THE UNIVERSITY OF BRITISH COLUMBIA

Access Control

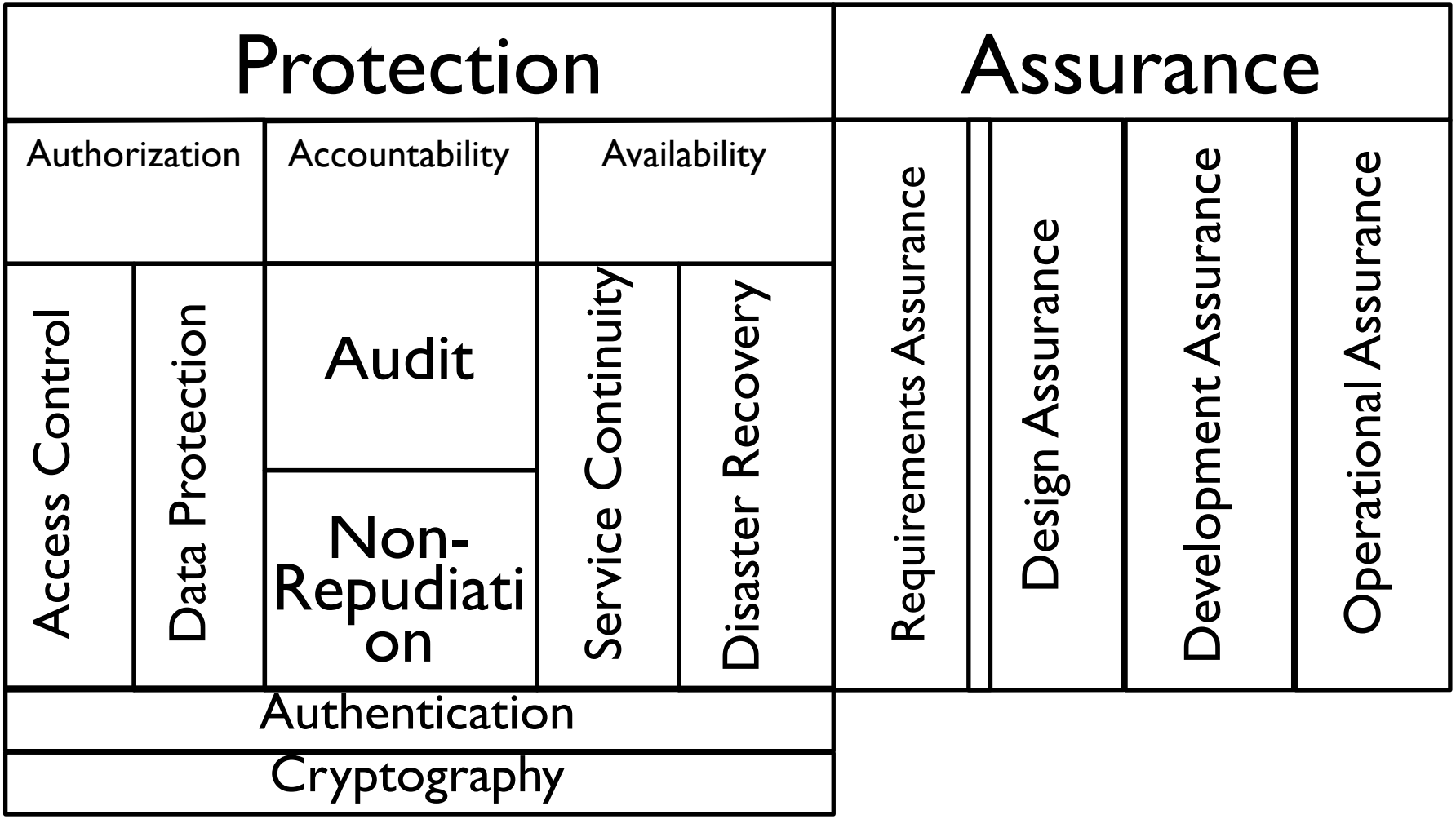
EECE 412

learning objectives

you should be able to

- explain confidentiality and integrity in terms of security policies
- explain c-lists and ACLs and differences between the two
- explain main access control poly models (BLP, CW, RBAC, DAC)
- convert a policy from one model to another

Where We Are


Protection
Assurance
Authorization
Accountability
Availability
Access Control
Data Protection
Audit
Non-Repudiation
Service Continuity
Disaster Recovery
Requirements Assurance
Design Assurance
Development Assurance
Operational Assurance
Authentication
Cryptography

Ross Anderson

"If you say that your problem can be solved with cryptography, then you don't understand your problem and you don't understand cryptography."

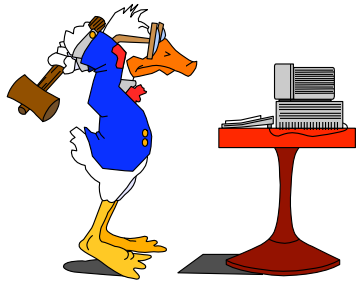
Roger Needham

Authorization Mechanisms:
Access Control

Definition: **enforces the rules, when rule check is possible**

Authorization Engine
Access Decision Function
PDP

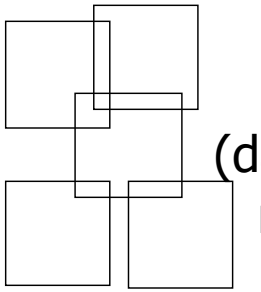
Subject
Principal
User, Client
Initiator



Action

Authorization Decision Entitlement

Reference Monitor
PEP



Object
Resource
(data/methods
menu item)
Target

Security Subsystem

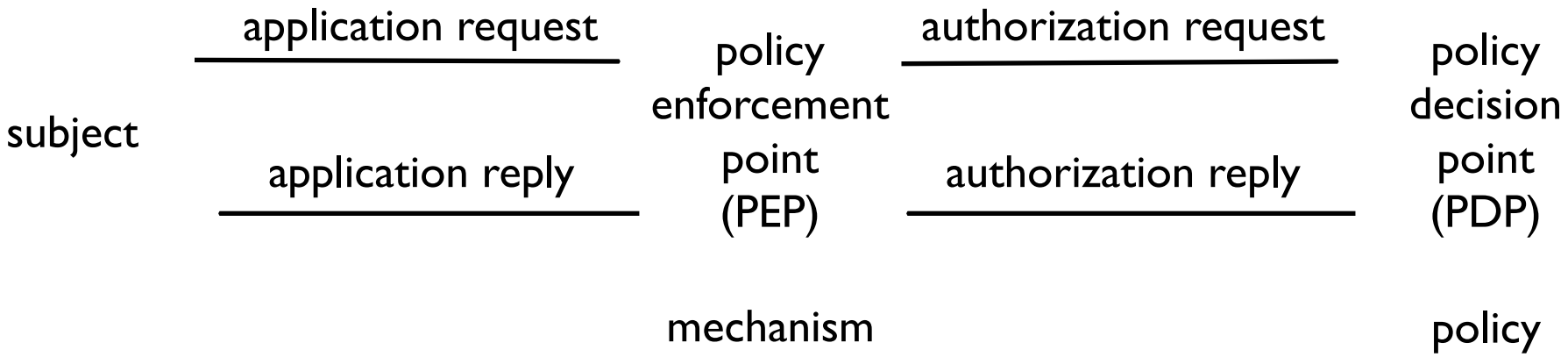
Mix of terms:

Authorization == Access Control Decision
Authorization Engine == Policy Engine

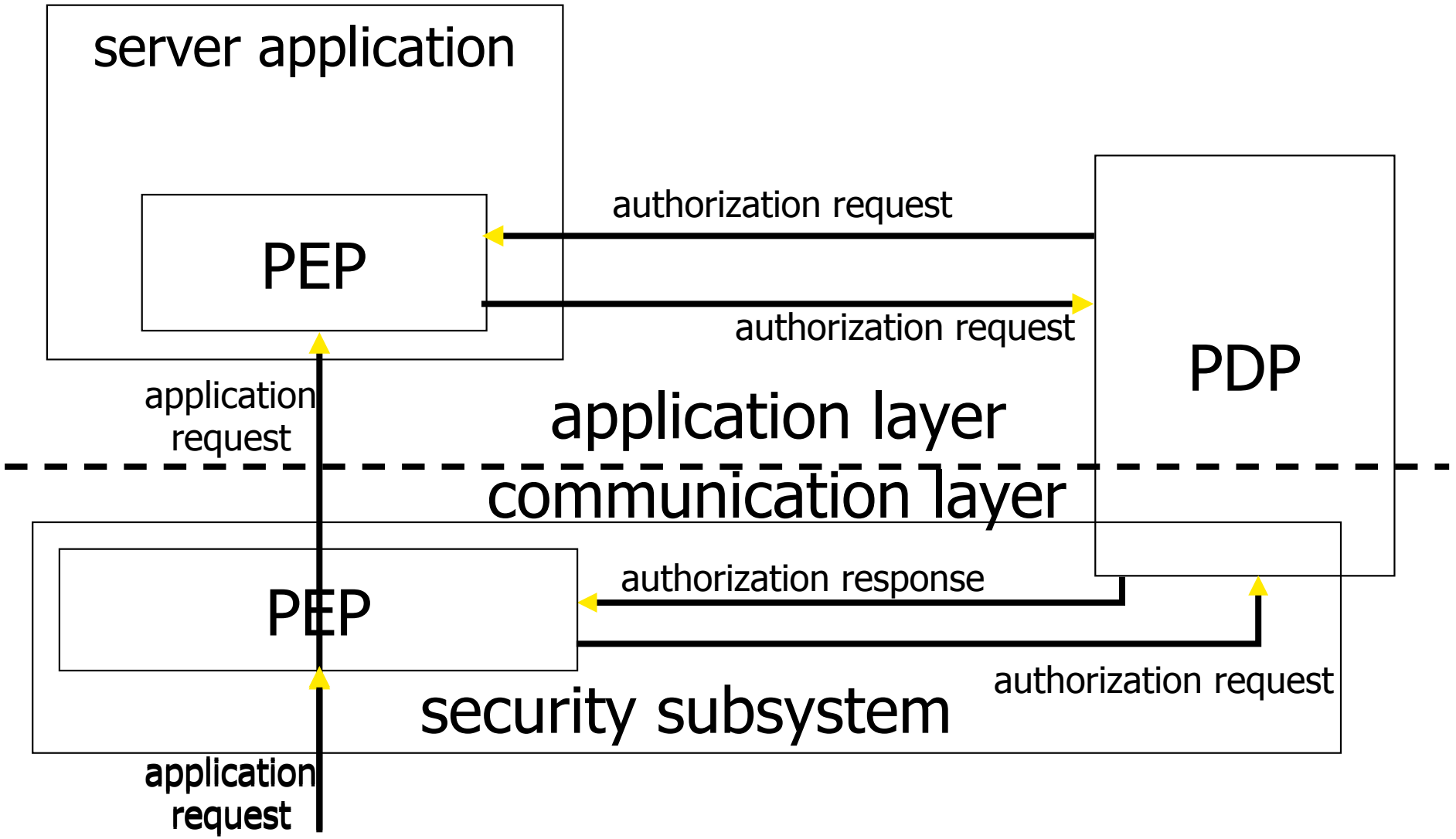
policies and mechanisms

Policies describe what is allowed

Mechanisms control how policies are enforced



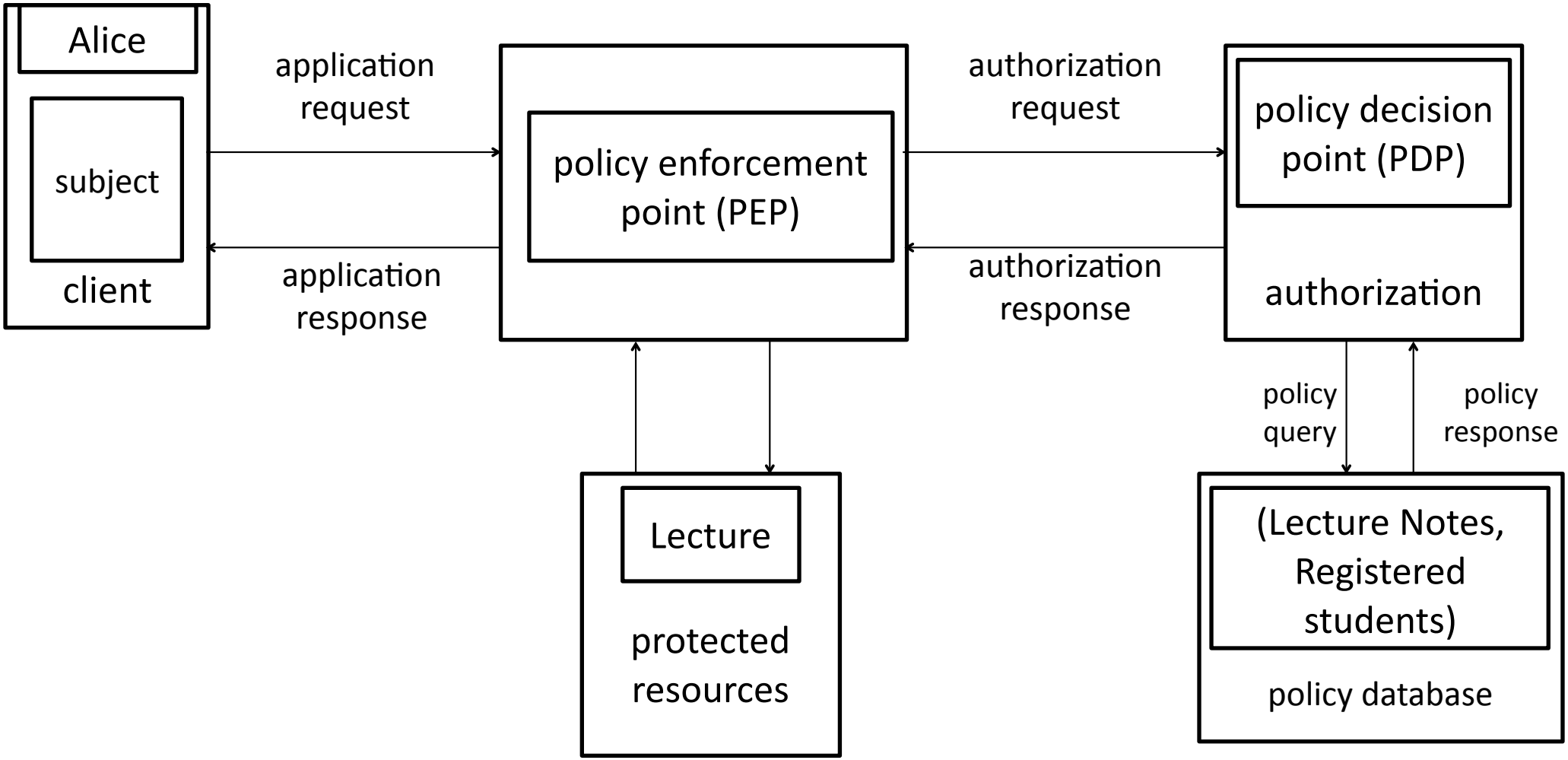
request-response paradigm



case study of research @ LERSSE:

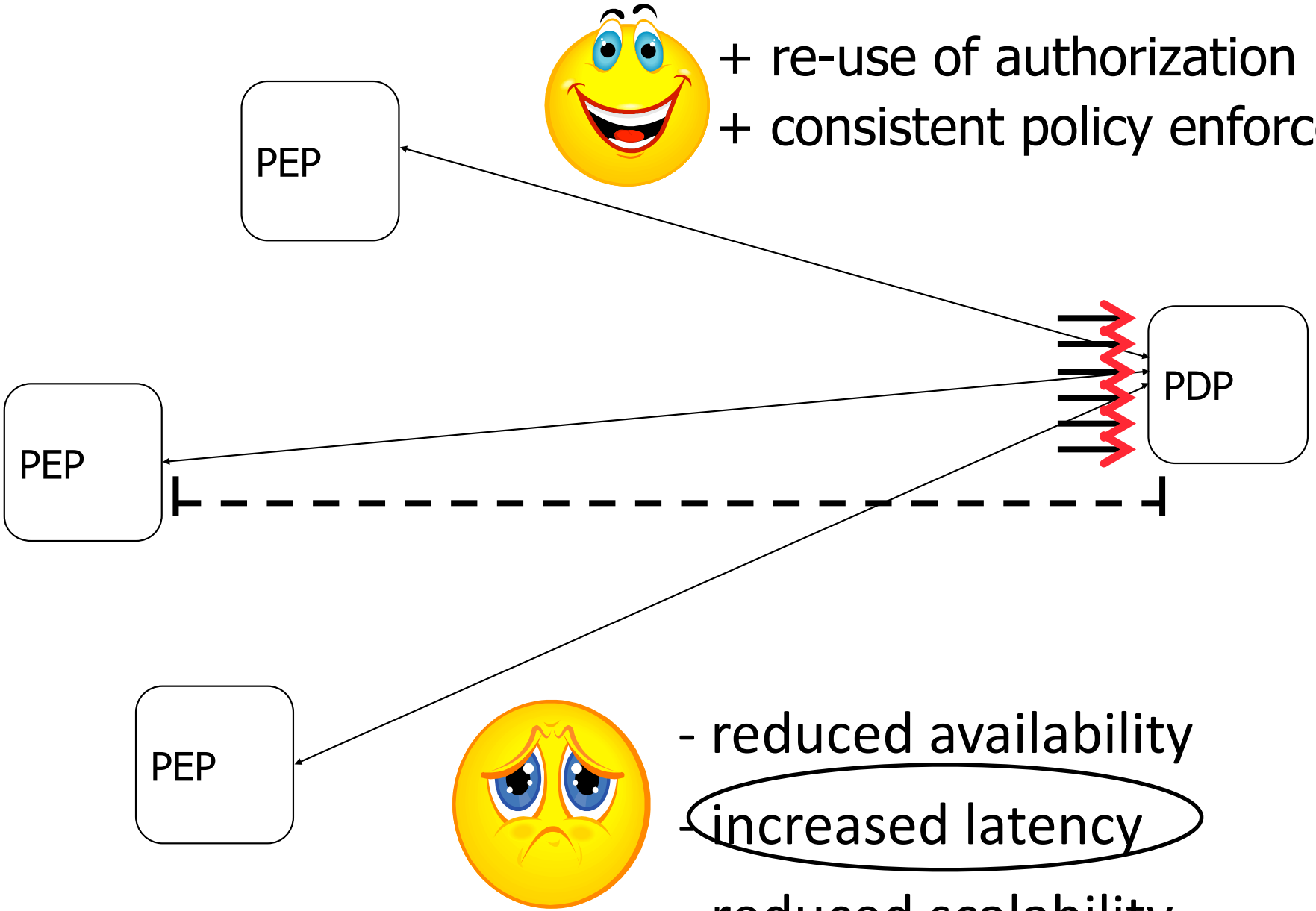
improving performance and availability of enterprise authorization architectures

