Cataloging RFID Privacy and Security

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Motivation

- Security and Privacy concern both the private and commercial sector
- Commercial sector:
  - Access control
  - Eavesdropping
- Private sector:
  - Information gathering
  - Traceability

Critical Security Problems in RFID Systems

- Denial of Service Attacks
  - there is no solution to this problem
- Information leakage
  - an unauthorized person or reader is able to obtain information about the tagged item

- Secure RFID System:
  - a system in which information leakage is impossible

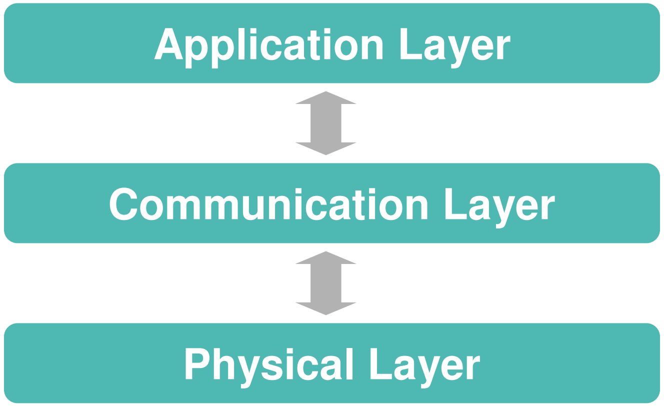
Critical Privacy Threats in RFID Systems

- Traceability
  - an unauthorized person or reader is able to link two sightings of the same tag

- Privacy Protecting RFID System:
  - a system which grants Non-Traceability

Layered Catalog of P&S Issues

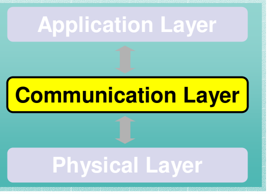
- Physical Layer
  - tracing a tag by its radio fingerprint or a person by the characteristic mix of tags
- Communication Layer
  - tracing a tag in an open Singulation Session
- Application Layer
  - eavesdropping
  - spoofing
  - tracing a tag by its unique identifier



Protection addressing the Physical Layer

- Erasing the tag ID
  - the ID of the tag can be shortened, removed (“killing”) or recoded
    - shortening does not solve all problems
    - removing prohibits benefits
    - recoding allows tracing
- Privacy-Protecting Tag
  - the size of the antenna can be reduced
    - tracking is only possible from a range of a few centimeters
    - overpowered / directed readers can enhance reading range

