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TU Berlin

Context-Aware Security for Mobiles
SIDAR SPRING 2009, Stuttgart

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CC SEC
Security

Motivation
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The Notion of Context
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Context-Awareness in IT-Security
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Proposed Approach
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Outline

1. Motivation

2. The Notion of Context
   - What is Context?
   - Context Classification
   - Context-Awareness

3. Context-Awareness in IT-Security
   - Security and privacy in context-aware applications
   - Context-awareness in security applications

4. Proposed Approach
   - The Problem - Revisited
   - Proposed Solution

Outline

Motivation   The Notion of Context   Context-Awareness in IT-Security   Proposed Approach

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Motivation

Motivation
What is context and why is it important?

- Anytime, anywhere connected.
- Increasing ubiquity of technology.
- The smartphone is always with you.
- But - is it secure enough?

Goal:
Make a smartphone more secure through automatic proactive and reactive assistance.

Problem

- Established security solutions are mostly designed for wired networks
- A mobile node moving through potentially hostile environments implies new security threats
- But: a node can tell a lot about its state and its environment
- Solution: consider this context information in security decisions

The Vision
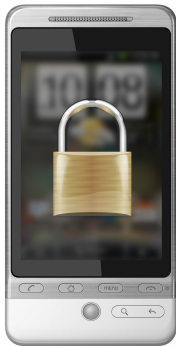
- Secure, autonomous, context-aware mobile device
- Use context information to:
  - Enforce security policies
  - Recognize data leaks
  - Provide the right information in the right context
  - Increase usability and acceptance of smartphones
  - Save power

Motivation

Use Cases

Corporate user

Highly secured (governmen-tal?) devices

A customer concerned about her privacy and security

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What is Context?

The Notion of Context
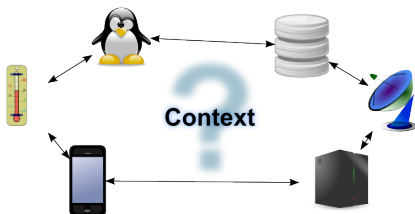
- Very complex notion.
- Everything - from *temperature* to grade of *happiness*.

What is Context?

Existing Definitions

- The complete state of the universe at an instant of time [McCarthy and Hayes, 1969]
- The elements of the user's environment that the computer knows about [Brown, 1996]
- Any information that can be used to characterize the situation of an entity [Abowd et al., 1999]

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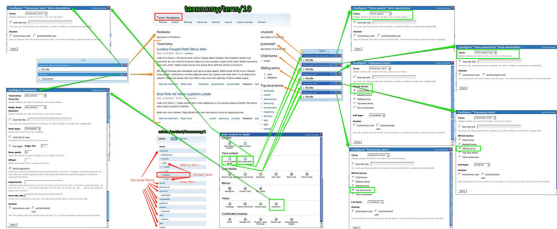Proposed Approach
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What is Context?

Existing Definitions II

The best one

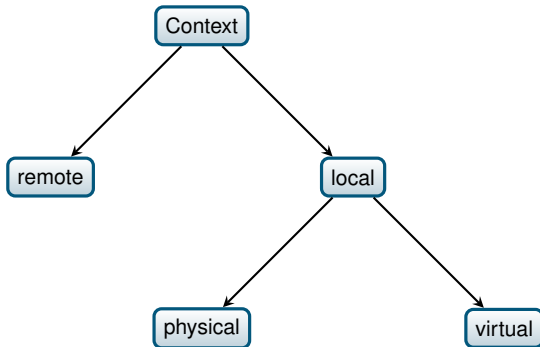## Precise, for ubiquitous computing - our case!

