CIS 4360
Secure Computer Systems

Access Control

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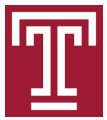
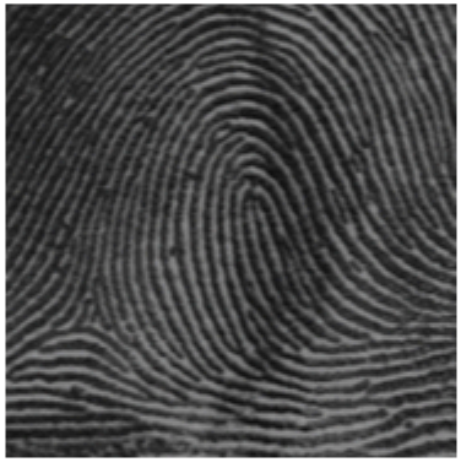
Spring 2017

Previous Class

- Biometrics
  - Measurement and applications of human characteristics
- Applications
- Advantages and Disadvantages
- False rejection rate; false acceptance rate
- Case Studies
  - Fingerprint
  - Iris



Face



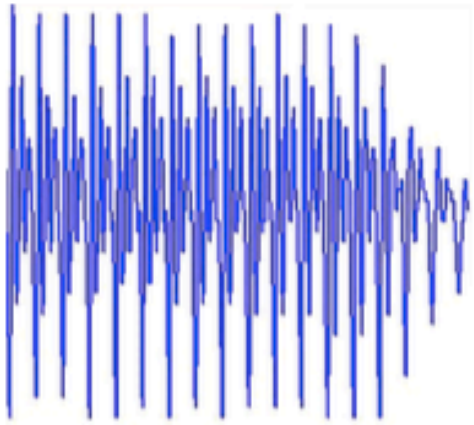
Fingerprint

Iris

Hand geometry

Palmprint

Signature

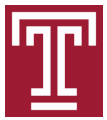


Voice

Gait

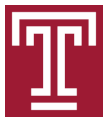
Outline

- Concepts of Access Control
- Access Matrix, Access Control List, Capabilities
- Main Types of Access Control Policies
  - DAC
  - MAC
  - RBAC



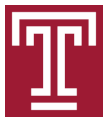
Access Control

- Access Control: the process of restricting access to resources according to a security policy
  - A security policy regulates who can do what
  - Access control implements a security policy
- Authorization: the action of granting access
- Access Control usually starts from Authentication (i.e., verifying the identity of a user)



Examples of Access Control

- The Temple's Blackboard system
- Operating Systems
- Database systems
- Governments
- Intelligence Departments
- …



Question

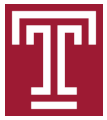
Consider “Entering a Temple building” as an example, point out “Policy”, “Access Control”, “Authentication”, “Authorization”

Policy: only Temple students, faculty and employees or verified visitors are allowed to enter the building

Access Control: the process of restricting people who can enter the building

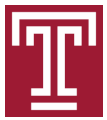
Authentication: verifying the identity of a person

Authorization: allowing a person to enter the building



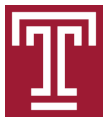
Concepts

- Subjects: entities to access resources
  - Users, processes, threads
- Objects: resources whose access is controlled
  - Files, relations, memory
- Access Rights: actions that are taken
  - Read, Write, Execute, Delete, Create, Search



Goals of Access Control

- Confidentiality (Secrecy)
- Integrity



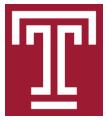
Question

To achieve confidentiality, is it sufficient by correctly restricting the read operation only?

It is insufficient. A malicious or buggy subject (e.g., a process) may read information from a sensitive file and then write to a file accessible by public

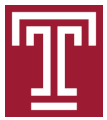
Sensitive Object -> Subject -> Non-sensitive object -> Public

Therefore, the access control has to regulate not only read but also write



Access (Control) Matrix

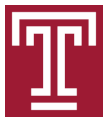
- An Access Matrix describes the rights of each subject with regard to each object in an Access Control system at some point of time
- But it does NOT model the rules by which rights are changed; thus, it is not equal with the access control policy