Attacks on the Communication Layer


Application Layer

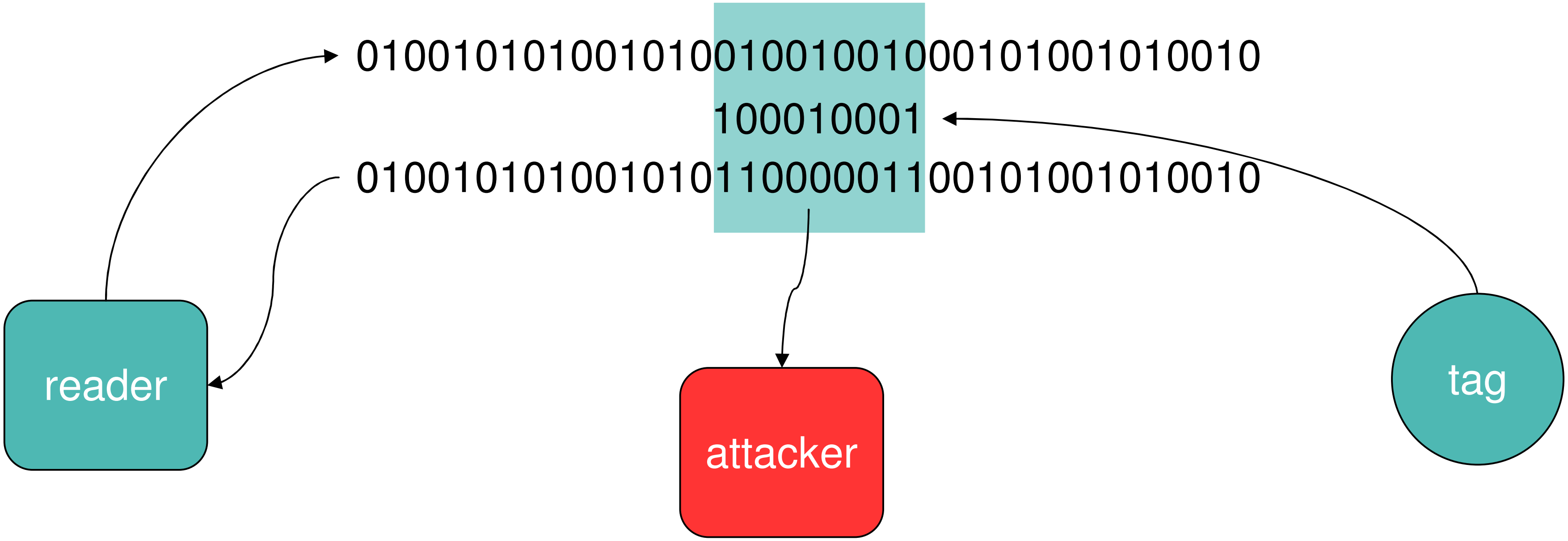
Communication Layer

Physical Layer

- Singulation is needed to guarantee undisturbed communication between a reader and several tags
  - there are deterministic and probabilistic approaches
- No change of ID during Singulation Sessions
  - tracing is possible
  - solution: timeouts

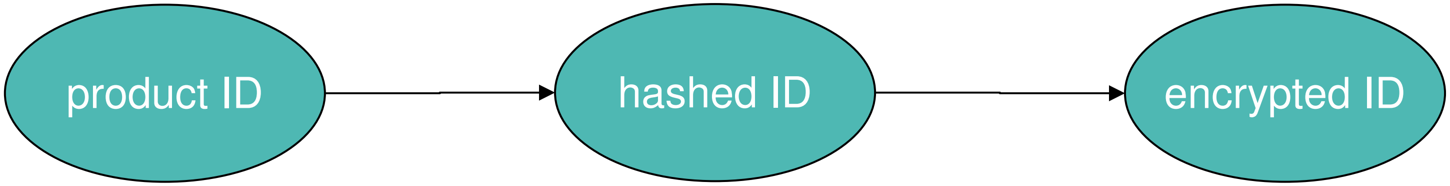
Cloaking

- Noisy Tags (Code-Based)
  - reader generates random bits
  - tag sends session key over the same channel
  - only reader can reconstruct session key



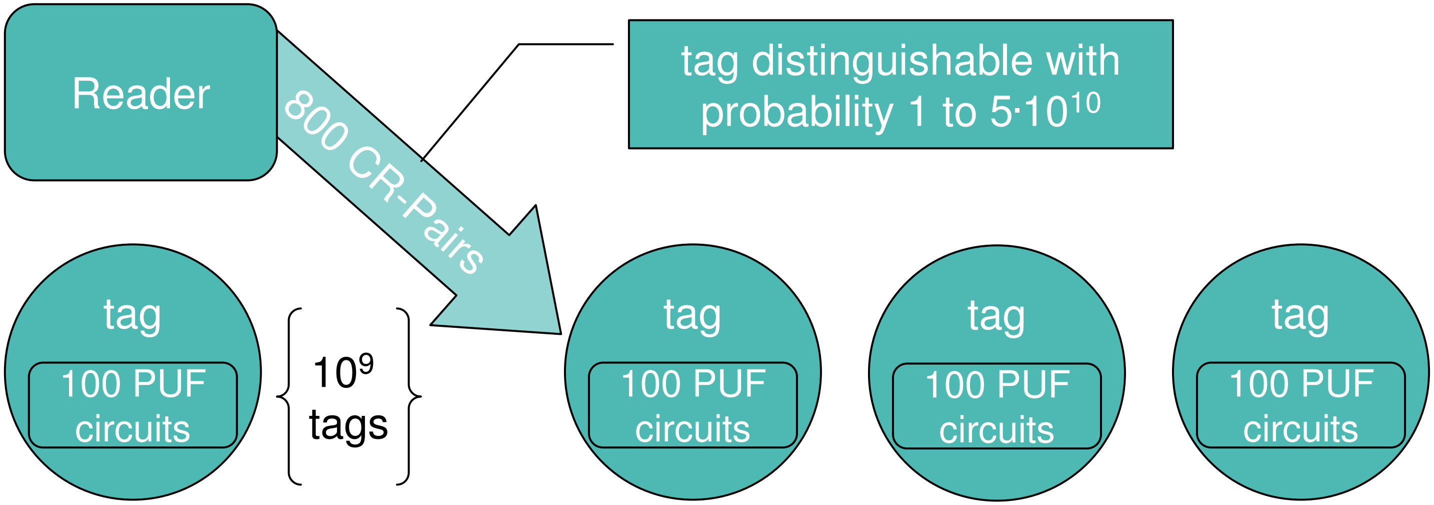
Encryption

- MACs - Message Authentication Codes
  - 128 bit ID is stored
    - constructed of the original ID using a hash function and encryption
- fabrication of fake tags is harder
- no information leakage
- Tracing is still possible



