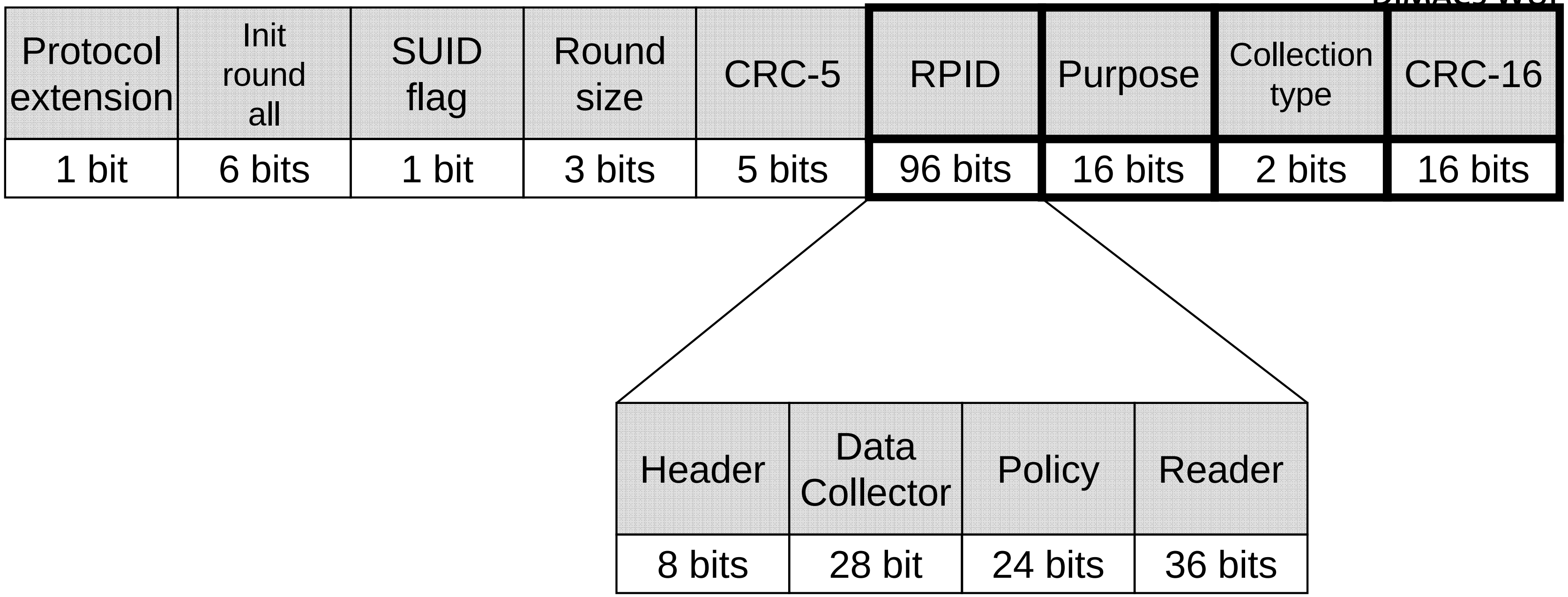


Openness

Protocol extension	Init round all	SUID flag	Round size	CRC-5	RPID	Purpose	Collection type	CRC-16
1 bit	6 bits	1 bit	3 bits	5 bits	96 bits	16 bits	2 bits	16 bits

- `Init_Round` Command in ISO 18000 Part 6
  - Begins read-round (Aloha-based anti-collision)
  - Contains anti-collision protocol parameters
- 130 Bits „Privacy-Header“ Extension

ReaderPolicyID



Protocol extension	Init round all	SUID flag	Round size	CRC-5	RPID	Purpose	Collection type	CRC-16
1 bit	6 bits	1 bit	3 bits	5 bits	96 bits	16 bits	2 bits	16 bits

Header	Data Collector	Policy	Reader
8 bits	28 bit	24 bits	36 bits

5F.4A886EC.8EC947.24A68E4F6

- All read-request uniquely identified
  - Data collector, reader, and policy identifiable
  - Format follows EPC standard (allows code reuse)

Collection Type

Protocol extension	Init round all	SUID flag	Round size	CRC-5	RPID	Purpose	Collection type	CRC-16
1 bit	6 bits	1 bit	3 bits	5 bits	96 bits	16 bits	2 bits	16 bits

1) Anonymous Monitoring
2) Local Identification
3) Item Tracking
4) Person Tracking

Declaration of Intent

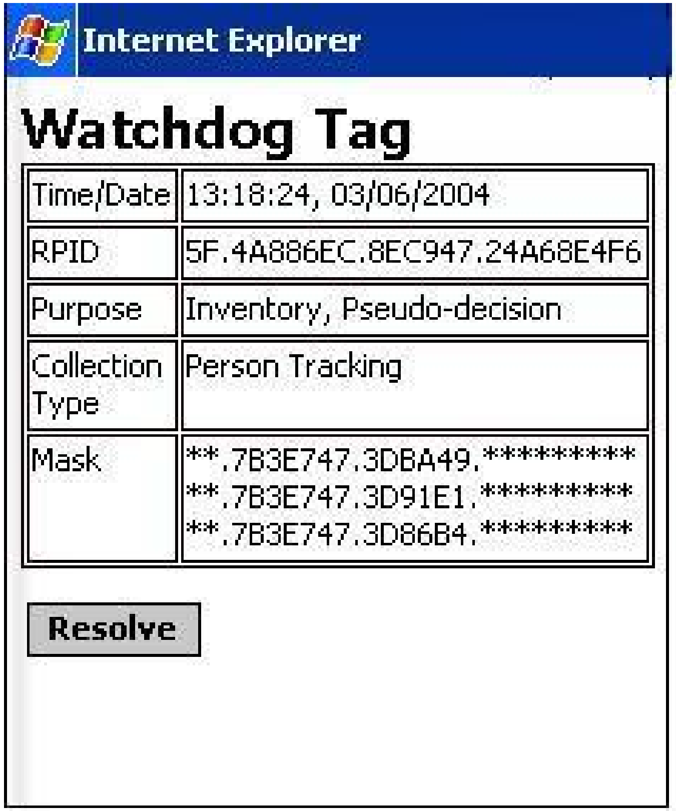
- Typical RFID usage w/o identification
  - personally identifiable data is collected but only used anonymously (needs audits)