authorization architecture

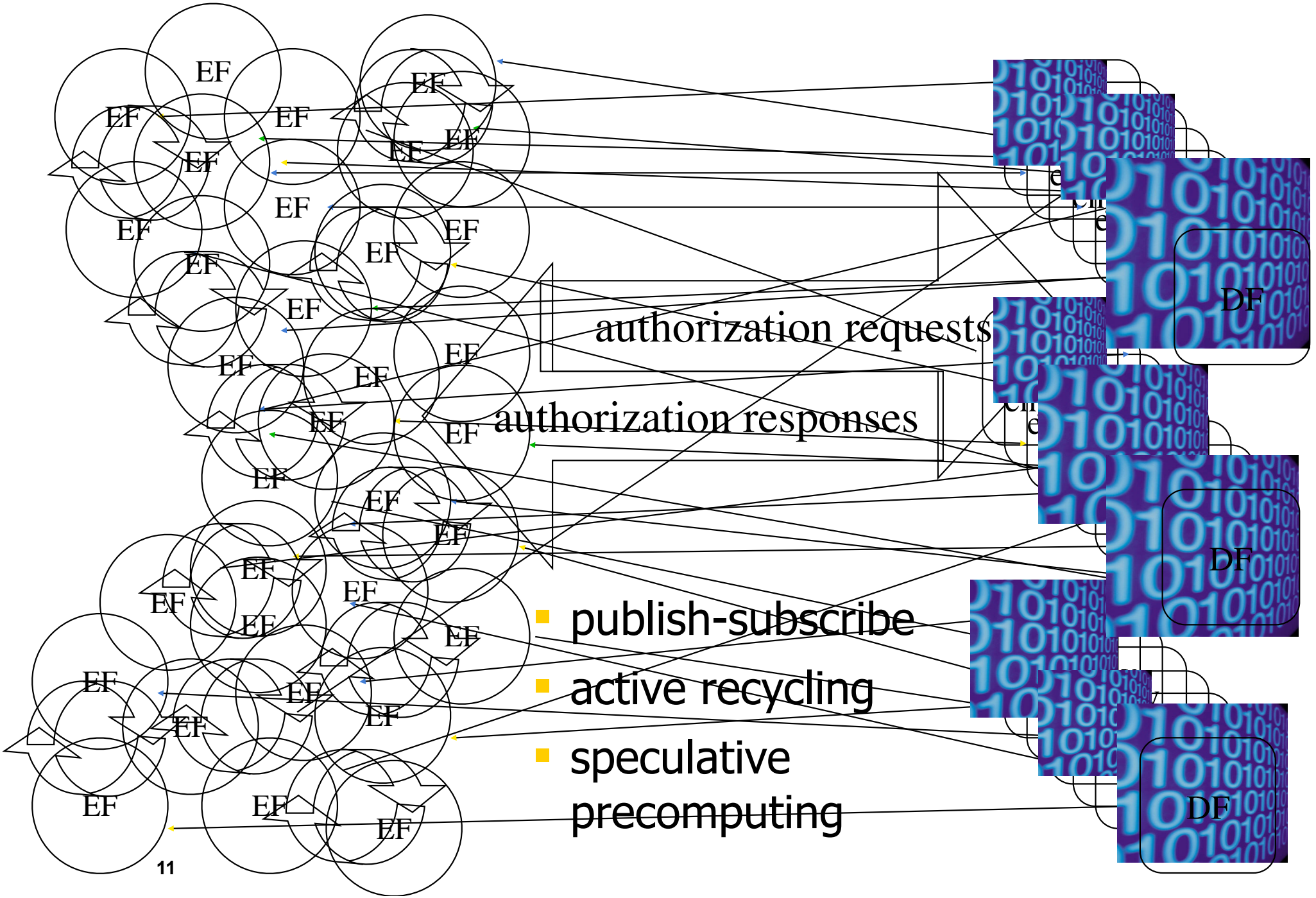


- also known as the request-response model
- used by IBM Access Manager, Entrust GetAccess, CA SiteMinder