Tag authentication

- PUF Circuits
  - Challenge-Response-Protocol for tag authentication
    - challenges stored in database
    - responses created using individual chip characteristics
  - creation of fake tags is virtually impossible
  - vulnerable to replay attacks
  - huge amount of data in the backend

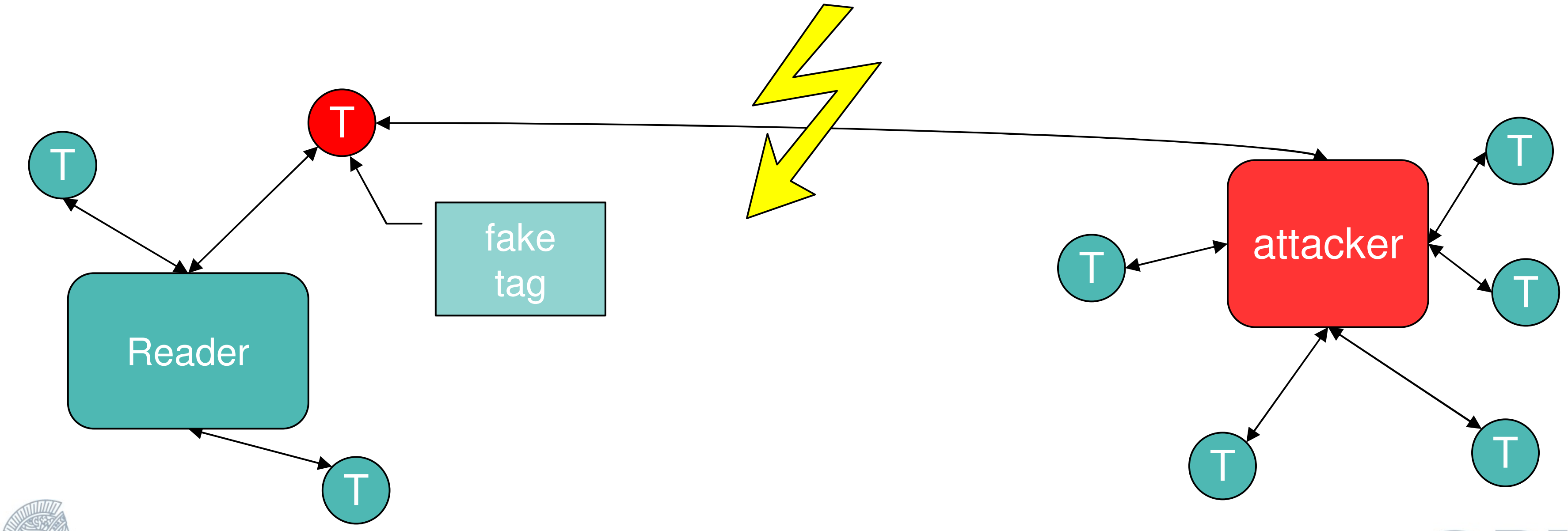


Protection for Low-Cost-Chips

- Many Shared Secrets
  - challenge response pairs stored on the tag
  - reader obtains next pair from database and challenges
  - mutual authentication
  - access limited by tag memory
  - must be online

