Security and Privacy in a Ubiquitous World

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Smart Labels

Object Identity

Interaction Type

Interaction Circumstances

- Object Location & Orientation
- Time of interaction
- Additional parameters

Absolute:	**eg. Geographical coordinates**
Relative:	**eg. To known object**
Semantic:	**eg. Contextual interpretation**

Absolute:	**eg. UTC**
Relative:	**eg. Simultaneously, After**
Semantic:	**eg. Contextual interpretation**

Environment:	**eg. Temperature**
Object properties:	**eg. Size, Ownership**
Object dynamics:	**eg. History**

Read only fields
Writeable fields
Associative fields
Sensor fields

Shadow World Assumption

Link to blue jeans

```
<SUITCASE>
     bought-by:   Clemens Cap
     bought-at:   Kaufhof
     loaction:    49° 33' 22'', 23° 23', 34''
     location:    Rostock
     location:    Car with license plate HRO-XC7
     content:     1 blue jeans, 5 shirts, ...
     value:       500.- USD
</SUITCASE>
```

Shadow World Assumption

We shall assume

- Every object carries a label
- High density of readers

Realistic assumption?

- Costs
- Standards & Interoperability
- Benefits

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Capacitive coupling

- No copper coils
- Printed antenna
- Defect tolerance
- Motorola Bistatix

Polymer based logic

- Easier process
- Promising examples
- Infineon / Erlangen / Ulm

Economies of Scales

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Realistic assumption?

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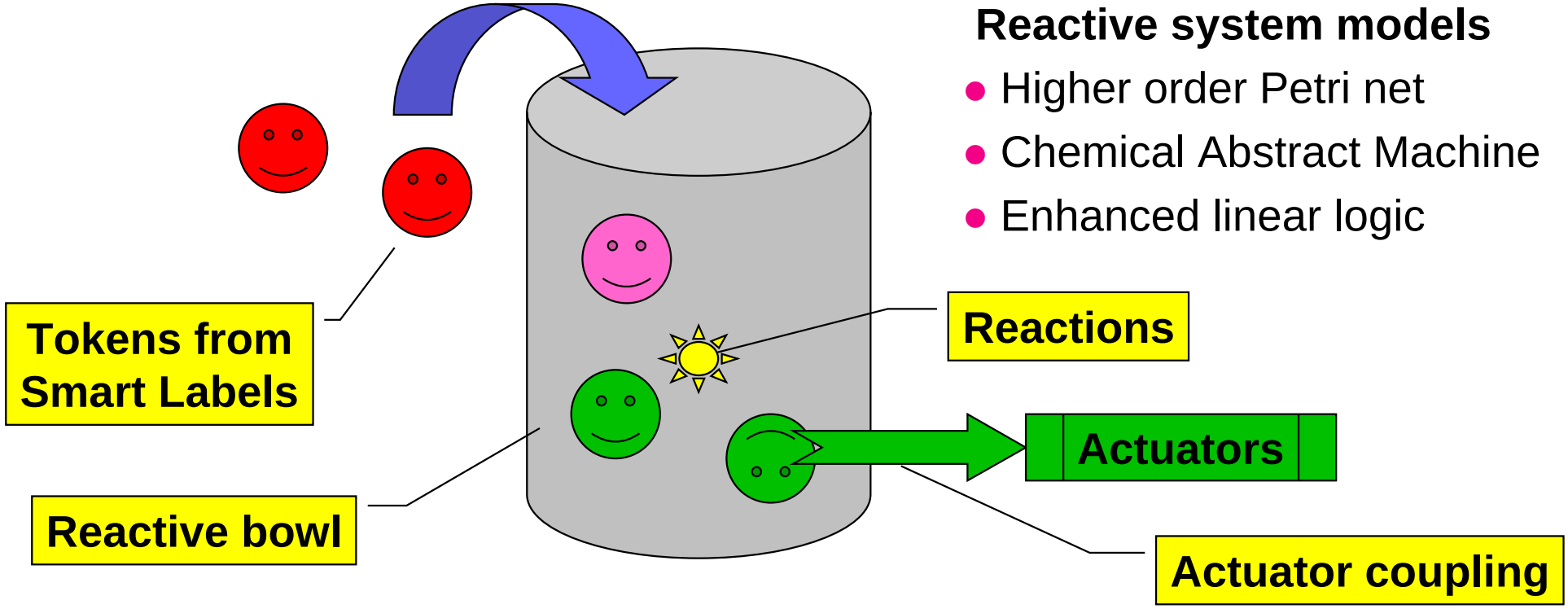
Example