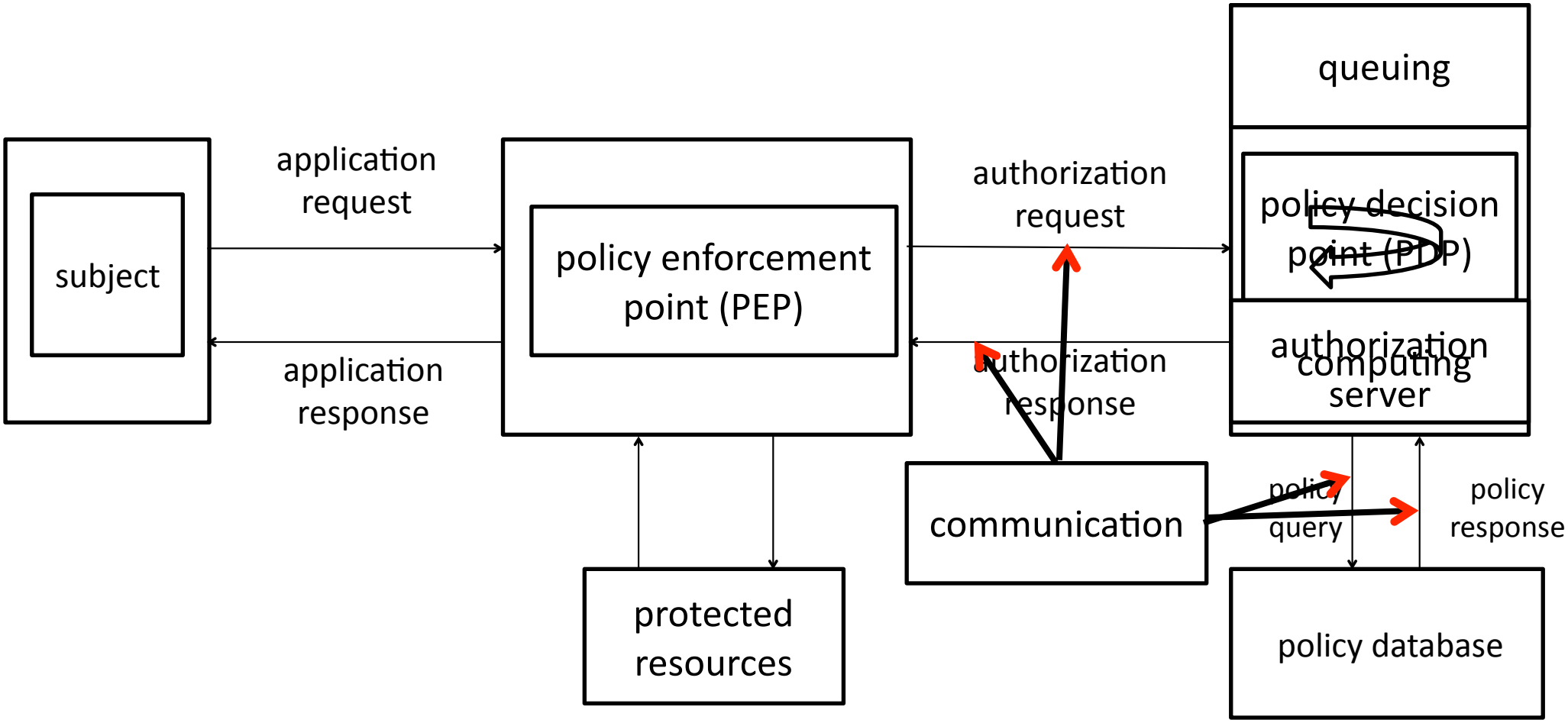
pros and cons



overall research direction



problem – authorization latency



authorization latency is the sum of the three delays

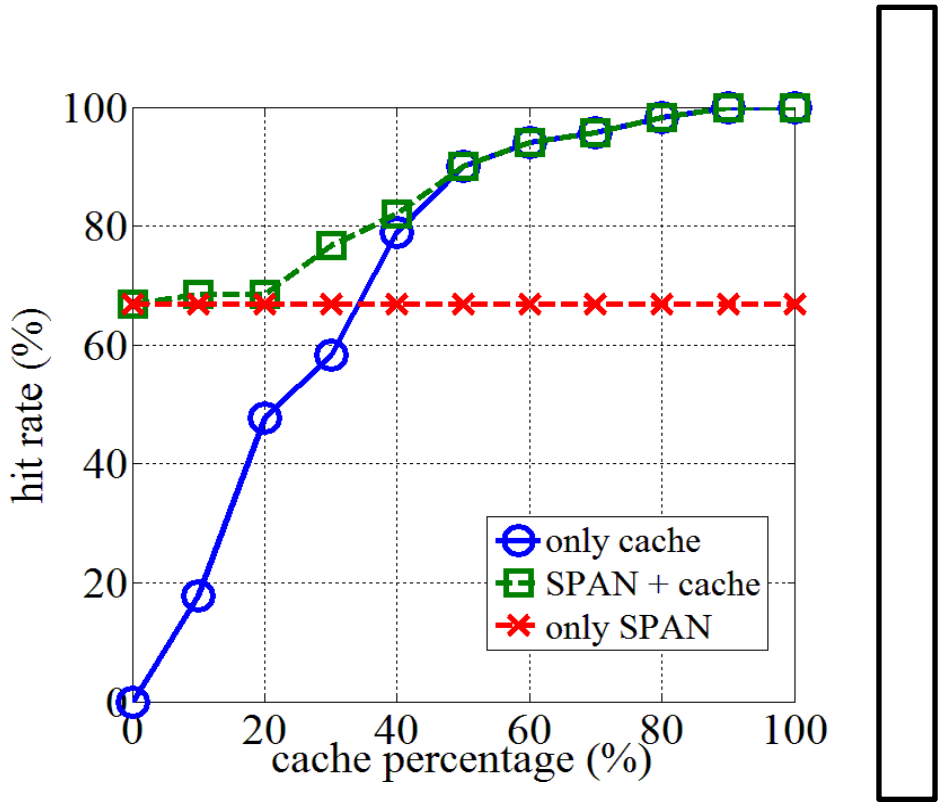
existing approaches

- group replication
  - + reduces the queuing delays
  - - require specialized OS/middleware
  - - poorly scale on large populations
  - - communication delays still exist
- caching previous authorizations
  - + simple, inexpensive
  - + improves overall latency
  - - serves only returning requests
- SAAM and its variants [1, 2]
  - + improve availability and performance
  - - delay incurred for computing responses remains unchanged
  - - designed for policies that are defined using the BLP model.

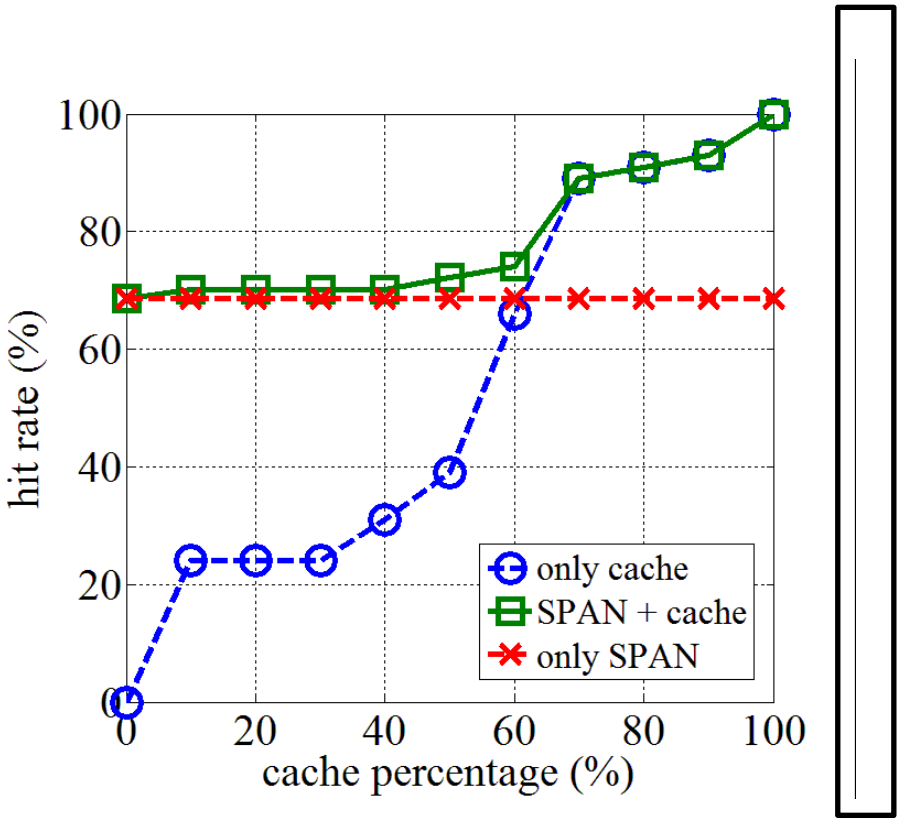
•[1]Crampton J, Leung W, and Beznosov. K Secondary and approximate authorizations model and its application to Bell-LaPadula policies. In Proceedings of the 11th ACM Symposium on Access Control Models and Technologies SACMAT'06), pages 111-120, Lake Tahoe, CA, USA, June 7-9 2006. ACM Press

•[2]Wei Q, "Towards Improving the Availability and Performance of Enterprise Authorization Systems," PhD dissertation, Department of Electrical and Computer Engineering, THE UNIVERSITY OF BRITISH COLUMBIA, October, 2009

caching and SPAN in same system



WebCT



FC

Access Matrix

Lampson's Access Control Matrix

Subjects (users) index the rows

Objects (resources) index the columns

	OS	Accounting program	Accounting data	Insurance data	Payroll data
Bob	rx	rx	r	---	---
Alice	rx	rx	r	rw	rw
Sam	rwx	rwx	r	rw	rw
Accounting program	rx	rx	rw	rw	rw

why access matrix is not used

Access control matrix has all relevant info

But how to manage a large access control (AC) matrix?

Could be 1,000's of users, 1,000's of resources

Then AC matrix with 1,000,000's of entries

Need to check this matrix before access to any resource is allowed

Hopelessly inefficient

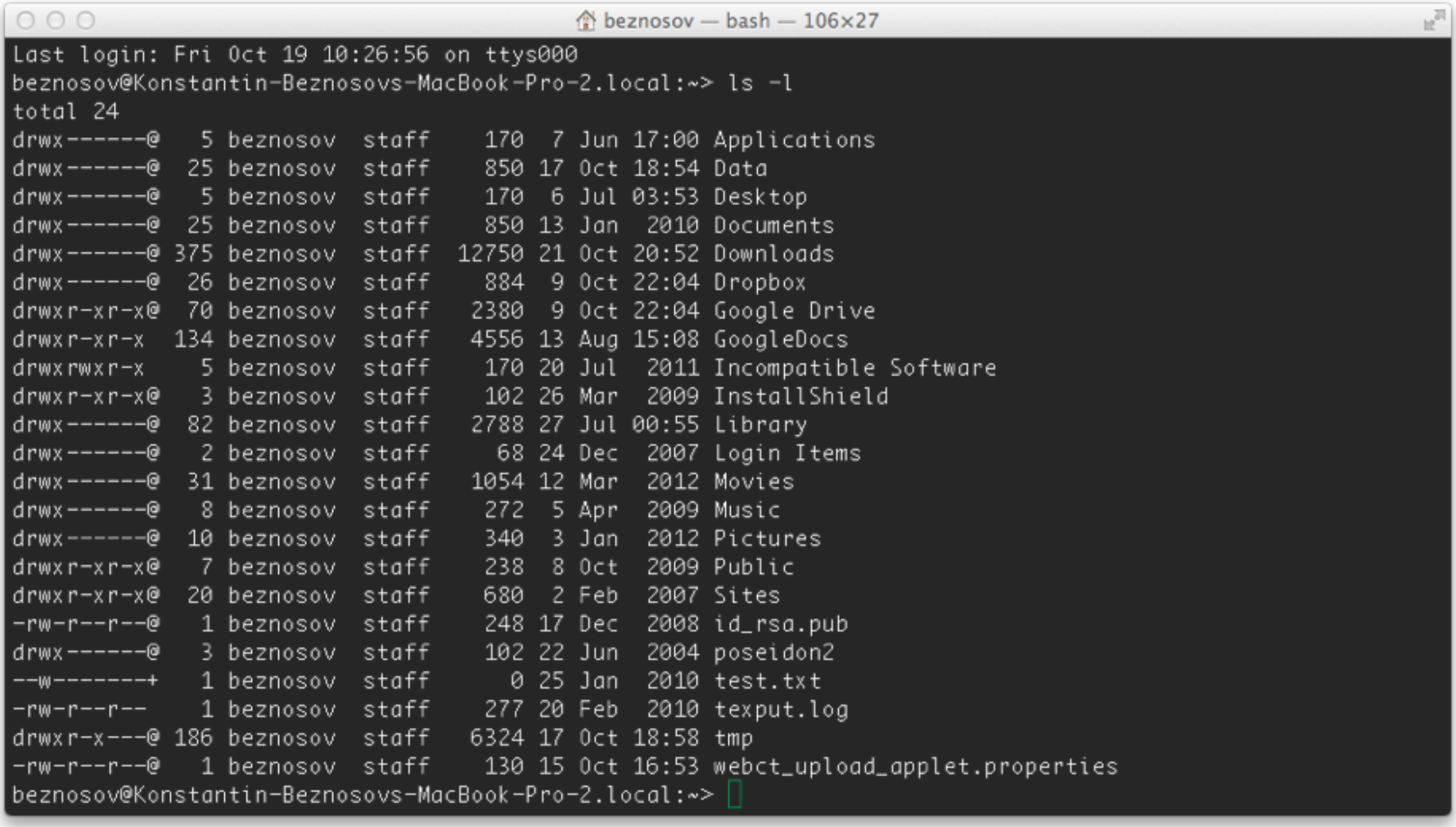
Access Control Lists

ACL: store access control matrix by **column**

Example: ACL for **insurance data** is in **yellow**

	OS	Accounting program	Accounting data	**Insurance data**	Payroll data
Bob	rx	rx	r	---	---
Alice	rx	rx	r	rw	rw
Sam	rwx	rwx	r	rw	rw
Accounting program	rx	rx	rw	rw	rw

example: MacOS X



Capabilities (or C-Lists)