Access Matrix

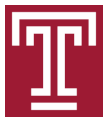
	File 1	File 2	File 3	File 4
User A	Own Read Write		Own Read Write	
User B	Read	Own Read Write	Write	Read
User C	Read Write	Read		Own Read Write

Disadvantage: it does not scale well



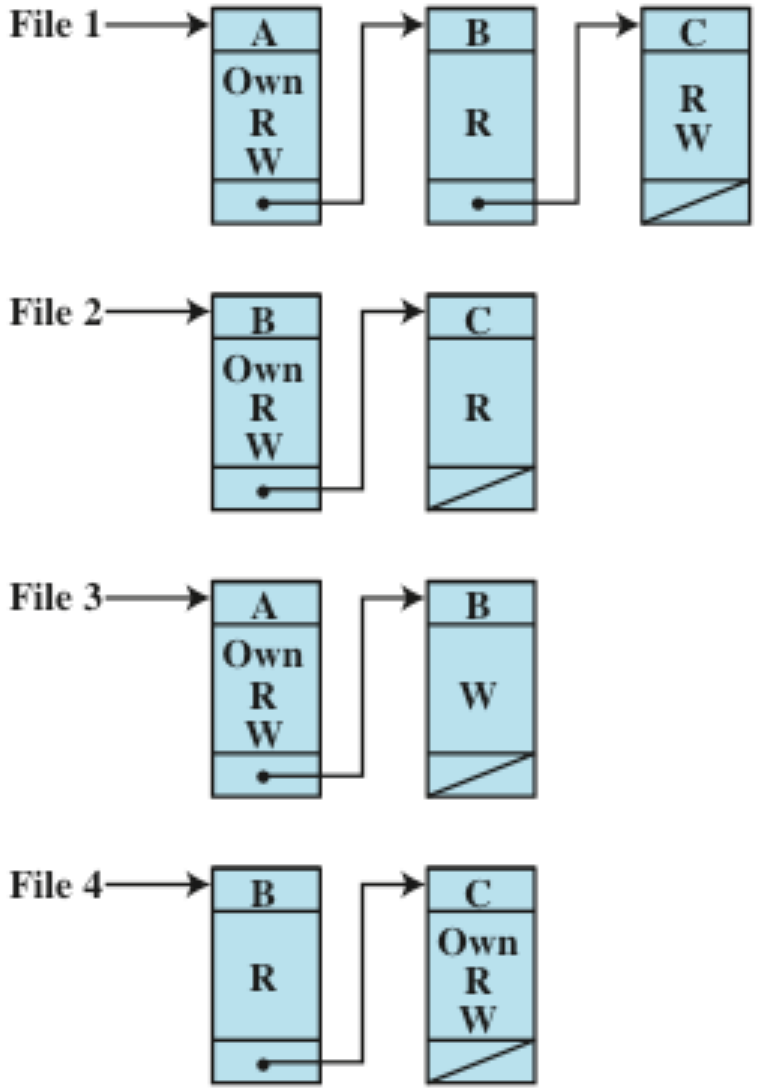
Three Ways to Express the Access Matrix

- One Access Tuple per cell:
  - <subject, object, rights>
  - E.g., <Bob, File2, read/write>
- One Access Control List per object (column)
- One Capability List per subject (row)