Context is the set of environmental states and settings that either determines an application's behavior or in which an application event occurs and is interesting to the user [Chen and Kotz, 2000]

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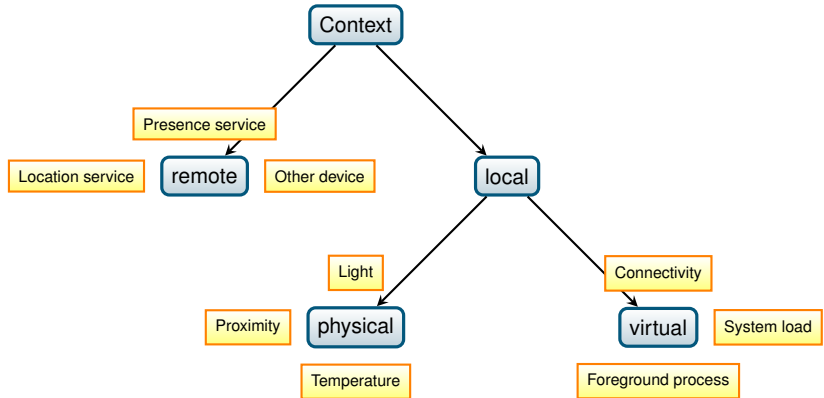Context Classification

Classification of Context Components

- Context consists of many components
- Almost **everything** can be considered context.
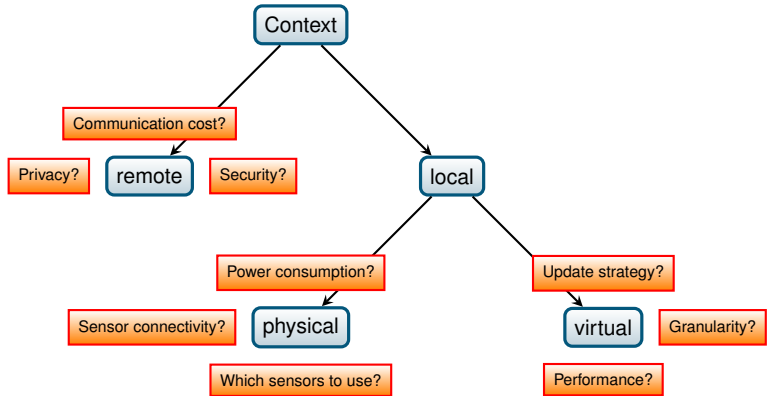- Now, how to classify these components?

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Context Classification

Classification of Context Components

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Context Classification

Examples of Sensors

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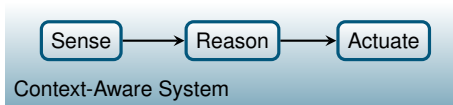Proposed Approach ○ ○○○○

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Context Classification

Arising Questions

Function of a Context-Aware Application

Context-aware software is able to sense, reason and actuate. [Baker et al., 2009]

Sense → Reason → Actuate

Context-Aware System

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Context-Awareness

Function of a Context-Aware Application

Context-aware software is able to sense, reason and actuate.
[Baker et al., 2009]

Looks familiar?

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Context-Awareness

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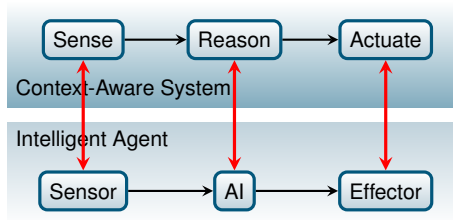Proposed Approach
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Context-Awareness

Function of a Context-Aware Application

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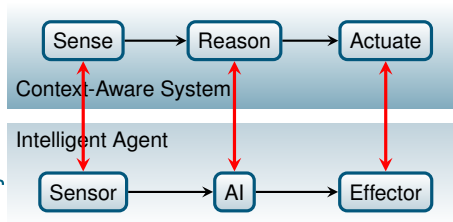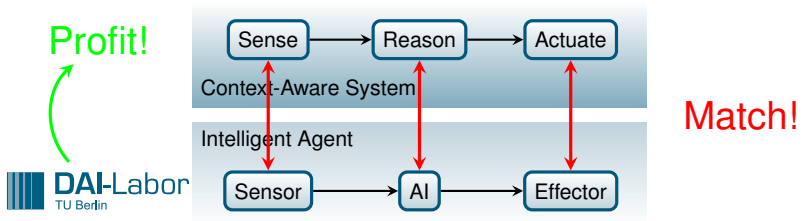[Baker et al., 2009]

Function of a Context-Aware Application

Context-aware software is able to sense, reason and actuate. [Baker et al., 2009]

Match!