Store access control matrix by **row**

Example: Capability for **Alice** is in **blue**

	OS	Accounting program	Accounting data	Insurance data	Payroll data
Bob	rx	rx	r	---	---
Alice	rx	rx	r	rw	rw
Sam	rwx	rwx	r	rw	rw
Accounting program	rx	rx	rw	rw	rw

example: OAuth v2

```
access_token = document.location.hash;
```

skip authentication if user has logged into the IdP in the same browser

horization if
d already

User/
Browser

Login with Facebook

JavaScript

redirect_uri

app_id, scope, redirect_uri, response=token

redirect_uri#access_token= access token

Relying Party (RP)

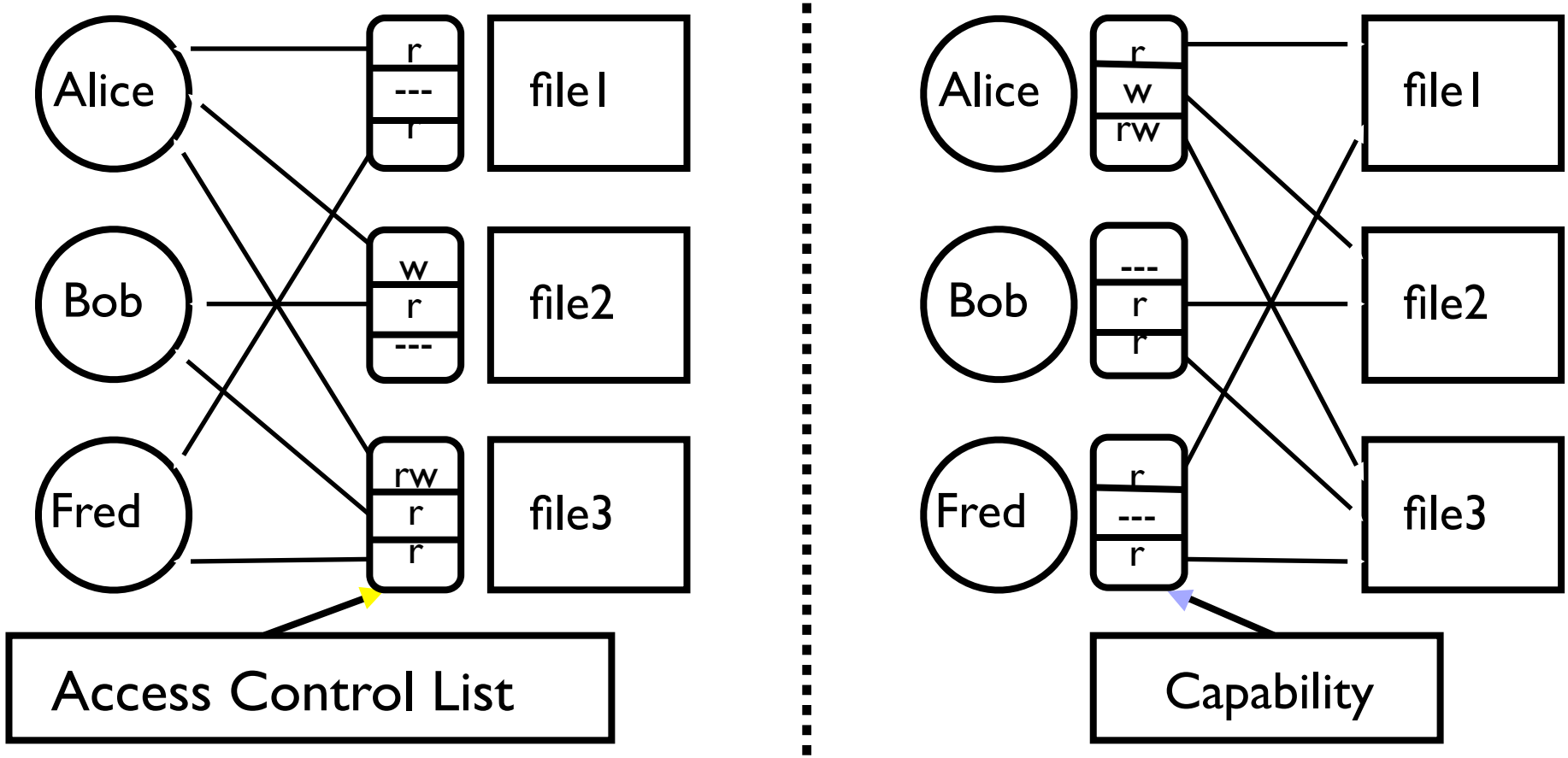
Identity provider (IdP)

facebook

Google

Windows Live

ACLs vs Capabilities



Note that arrows point in opposite directions!

With ACLs, still need to associate users to files

ACLs vs Capabilities

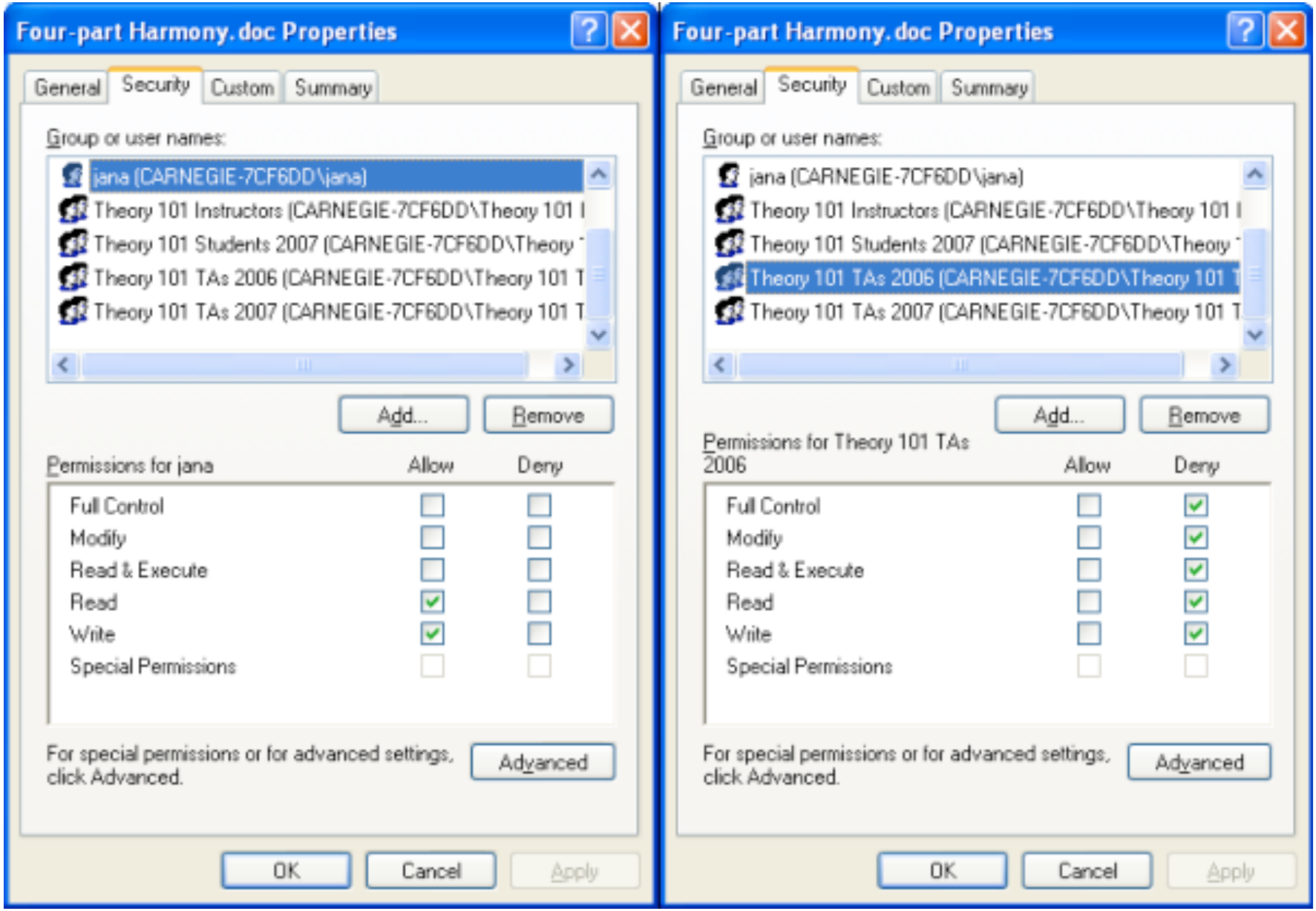
ACLs

- Good when users manage their own files
- Protection is data-oriented
- Easy to change rights to a resource

Capabilities

- Easy to delegate
- Easy to add/delete users
- Easier to delegate rights
- Harder to control the delegation
- More difficult to implement
- The "Zen of information security"

can jana read Four-part Harmony.doc?



source: http://www.robreeder.com/projects/xgrids.html

can jana read Four-part Harmony.doc?

source: http://www.robreeder.com/projects/xgrids.html

Security Policies

what's secure system?