Purpose Specification

1) Access Control
2) Anti-Counterfeiting
3) Anti-Theft
4) Asset Management
5) Contact
6) Current
7) Development
8) Emergency Services
9) Inventory

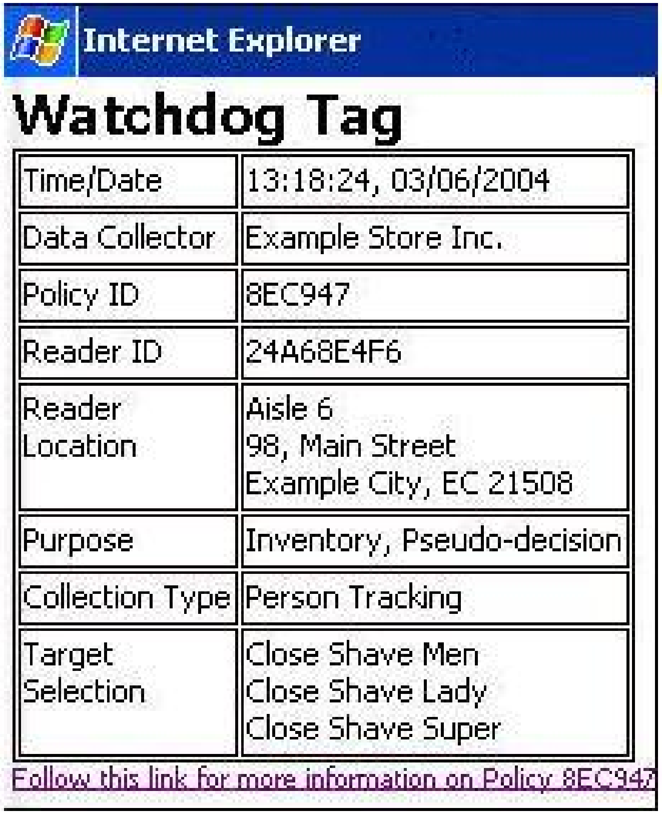
10) Legal
11) Payment
12) Profiling
    a. Ad-Hoc Tailoring
    b. Pseudo Analysis
    c. Pseudo Decision
    d. Individual Analysis
    e. Individual Decision
13) Repairs & Returns
14) Other Purpose

Transparency: Watchdog Tag


Internet Explorer

Watchdog Tag

Time/Date	13:18:24, 03/06/2004
RPID	5F.4A886EC.8EC947.24A68E4F6
Purpose	Inventory, Pseudo-decision
Collection Type	Person Tracking
Mask	**.7B3E747.3DBA49.********* **.7B3E747.3D91E1.********* **.7B3E747.3D86B4.*********


Internet Explorer

Watchdog Tag

Time/Date	13:18:24, 03/06/2004
Data Collector	Example Store Inc.
Policy ID	8EC947
Reader ID	24A68E4F6
Reader Location	Aisle 6 98, Main Street Example City, EC 21508
Purpose	Inventory, Pseudo-decision
Collection Type	Person Tracking
Target Selection	Close Shave Men Close Shave Lady Close Shave Super

Follow this link for more information on Policy 8EC947

Feasibility?

- Extending Reader Devices
  - Software-update
  - Integrates with enterprise solutions (“Privacy-DB”)
- Extending Tags
  - Needs protocol-level standardization (EPC, P3P, ...)
  - No new hardware (program logic only)
  - Good performance (only about 1% loss in speed)
- Reliability?
  - No tag configuration necessary
  - “Reliable” like a public announcement (poster, etc)
    - can be ignored by consumer, but lacking it can be noticed

Summary

- Ubicomp brings privacy challenges
  - Large-scale, unnoticed data collections
  - RFID-technology most prominent example
- Current RFID privacy solutions fall short
  - Too complicated, expensive
- Proposal: Put Transparency into RFID
  - Readers identify themselves, purpose, etc…
  - Support for laws & regulations

For more information...

- Ch. Flörkemeier, R. Schneider, M. Langheinrich, *Scanning with a Purpose – Supporting the Fair Information Principles in RFID Protocols*. Submitted for publication
- M. Langheinrich, *A Privacy Awareness System for Ubiquitous Computing Environments*. Proceedings of Ubicomp 2002
- M. Langheinrich, *Die Privatsphäre im Ubiquitous Computing – Datenschutzaspekte der RFID-Technologie*. Appears in 2004 (German)

http://www.vs.inf.ethz.ch/publ/