If my shoes leave my house without my umbrella and there is a forecast for rain, then inform me accordingly

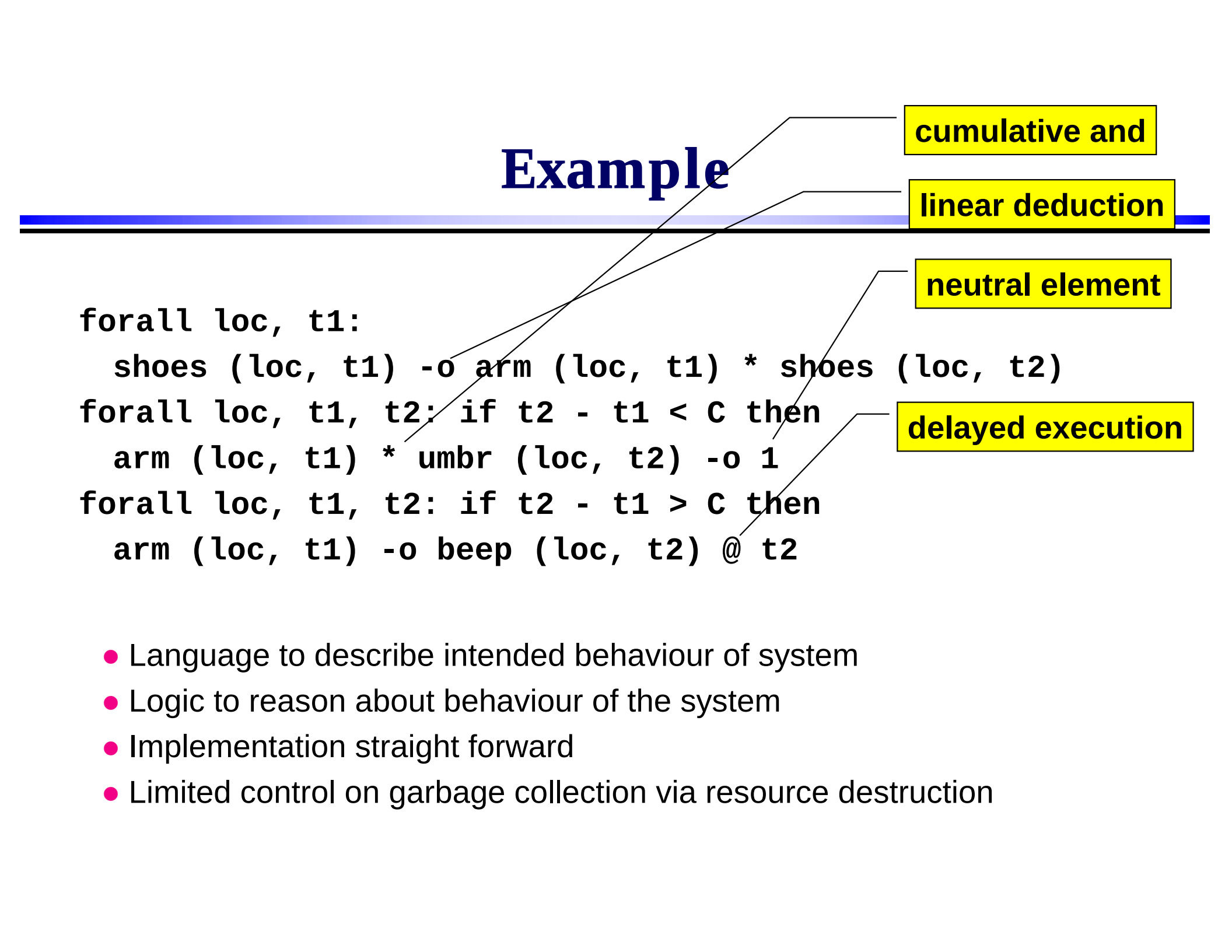


Reactive system models

- Higher order Petri net
- Chemical Abstract Machine
- Enhanced linear logic

Example

```
forall loc, t1:
  shoes (loc, t1) -o arm (loc, t1) * shoes (loc, t2)
forall loc, t1, t2: if t2 - t1 < C then
  arm (loc, t1) * umbr (loc, t2) -o 1
forall loc, t1, t2: if t2 - t1 > C then
  arm (loc, t1) -o beep (loc, t2) @ t2
```

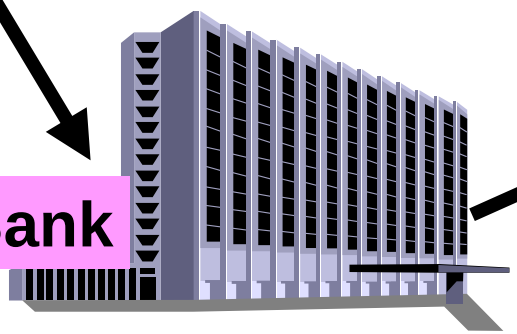


- Language to describe intended behaviour of system
- Logic to reason about behaviour of the system
- Implementation straight forward
- Limited control on garbage collection via resource destruction

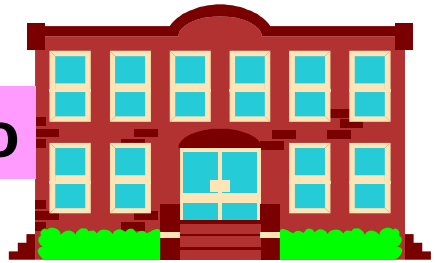
A Short Story

Home

Bank



Casino



Red Light District

Prison

So what is the story?

- A family tragedy ?
- A policeman on his daily tour ?
- A mafia boss caught on his daily tour ?
- A medical doctor called in for an emergency ?
- A taxi driver at work ?
- . . .

Lessons learned so far

Lesson 1: Raw sensor data is practically meaningless

Lesson 2: Derivation of semantics is (very) difficult
Additional info may be required

Lesson 3: Mining in raw sensor data can be misleading

Lesson 4: Must protect raw sensor data

Technical Approaches (1)

No security

- Everyone can read / write / access label
- Attack: Buy compatible reader / label

Password protection

- Password used to read / write / access label
- Structure: Several passwords & access areas
- Attack: Crack password
  (but: blocking mechanism) [but: DOS attack] {but: reader auth}
- Attack: Replay password
- Attack: Sniff the password
  (but: encrypt it) [but: replay attack]

Technical Approaches (2)