- Secure system
  - Starts in authorized state
  - Never enters unauthorized state

  If the system enters any of these states, it's a security violation

  Authorized state in respect to what?

  Policy partitions system states into:
  - Authorized (secure)
    - These are states the system can enter
  - Unauthorized (nonsecure)

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CIA

What's Confidentiality?

X set of entities, I information

I has confidentiality property with respect to X if no $x \in X$ can obtain information from I

I can be disclosed to others

Example:

- X set of students
- I final exam answer key
- I is confidential with respect to X if students cannot obtain final exam answer key

what's confidentiality policy?

Goal: prevent the unauthorized disclosure of information

- Deals with information flow
- Integrity incidental

Multi-level security models are best-known examples

- Bell-LaPadula Model basis for many, or most, of these

What's Integrity?

X set of entities, I information

I has integrity property with respect to X if all x ∈

X trust information in I

Examples?

Types of Access Control Policies

Discretionary Access Control (DAC, IBAC)

- individual user sets access control mechanism to allow or deny access to an object

Mandatory Access Control (MAC)

- system mechanism controls access to object, and individual cannot alter that access

Originator Controlled Access Control (ORCON)

- originator (creator) of information controls who can access information

Multilevel Security (MLS) Models

Classifications and Clearances

Classifications apply to **objects**

Clearances apply to **subjects**

US Department of Defense uses 4 levels of classifications/clearances

TOP SECRET

SECRET

CONFIDENTIAL

UNCLASSIFIED

Clearances and Classification

To obtain a **SECRET** clearance requires a routine background check

A **TOP SECRET** clearance requires extensive background check

Practical classification problems

- Proper classification not always clear
- Level of granularity to apply classifications
- Aggregation — flipside of granularity

Subjects and Objects

Let O be an **object**, S a **subject**

O has a classification

S has a clearance

- Security **level** denoted L(O) and L(S)

For DoD levels, we have

TOP SECRET > SECRET > CONFIDENTIAL > UNCLASSIFIED

Multilevel Security (MLS)

MLS needed when subjects/objects at different levels use same system

MLS is a form of **Access Control**

Classified government/military information

Business example: info restricted to

- Senior management only
- All management
- Everyone in company
- General public

Network firewall

- Keep intruders at low level to limit damage

Confidential medical info, databases, etc.

Example

security level	subject	object
Top Secret	Alice	Personnel Files
Secret	Bob	E-Mail Files
Confidential	Chiang	Activity Logs
Unclassified	Fred	Telephone Lists

Alice can read all files

Chiang cannot read Personnel or E-Mail Files

Fred can only read Telephone Lists

Bell-LaPadula

BLP security model designed to express essential requirements for MLS

BLP deals with **confidentiality**

- To prevent unauthorized reading

Recall that O is an object, S a subject

- Object O has a classification
- Subject S has a clearance
- Security level denoted $L(O)$ and $L(S)$

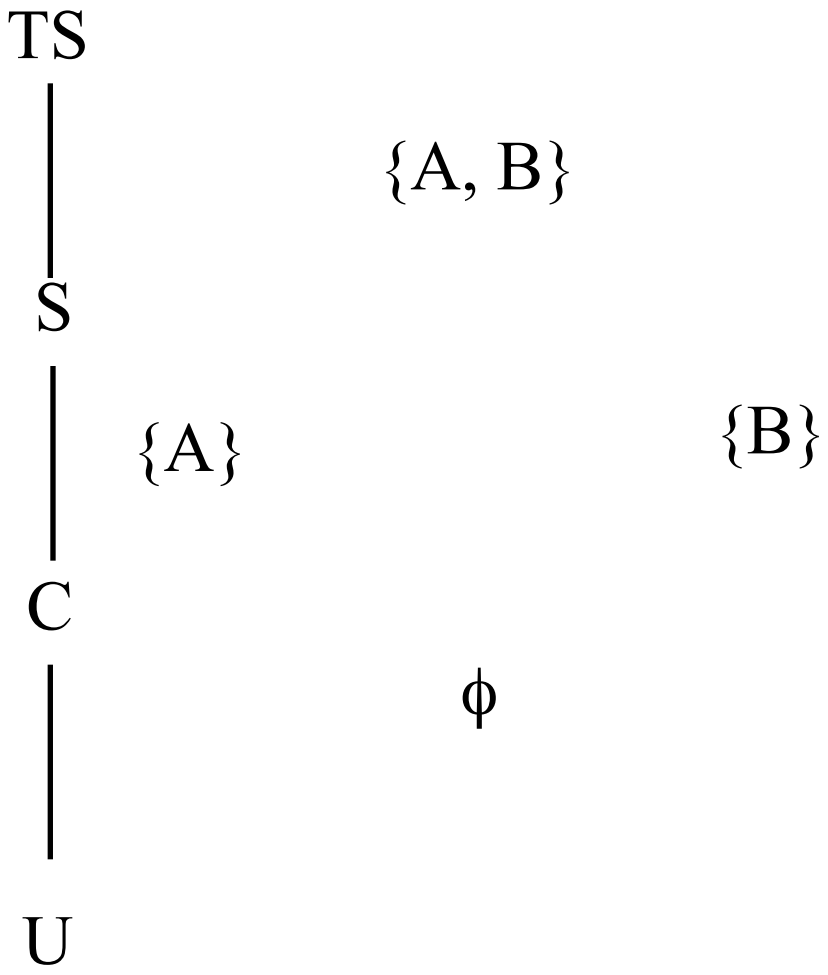
BLP rules

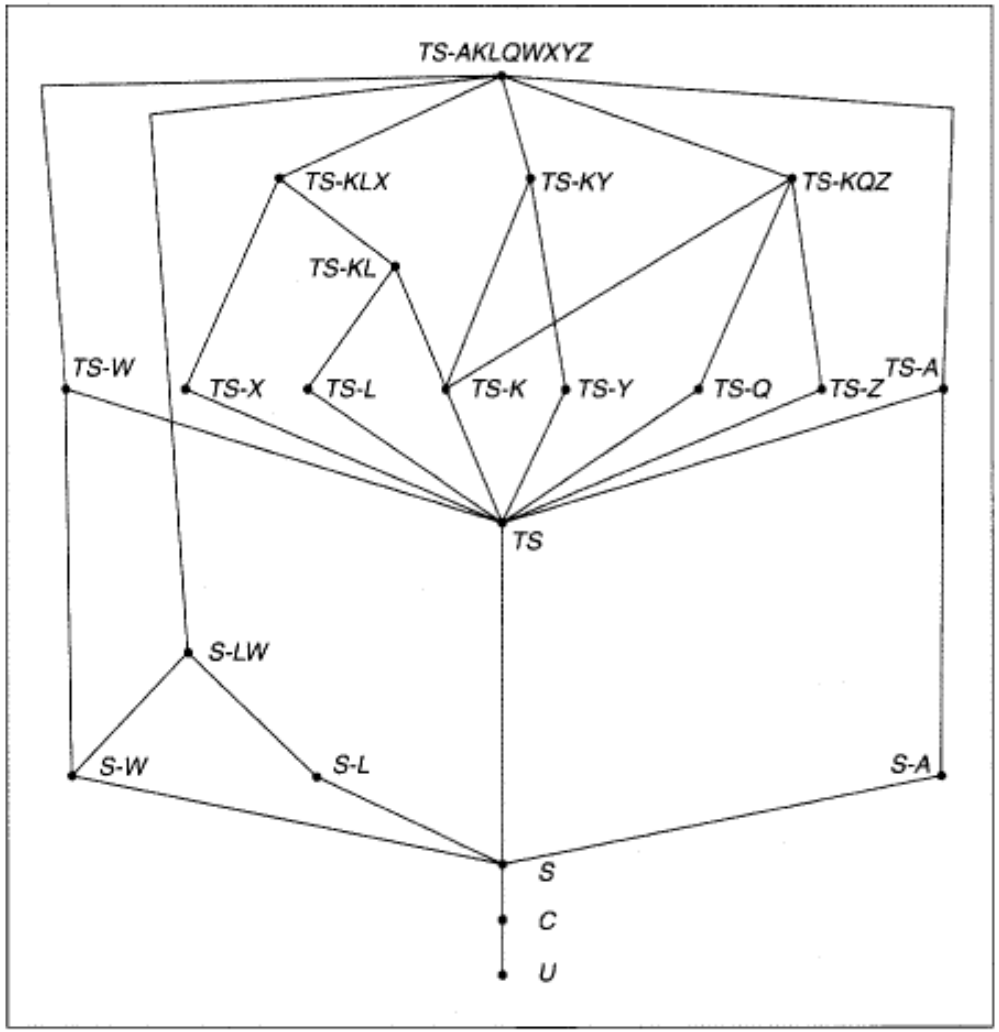
Simple Security Condition: S can read O if and only if L(O) ≤ L(S)

