# Computer Security in 3D

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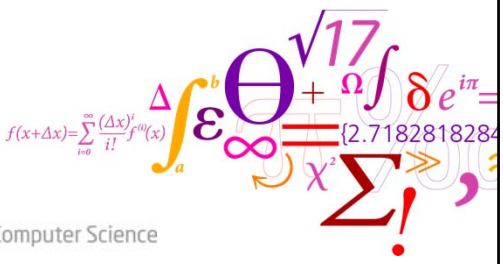

DTU Compute
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## Traditional Security – Perimeter Defense

## Traditional Computer Security in Practise

- Distinguish between logical and physical security
  - Logical Security is enforced by the computer system
    - *Login performs authentication*
    - *Access control enforced when resources are accessed*
  - Physical Security is enforced by external "agents"
    - *Locked server rooms (keys/access card/biometrics to enter)*
    - *Guards and alarms*

- Logical security requires physical security
  - Servers are locked in secure server rooms
  - Assumes that the person who logged in is now sitting at the terminal
  - Object can only be accessed by subject who requested the operation
    - *Printing exam scripts on shared departmental printers???*



## The security perimeter is dissolving

- Computers are brought into the shared workplace
  - Personal computers in open plan offices (cubicles)
- Mobile-/wearable computers (there is an App for that)
  - Access to computing resources anytime, anywhere
    - *Working from home, on the move, always-on*
  - Changing both virtual and physical locations
- System integration across system boundaries
  - Virtual Enterprises/- Organisations
  - Opportunistic Collaboration and Dynamic Coalitions
- Internet of Things
  - Ubiquitous access to embedded (control) systems (e.g. smart meters)
  - Computers embedded in everyday things (TVs, refrigerators, cars, …)

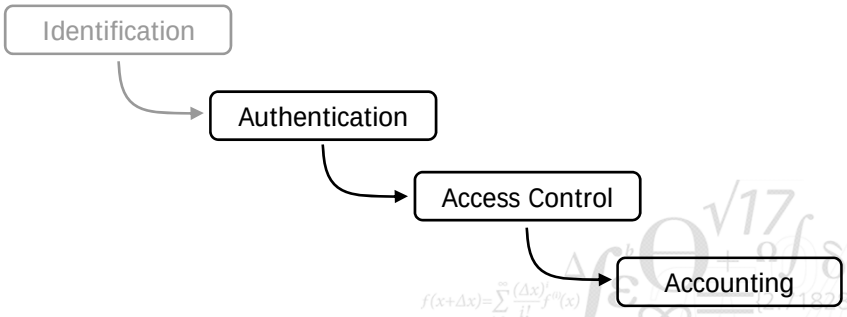
## Ambient Intelligence

- Embedding sensors, actuators & computing capabilities in env.
  - Sensors establishes current context
  - Actuators adapts "environment" to the need of the users
    - *Environment may include computer equipment, monitors, etc.*
  - Computing capabilities implement smart behaviour
    - *Context aware applications, location based services, …*

- Ambient intelligence may provide environmental context to the logical access control mechanism
  - Sensors allow the system to establish location of human users
  - Computing capabilities may determine context of human users
  - Actuators will not be used by security mechanism, but logical access controls may be considered some form of "actuators"