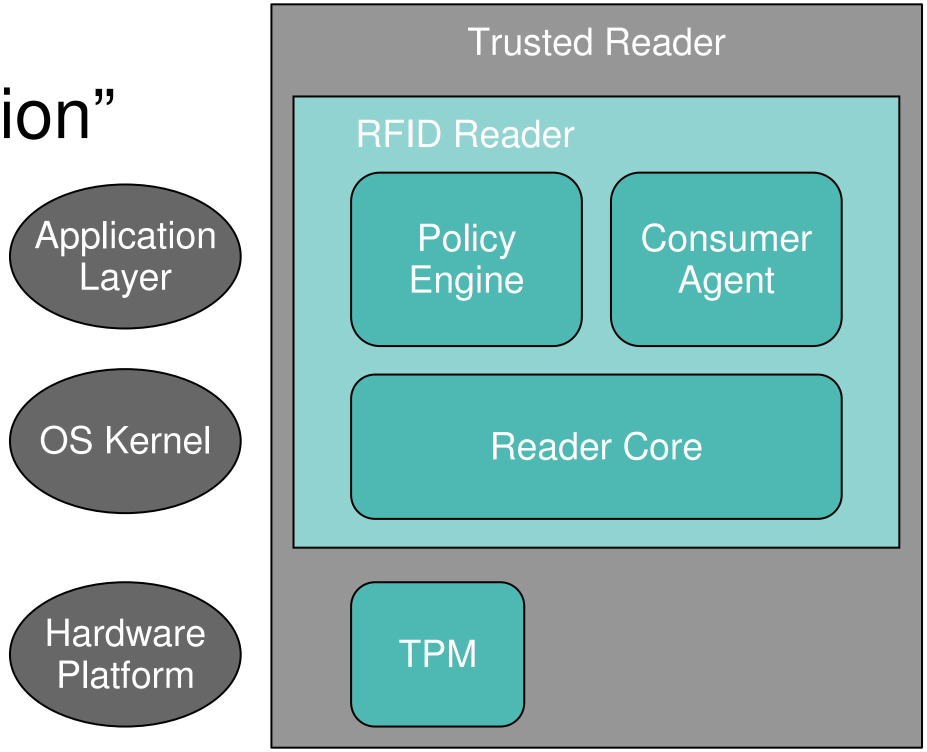
Distance Bounding

- Provides possibility to prevent relay attacks
- Guarantees the proximity of tag to reader
  - triangulation is used to calculate the distance
  - uses Challenge-Response-Protocol
  - correct response only accepted in a fixed time window

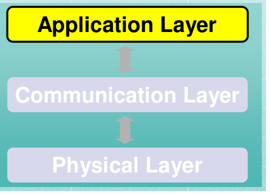


Trusted Computing

- Reader design divided into three parts:
  - Reader Core
  - Policy Engine
  - Consumer Agent
- Uses “Remote Attestation”
  - ensures S&P of communication if reader compromised
- Only suitable for online readers



Pseudonym Protocol



- Generation of pseudonym ID codes on questioning
  - inscrutable to a reader
  - application layer questions trusted center to get desired information
    - must authenticate itself
  - tracing is virtually impossible
  - must be online
    - trusted center can give next pseudonym IDs to read the tag more than once
  - ownership transfer is made easy

Conclusions

- RFID technologies have promised multiple benefits
  - can only be achieved if quality attributes are addressed properly
- Trust in RFID has to be established
  - only possible with secure, privacy-protecting interaction between tags and readers
- Tradeoff: Security/Privacy vs. Price per Tag
- Layered catalog helps to understand and to apply techniques
  - Keep extending the catalog with further techniques and eventually more layers

References

- G. Avoine and P. Oechslin. RFID Traceability: A Multilayer Problem. In Procs. Financial Cryptography and Data Security FC'05, Roseau, The Commonwealth of Dominica, Feb 2005
- M. Bhuptani and S. Moradpour. RFID Field Guide. Prentice Hall, 2005.
- C. Bornhovd, T. Lin, S. Haller, and J. Schaper. Integrating Smart Items with Business Processes: An Experience Report. Procs. 38th Hawaii International Conference on System Sciences, 08:227c, 2005.
- C. Castelluccia and G. Avoine. Noisy Tags: A Pretty Good Key Exchange Protocol for RFID Tags. In Procs. International Conference on SmartCard Research and Advanced Applications CARDIS'06, Tarragona, Spain, Apr 2006.
- G. Hancke and M. Kuhn. An RFID Distance Bounding Protocol. In Procs. 1st. IEEE/CreateNet International Conference on Security and Privacy for Emerging Areas in Communication Networks, Athens, Greece, Sep 2005.
- F. Kahn. Can Zero-Knowledge Tags Protect Privacy? Cryptology ePrint Archive, Report 2005/049, Nov 2005.
- G. Karoth and P. Moskowitz. Disabling RFID Tags with Visible Confirmation: Clipped Tags Are Silenced. Procs. ACM Workshop on Privacy in Electronic Society, Nov 2005.
- D. Molnar, A. Soppera, and D. Wagner. A Scalable, Delegatable Pseudonym Protocol Enabling Ownership Transfer of RFID Tags. In Procs. Workshop on RFID and Lightweight Crypto, Graz, Austria, Jul 2005.
- D. Molnar, A. Soppera, and D. Wagner. Privacy For RFID Through Trusted Computing. In Procs.Workshop on Privacy in the Electronic Society WPES'05, Alexandria, VA, USA, Nov 2005.
- D. Ranasinghe, D. Engels, and P. Cole. Security and Privacy: Modest Proposals for Low-Cost RFID Systems. In Procs. Auto-ID Labs Research Workshop, Zürich, Switzerland, Sep 2004.