***-Property** (**Star Property**): S can write O if and only if L(S) ≤ L(O)

No read up, no write down

The Military Lattice





Key Points Regarding Confidentiality Policies

Confidentiality policies restrict flow of information

Bell-LaPadula model supports multilevel security

Cornerstone of much work in computer security

Chinese Wall Model

What's Chinese Wall Model

Problem:

Tony advises American Bank about investments

He is asked to advise Toyland Bank about investments

Conflict of interest to accept, because his advice for either bank would affect his advice to the other bank

Organization

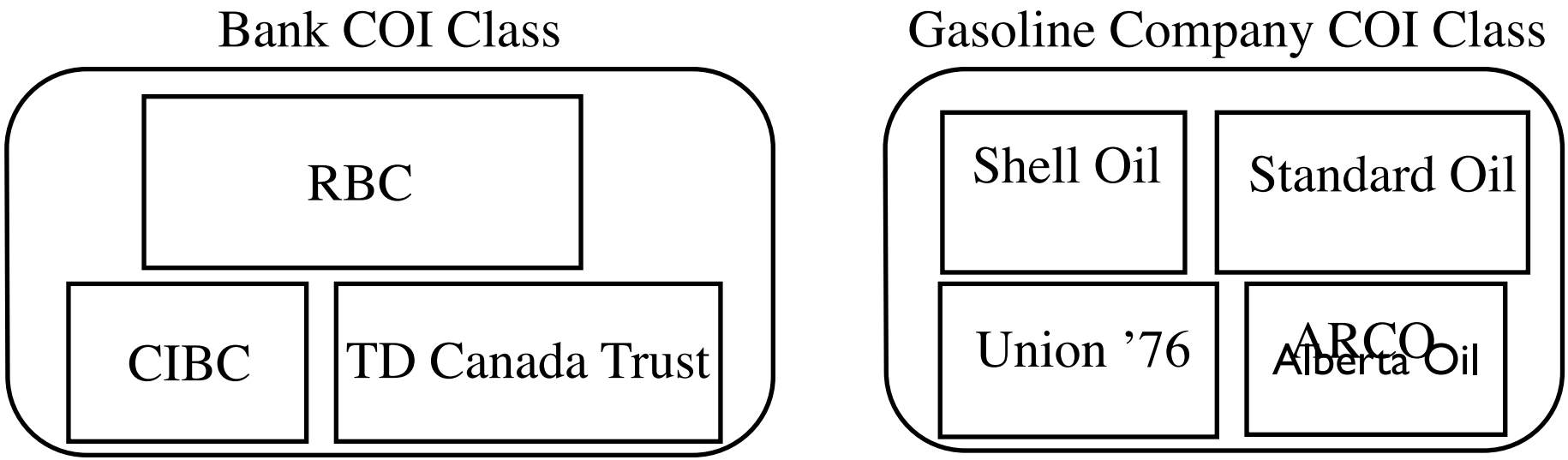
Organize entities into “conflict of interest” classes

Control subject accesses to each class

Control writing to all classes to ensure information is not passed along in violation of rules

Allow sanitized data to be viewed by everyone

Example



- If Anthony reads any Company dataset (CD) in a conflict of interest (COI), he can never read another CD in that COI
  - Possible that information learned earlier may allow him to make decisions later

Role-based Access Control (RBAC)

RBAC

Access depends on role, not identity or label

Example:

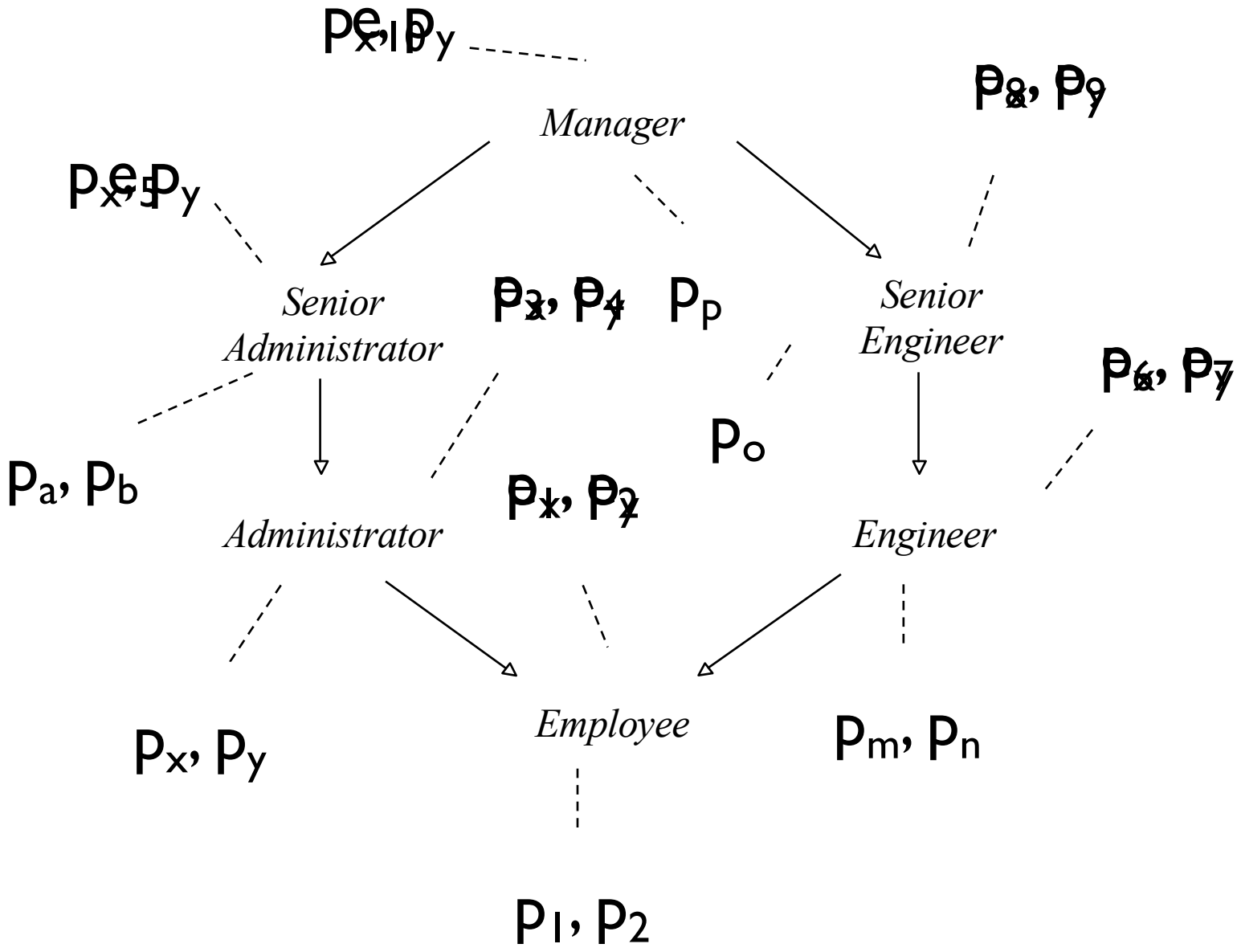
Allison, administrator for a department, has access to financial records.

She leaves.

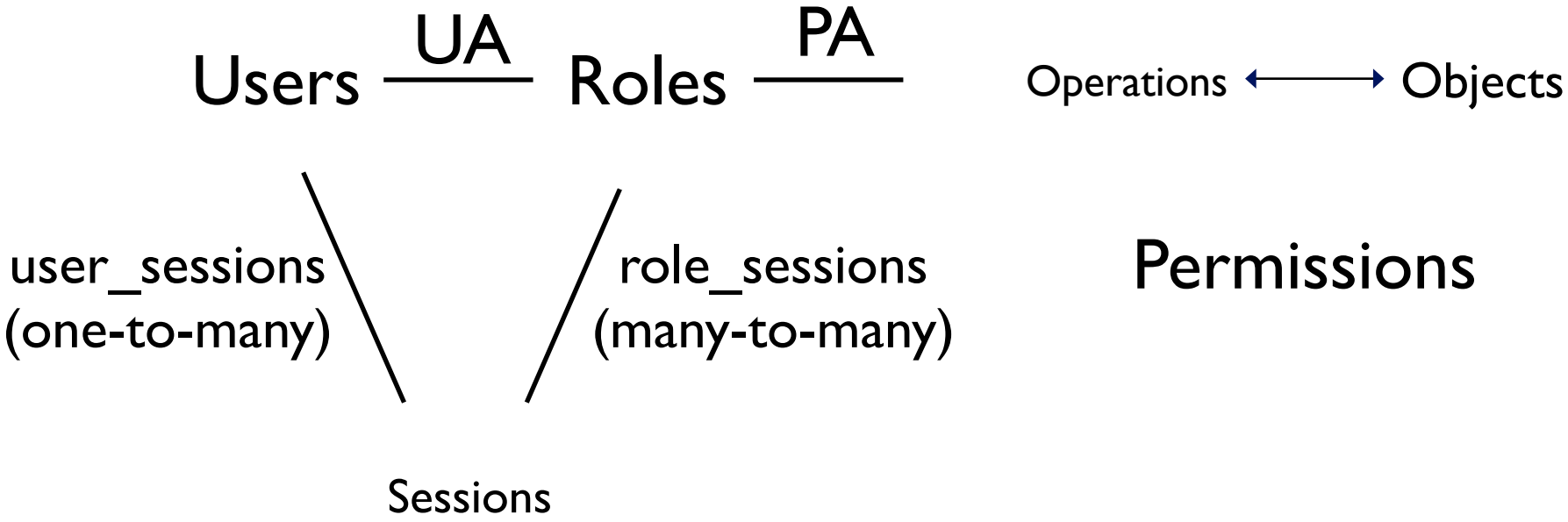
Betty hired as the new administrator, so she now has access to those records

The role of "administrator" dictates access, not the identity of the individual.