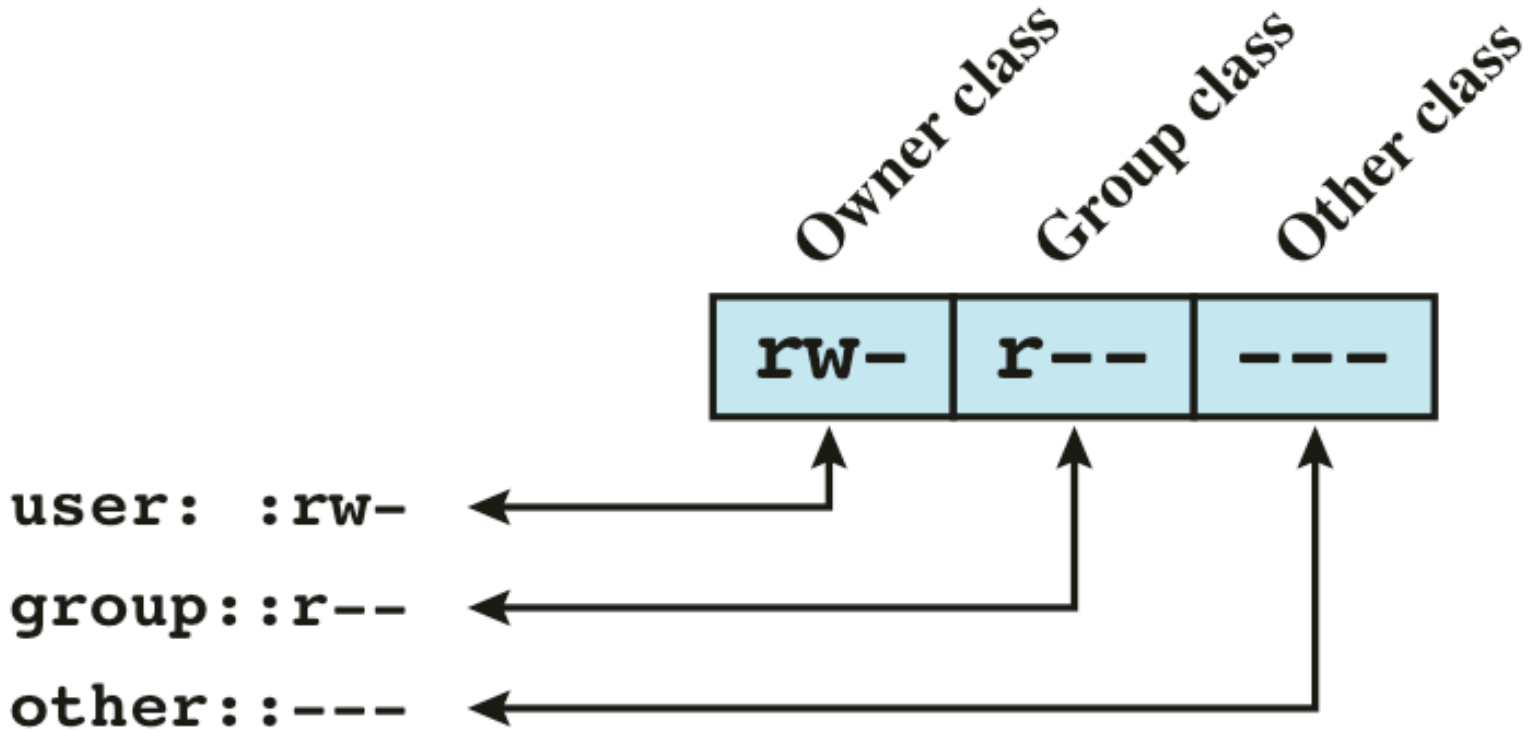


Access Control Lists

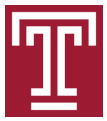
- An ACL is a list of subjects and their rights to an object
- One ACL per object
- It is difficult to find out all files accessible by a given user
- Widely used in Unix/ Linux/Windows