Motivation | **The Notion of Context** | Context-Awareness in IT-Security | Proposed Approach
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Context-Awareness
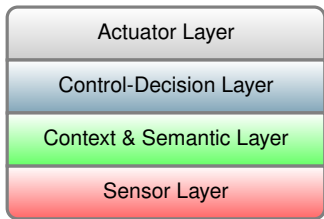
Function of a Context-Aware Application

Context-aware software is able to sense, reason and actuate.
[Baker et al., 2009]

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Context-Awareness

Common Properties of a Context-Aware System

Actuator Layer
Control-Decision Layer
Context & Semantic Layer
Sensor Layer

CAS Layers [Baker et al., 2009]

- Context-Aware Systems are often knowledge-oriented
- AI methods are frequently used for context definition and analysis

Motivation   **The Notion of Context**   Context-Awareness in IT-Security   Proposed Approach
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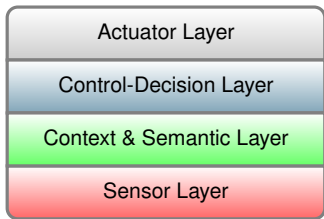TU Berlin

Context-Awareness

Common Properties of a Context-Aware System

CAS Layers [Baker et al., 2009]

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Context-Awareness

Common Properties of a Context-Aware System

| Actuator Layer |
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(!)

CAS Layers [Baker et al., 2009]

- Context-Aware Systems are often knowledge-oriented
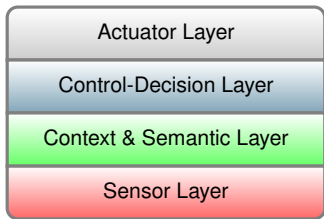- AI methods are frequently used for context definition and analysis

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Context-Awareness

Aspects of Context Handling

Active Badge Indoor Positioning

System - the godfather of

context-aware applications

- Sensor access strategy:
  - direct
  - middleware
  - networked
- Context dissemination strategy:
  - polling ("pull")
  - publish-subscribe ("push")
- Application field:
  - cyberguides
  - smart environments
  - augmented reality
  - . . .

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Context-awareness and Security

Two aspects:
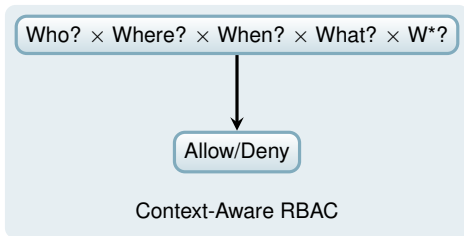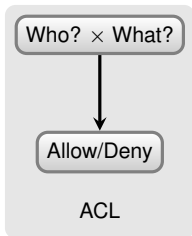
- Security and privacy in context-aware applications
- Context-awareness in security applications ⇐ this one is more interesting for me

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Security and privacy in context-aware applications

Securing existing context-aware applications

- Security is an issue in distributed context-aware applications
- Most authors concentrate on two issues [Baldauf et al., 2004]:
    1. establishing secure communications
    2. ensuring the credibility of context - "Quality of Context" [Toninelli et al., 2009]

Context-aware access control

- Several authors propose using context information to enrich access control mechanisms
- A common concept is adding context-awareness to RBAC
- ACL vs. Context-Aware RBAC:

Context-awareness in security applications

Context-aware access control
Exisiting solutions

- CASA - Context Aware Security Architecture [Covington et al., 2002]
  - Provides access control in a smart home
  - Based on GRBAC [Covington et al., 2001]
  - Uses a modified Context Toolkit [Dey et al., 1999]
- DRBAC - Dynamic RBAC [Zhang and Parashar, 2004]

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Context-awareness in security applications

Context-aware access control

Existing solutions (continued)

- DCASS - Dynamic Context-Aware Security System
  [Hu and Weaver, 2004]
  - Provides access control in a pervasive healthcare
    environment
  - Heavy use of web services, WS-Policy
  - Overly complicated, but theoretically sound
- Proteus - semantic context-aware access control model
  that is centered around the concept of context
  [Toninelli et al., 2009]
  - Introduces the quality of context as a measure of context
    trustworthiness
  - Uses RDF to define policies
  - Uses Contory [Riva, 2006] and SPARQL
    [Prud'hommeaux and Seaborne, 2006]