## Traditional Security Framework

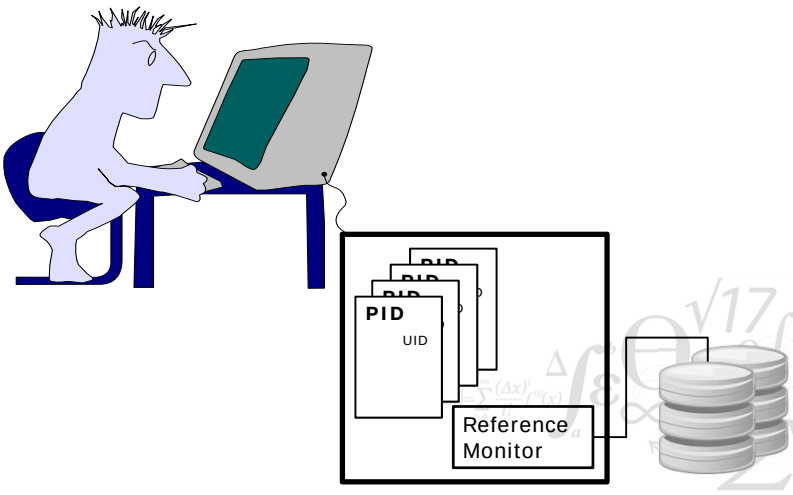


## Identification & Authentication

- The user identity serves three primary purposes
  - It allows the representation of a human user as a system subject
    - *Human user claims right to a system identity (subject id)*
    - *Requires authentication of subjects (validation of claimed id)*
    - *Human (real world) identity is difficult/expensive to change*
      - Reduces probability of White-washing and Sybil attacks
  - It allows different permissions to be granted to different subjects
    - *Defined in the access control policy*
    - *Ultimately based on the identity mapped to the subject*
  - It allows accountability
    - *Record the identity mapped to the subject performing an action*
    - *Log serves as evidence if something goes wrong*



## Access Control in Practise



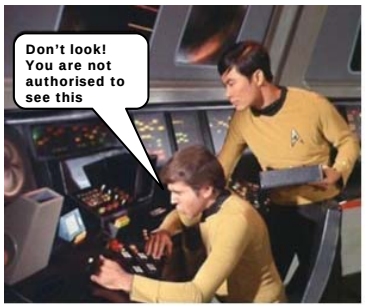
## Enforcing Computer Security Policies

- Security enforced by logical and physical security mechanisms
- Granularity of security mechanisms
  - Logical Security is fine-grained (individual records/files/…)
  - Physical Security is coarse-grained (buildings/rooms/…)
- Computer Enforced Security Mechanisms (logical security)
  - Restricted to consider the state of computer system entities
    - *Human users are not directly part of computer systems*
    - *Data must be rendered physically to be consumed by users*
      - Displayed on monitor, printed, played on speakers
    - *Access to rendered data is constrained by physical security*
      - Confidentiality by restricting access to output devices
      - Integrity by restricting access to input devices



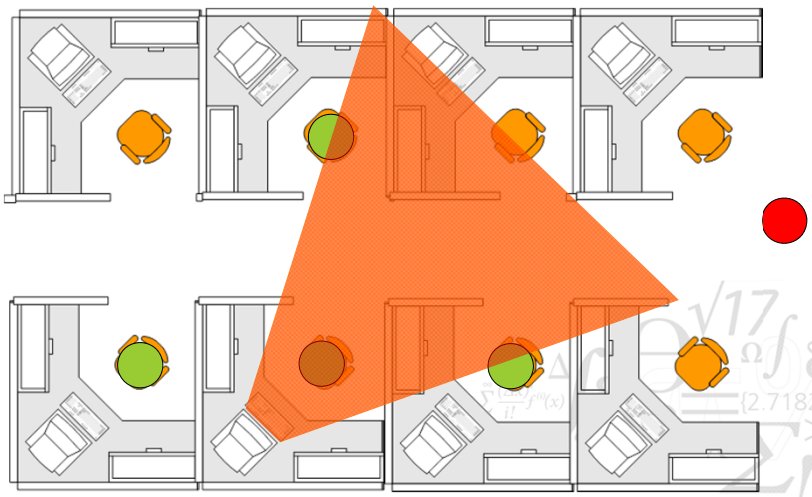
## The Granularity Gap in Acces Control

- Granularity of physical access control (room, floor, building, …)
  - Defines the context for logical access control
  - Granularity of physical security dominates
    - *min(physical, logical) = physical*