Access Control Lists in Unix

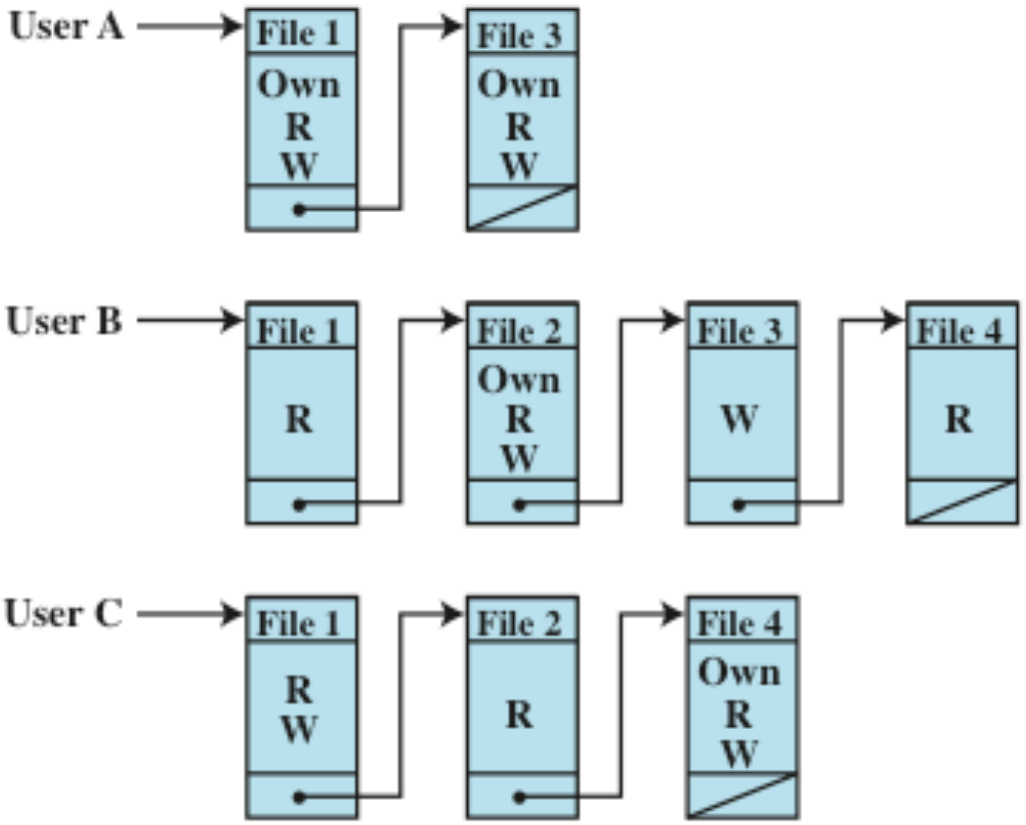


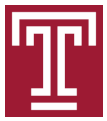
(a) Traditional UNIX approach (minimal access control list)



Capability Lists

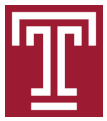
- A Capability List is the list of objects accessible by a subject and the corresponding rights





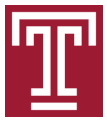
Capability in real-world

- int fd = open("/etc/passwd", O_RDWR);
- fd is an index into the process's file descriptor table, which can be regarded as a runtime capability list
- Each file descriptor is a capability
  - For all subsequent read/write/seek operations, one critical parameter being passed is "fd"
- It is unforgeable by a user program, as the file descriptor table is stored in kernel space



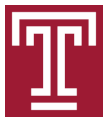
Types of Access Control Policies

- Discretionary Access Control (DAC)
- Mandatory Access Control (MAC)
- Role-Based Access Control (RBAC)
- …



Discretionary Access Control (DAC)

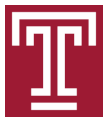
- DAC means subjects themselves can grant rights to other subjects
  - E.g., in Unix/Linux, the owner of a file can set up and change the ACL of the file
- Convenient but cannot achieve the goals of confidentiality and integrity
  - Subjects make decisions about access permissions; the decisions may be bad decisions



Question

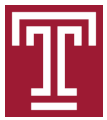
There are two ACLs defined in a DAC system, File 1: <Alice: write, Bob: read>, File 2: <Bob: write, Charlie: read>. The confidentiality goal is that "Alice does not leak info to Charlie". Can this goal be achieved here?

No. Alice -> File1 -> Bob -> File2 -> Charilie



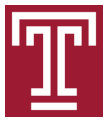
MAC

- A *mandatory access control* (MAC) policy is a means of assigning access rights based on regulations by a central authority
- The underlying philosophy the information in a file belongs to the organization rather than the file owner. So it should be the organization who assigns access rights and regulates the information flow



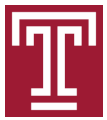
A Simple Example of MAC

- In Military department, there are four levels of clearance
  - Unclassified
  - Confidential
  - Secret
  - Top Secret
- Assume you, as an employee, created a file labeled as <“Secret”, Nuclear>
  - You are not allowed to decide who can access the file
  - People who have the “Secret” or “Top Secret” clearance and the Nuclear duty can access the file



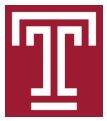
Role Based Access Control (RBAC)