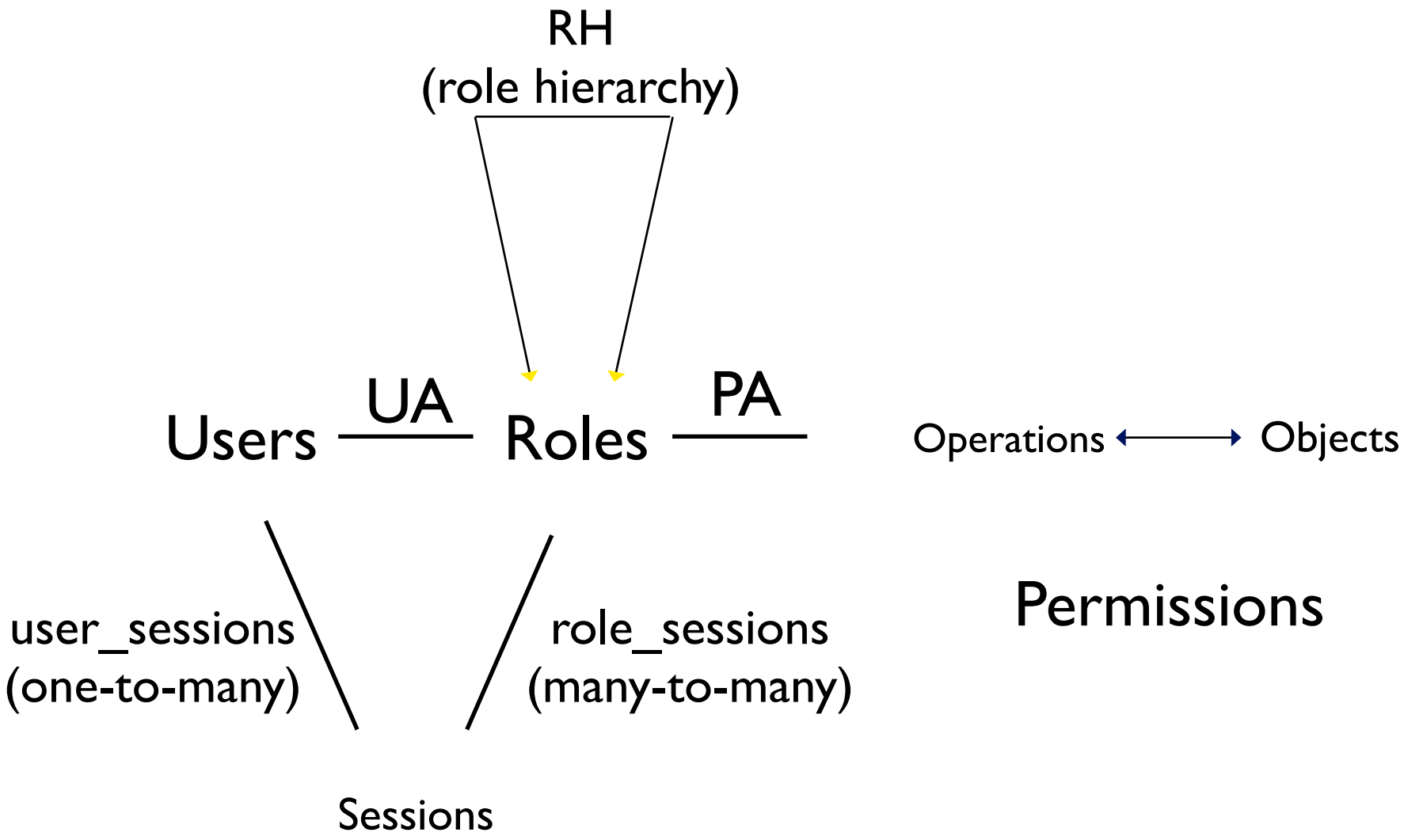
Example


Manager
Senior Administrator
Senior Engineer
Administrator
Engineer
Employee
Pa, Pb
Px, Py
Pm, Pn
P1, P2

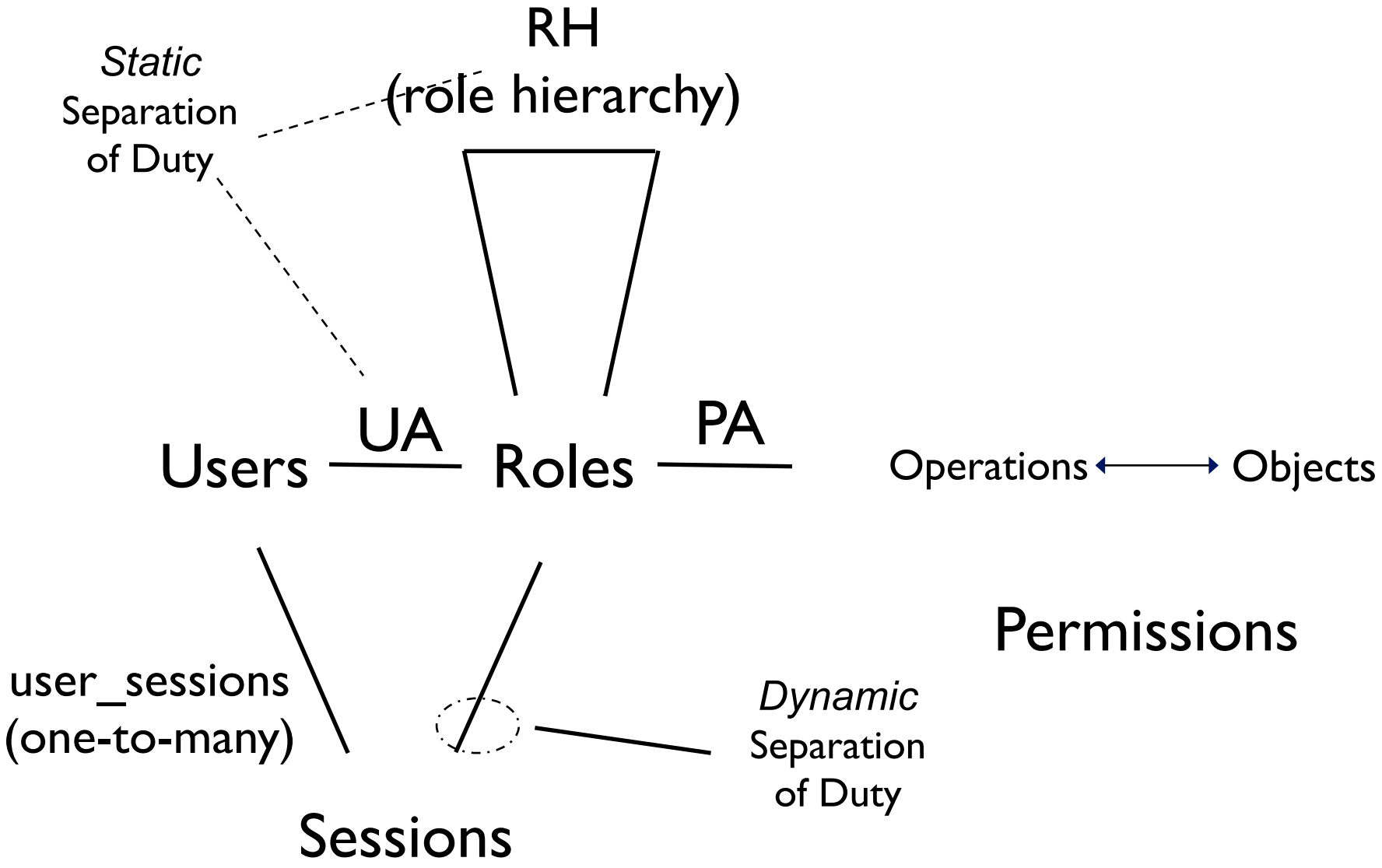
RBAC (ANSI Standard)



RBAC with General Role Hierarchy



Constrained RBAC



what we learned so far

structure of access controls (PEP & PDP)

access matrix

- ACLs and capability lists

security policies

- confidentiality & integrity
- types of policies (DAC, MAC, OrCon)

BLP model

Chinese Wall model

RBAC model