- Trust in subject fills the granularity gap

## Computer Security in 3D



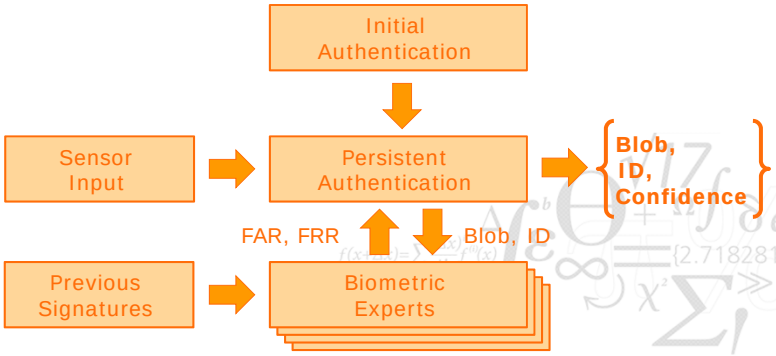


## Authentication in 3D

- Discrete Authentication
  - Login is a discrete event (login + password, biometrics, …)
  - Authentication is extended in time through a session
    - *Re-authentication is explicit and rare (Kerberos)*
    - *What happens if person leaves device with session open?*
- Continuous Authentication
  - Authentication is extended in time
    - *Token-based (Zero Interaction Authentication)*
      - Presence of token is continuously required
      - Secure location services
    - *User-centric*
      - Biometrics (laptop webcam confirms user is still present)
  - Authentication is extended in time and space
    - *Persistent Authentication*

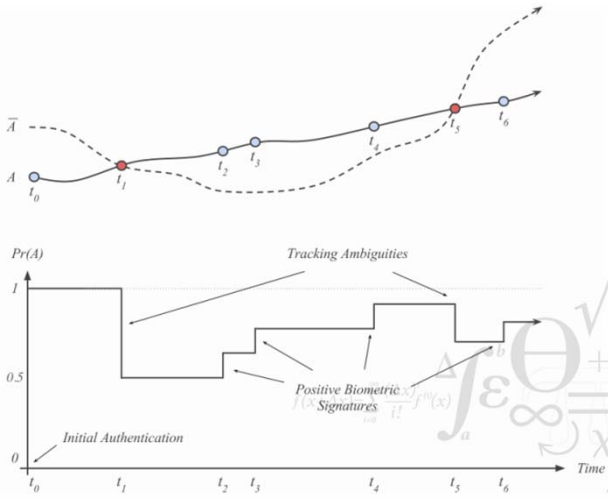
## Persistent Authentication

- Persistent Authentication provides a calm approach to continuos authentication, using sensors from the smart environment to associate the initial authentication with users moving around