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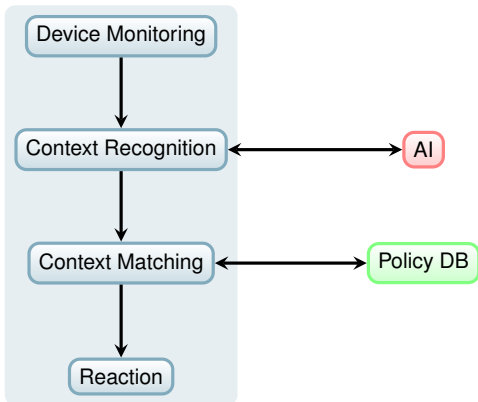4 **Proposed Approach**
- **The Problem - Revisited**
- **Proposed Solution**

Disadvantages of the existing solutions
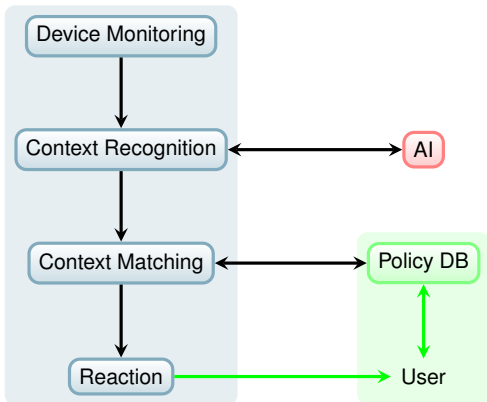
- Most mobile solutions focus on usability, not security
- Most security-enabling solutions do not focus on mobile devices
- Those which focus on both have evolved out of Smart Home Environments and thus rely on an external sensor architecture.

Motivation
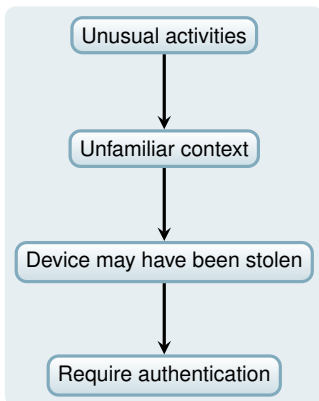The Notion of Context
Context-Awareness in IT-Security
Proposed Approach

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Proposed Solution

Overview

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Context-Awareness in IT-Security
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Proposed Solution

Overview

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Proposed Solution

Scenario: Stolen Device

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Proposed Solution

Scenario: Insecure Environment

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Proposed Solution
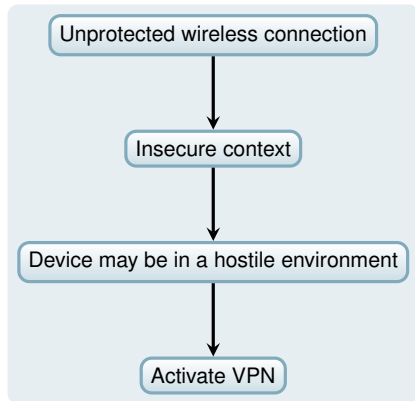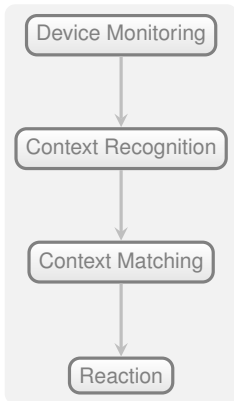
Scope

In scope

- Run locally on the device
- Rely on as less external architecture as possible
- Modular, configurable and manageable
- Shift security responsiblity from the user to the middleware

Out of scope

- Using AI to render policies
- Bullet-proof system, immune against attacks
- A corporate-grade quality product

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For Further Reading

Thank you!

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For Further Reading I

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Towards a better understanding of context and context-awareness.
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A context-based infrastructure for smart environments.
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Contory: a middleware for the provisioning of context information on smart phones.
In *Middleware '06: Proceedings of the ACM/IFIP/USENIX 2006 International Conference on Middleware*, pages 219–239, New York, NY, USA. Helsinki Institute for Information Technology, HUT, Finland, Springer-Verlag New York, Inc.

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A quality of context-aware approach to access control in pervasive environments.
In *MobileWireless Middleware, Operating Systems, and Applications*, pages 236–251.

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