A holistic approach to RFID security and privacy

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IOT, RFID and security

- Build IOT security by designing from the start secure components
- Everyday objects tagged with low cost RFID tags will populate the IOT

RFID protocols class	**Hardware Requirements**
Full-fledged	Cryptographic operations (ECC in 4500+ gates equiv.)
Simple	Cryptographic one-way hash functions
Lightweight	Random number generator & simple functions (e.g. Cyclic Redundancy Code) checksum
Ultra-lightweight	Simple bitwise operations (e.g. XOR)

A set of security requirements

- Resistant to:
    - Tag impersonation
    - Reader impersonation
    - Denial of Service
- Tag anonymity:
    - Forward security
    - Backward security

Operations:

- Tag authentication
- Revocable access delegation
- Ownership transfer
- Permanent & temporal tag invalidation

- Economic restrictions

Policies: Problematic

Control tag resources with Access control mechanisms

- Static systems
  - ACL, RBAC...
- Dynamic environment (IOT)
  - ABAC/RuBAC
  - Policies

Tag's Life Cycle

- Creation
- Attachment
- Operation
- End-of-life

Policies: Open Issues

- Efficiency
- Policy and rule construction
- Access control complexity
- Privacy issues regarding use of attributes
- Interoperability

A protocol for secure tag management

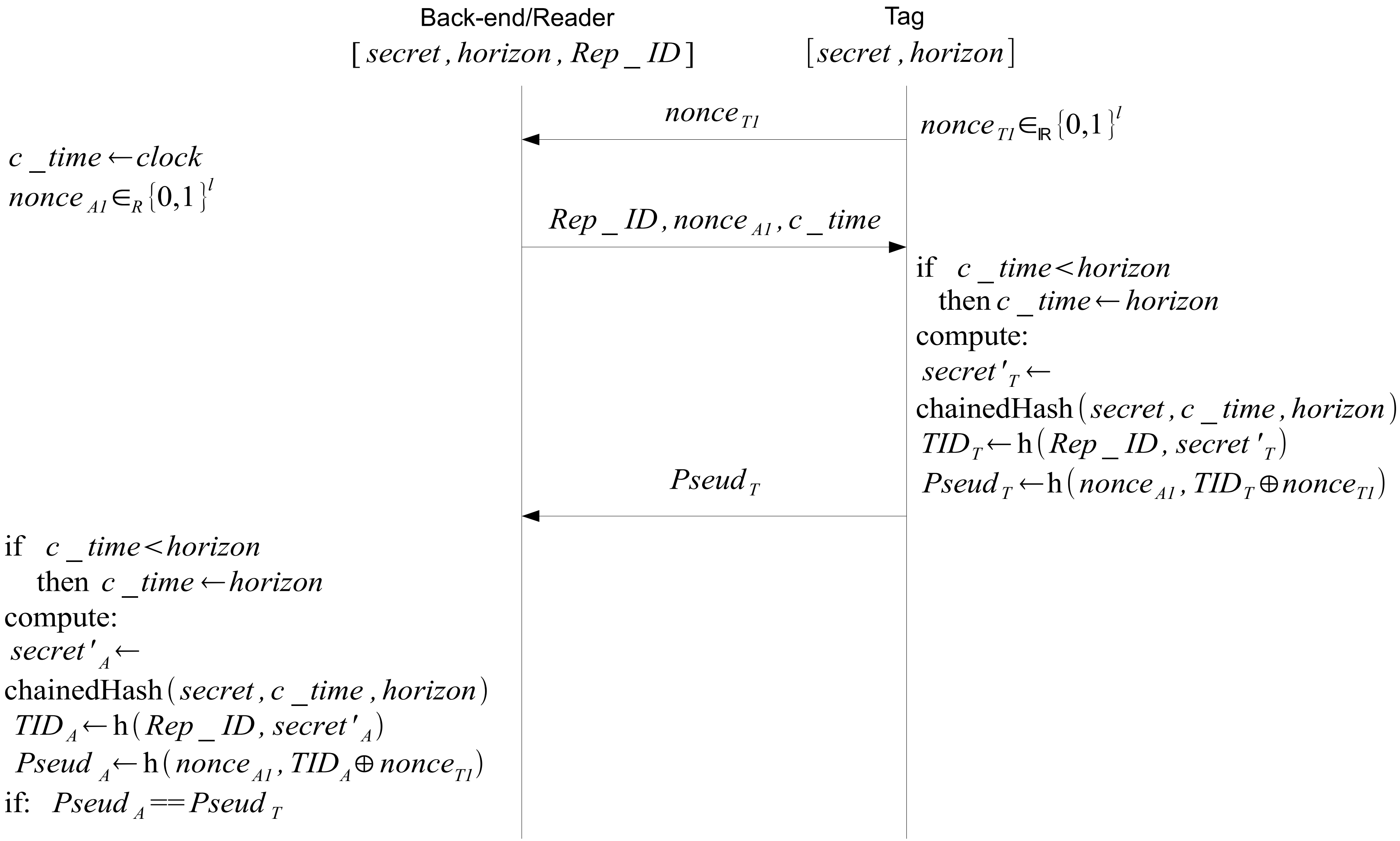
Goals

- Tag Authentication
- Delegated Tag Authentication
- Revocation of Tag Delegation
- Ownership Transfer
- *Plays well* with policies

Assumptions

- *Simple* tag (hash function, pRNG)
- Safe time slots
- Secure communication channel between the reader and the back-end system

Tag authentication



Back-end/Reader

$[\,secret, horizon, Rep\_ID\,]$

Tag

$[\,secret, horizon\,]$

$nonce_{T1} \in_{\mathbb{R}} \{0,1\}^l$

$nonce_{T1}$

$c\_time \leftarrow clock$

$nonce_{A1} \in_R \{0,1\}^l$

$Rep\_ID, nonce_{A1}, c\_time$

if $c\_time < horizon$

then $c\_time \leftarrow horizon$

compute:

$secret'_T \leftarrow$

chainedHash$(secret, c_time, horizon)$

$TID_T \leftarrow \mathrm{h}(Rep\_ID, secret'_T)$

$Pseud_T \leftarrow \mathrm{h}(nonce_{A1}, TID_T \oplus nonce_{T1})$

$Pseud_T$

if $c\_time < horizon$

then $c\_time \leftarrow horizon$

compute:

$secret'_A \leftarrow$

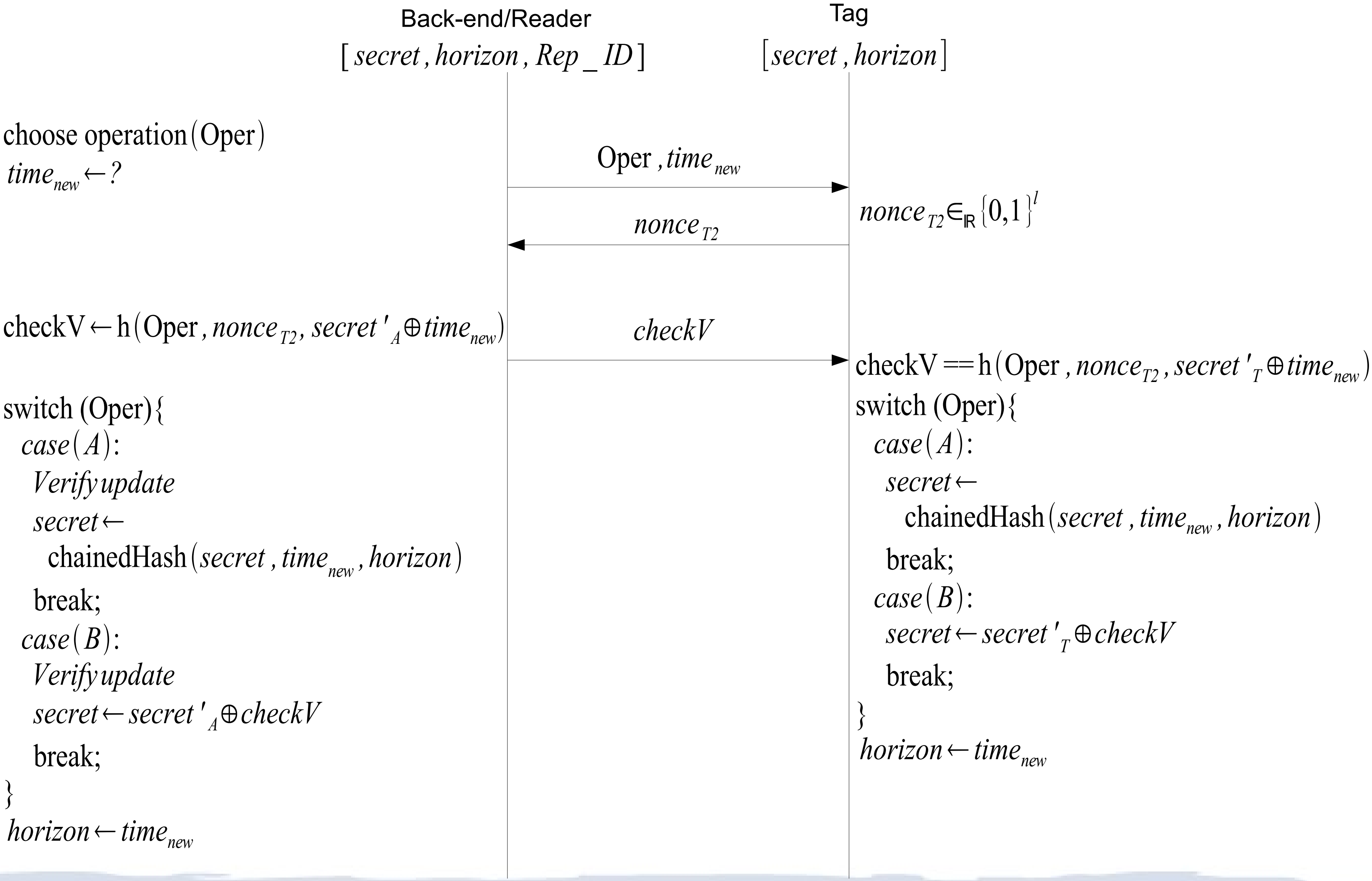
chainedHash$(secret, c_time, horizon)$

$TID_A \leftarrow \mathrm{h}(Rep\_ID, secret'_A)$

$Pseud_A \leftarrow \mathrm{h}(nonce_{A1}, TID_A \oplus nonce_{T1})$

if: $Pseud_A == Pseud_T$

Tag data update



Back-end/Reader

$[\,secret, horizon, Rep\_ID\,]$

Tag

$[\,secret, horizon\,]$

```
choose operation(Oper)
$time_{new} \leftarrow ?$
```

$\xrightarrow{\text{Oper}, time_{new}}$

$nonce_{T2} \in_R \{0,1\}^l$

$\xleftarrow{nonce_{T2}}$

```
$\text{checkV} \leftarrow \text{h}(\text{Oper}, nonce_{T2}, secret'_A \oplus time_{new})$
```

$\xrightarrow{checkV}$

```
$\text{checkV} == \text{h}(\text{Oper}, nonce_{T2}, secret'_T \oplus time_{new})$
switch (Oper){
  $case(A)$:
    $secret \leftarrow$
      $\text{chainedHash}(secret, time_{new}, horizon)$
    break;
  $case(B)$:
    $secret \leftarrow secret'_T \oplus checkV$
    break;
}
$horizon \leftarrow time_{new}$
```

```
switch (Oper){
  $case(A)$:
    $Verify update$
    $secret \leftarrow$
      $\text{chainedHash}(secret, time_{new}, horizon)$
    break;
  $case(B)$:
    $Verify update$
    $secret \leftarrow secret'_A \oplus checkV$
    break;
}
$horizon \leftarrow time_{new}$
```

Security Analysis

Attacker's arsenal

- Eavesdropping (*Weak-Passive*)
- Full control of network operations (*Weak-Active*)
- Tag corruption at end of attack (*Forward-Corruptive*)
- Destructive tag corruption (*Destructive-Corruptive*)
- Arbitrary tag corruption (*Strong-Corruptive*)

- *Side channel knowledge*

Security Analysis

- Tag & Reader impersonation
  - Against active attackers
- DOS/Desynchronization
  - Against active attackers
- Tag anonymity
  - Against active attackers
- Forward untraceability
  - Against strong attackers
- Backward untraceability
  - Using safe slots

Conclusions

- Effort on complete and low cost security solutions
- More research on the combination of dynamic *access control mechanisms* and *policies* in IOT environments
    - Efficiency, usability, interoperability etc.

Thank you very much