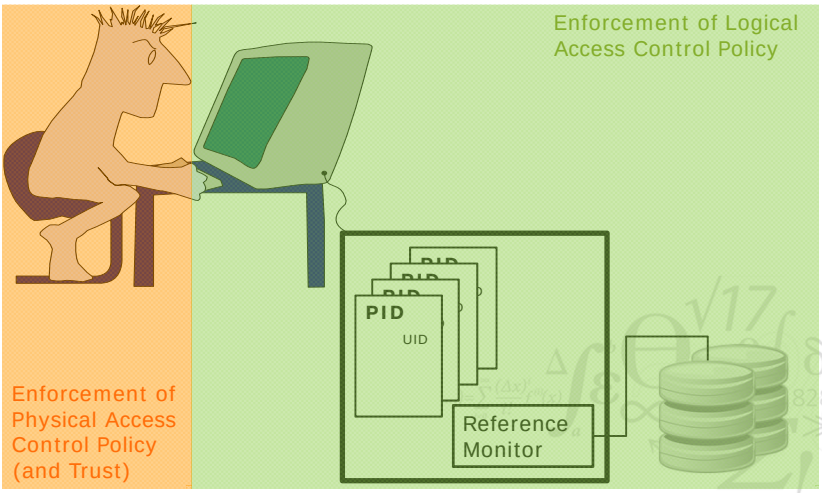





## Authentication Confidence



## Access Control in Practise

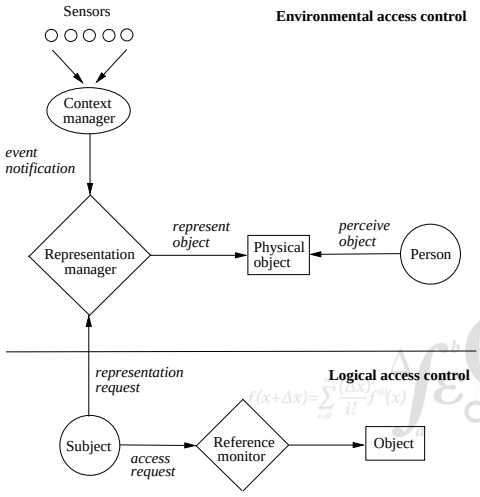





## Access Control in 3D
## Sensor Enhanced Access Control

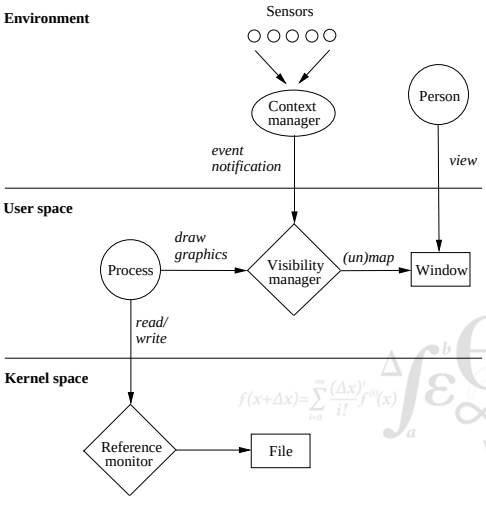
- Motivation
  - To extend logical access control with context awareness
  - Allows logical access control to be enforced in the physical env.
- Defines two models
  - Logical access control
    - *In principle any access control mechanism*
    - *Mandatory access control mechanisms are natural candidates*
  - Environmental access control
    - *Establish the context of subjects and objects*
    - *Defines authorization zones for location based services*
      - Visibility zones for output devices (monitors)
    - *Enforces logical access control policy in authorization zones*
      - Continuous enforcement based on context

## SEAC Model






## SEAC Prototype Architecture



## SEAC Prototype Implementation

- Proof of concept prototype developed for standard Linux system
- Simple mandatory access control model (based on Bell & LaPadula)
  - Simple security property (no read up)
  - *-property (no write down) – *not implemented in prototype*
- Security Labelled file system (and open file monitor)
  - Associates security labels with all files + processes that open files
  - Implements logical access control
- Context Manager
  - Derives context from sensors
    - *Issues events when users enter/leave visibility zone*
- Visibility manager
  - Subscribes to events from context manage
  - Maps/unmaps X-windows based on subject clearances
    - *Considers all persons in the visibility zone (minimum rule)*



## Summary

## Conclusions and Perspectives

- Logical access controls are not enforced in the real world
  - Who has access to physical representation of logical object?
- Smart Environments provides context for logical access control
  - Environmental access control enforces logical AC in the real world
- Environmental access control policies
  - Multiple subjects and continuity of enforcement
  - Policy specification requires an aggregated subject (new challenge)
    - *Simple minimum rule, relative importance rule, …*
  - Policy specification requires context definition (new challenge)
    - *Confidentiality rule, integrity rule, …*
  - Allows community access control policies (new opportunity)
    - *Simple separation of duty*
      - Two (authorised) people present to pay a bill
    - *Declassification of sensitive information*
      - Two (authorised) people are needed to declassify information