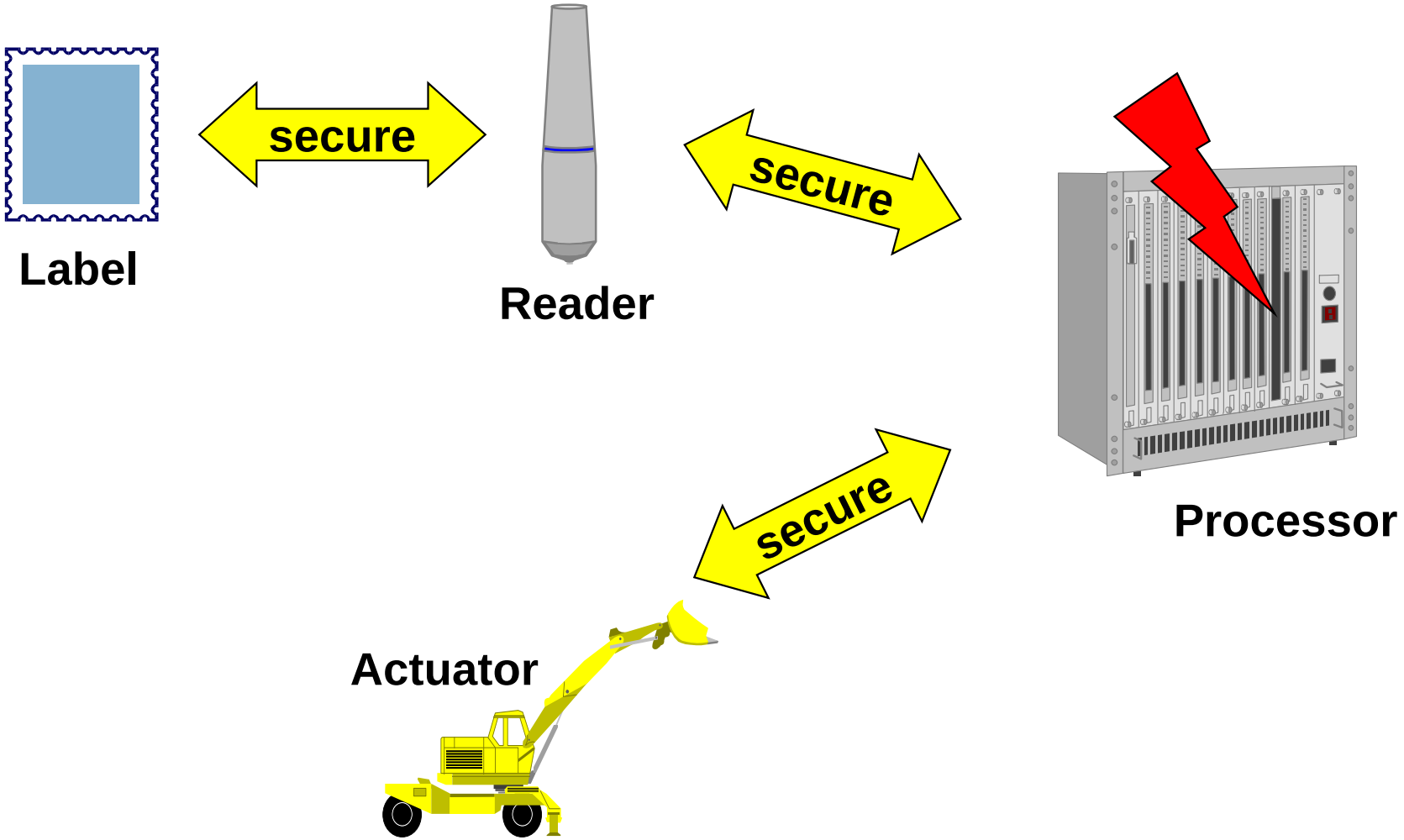
Rolling code system

- Get a new password every time
- Synchronize time of generating device (SecureID token)
- Synchronize state of generating device (car alarm)
  But: out-of-synch, state replication

Challenge response

- Reader provides a challenge
- Label calculates a response
- Attack: Man-in-the-middle
  (but: reader must provide proper challenge)

Overall Situation



Requirements

Processor must be implemented as a

- distributed
- multiparty protocol
- between sensors (and maybe computing nodes)
- with input privacy
- and resilience against cheating participants

Basic result (Yao; Chaum et al; Goldreich et al.)

- can be done if not too many cheaters are present

Example for equality of owner of shoes and umbrella

Some observations
(user interviews in the FASME project)

Observation 1: The privacy & most security issues are mainly in our minds and hence must be treated accordingly

Observation 2: Privacy must be enforced by technology, not by regulations

Observation 3: Privacy must be visible to the user

Observation 4: User must be able to check what is stored about him