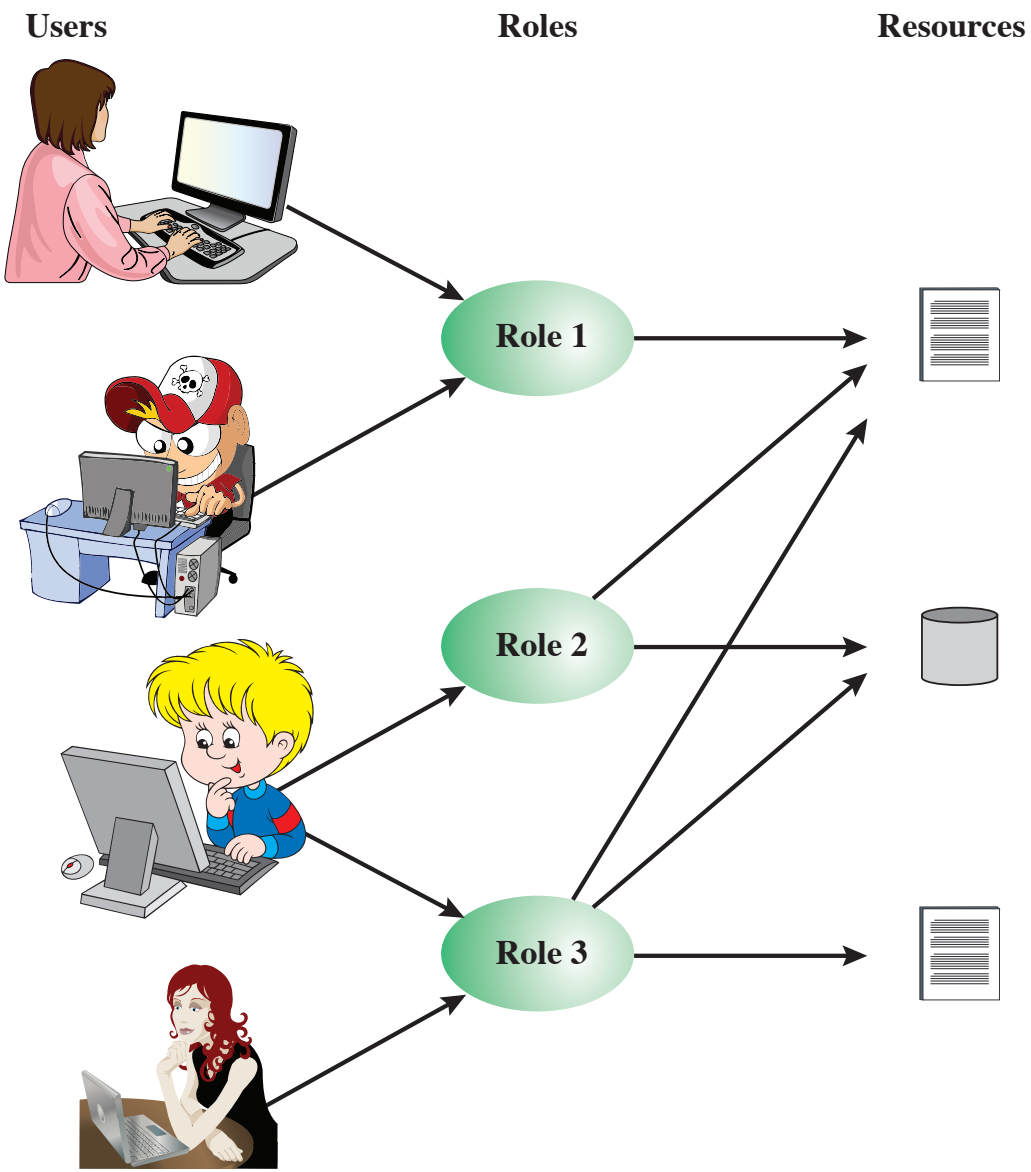
- In the real world, especially in enterprises, the responsibilities of a person change dynamically
  - In a large company, every day many people change their jobs
  - Is there a convenient way to access control?
- Role Based Access Control assign access rights to roles rather than subjects
- A *role* is a job function or title and can be translated to rights in a RBAC system

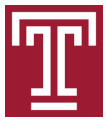


The Principle of Least Privilege

- A user can be assigned with multiple roles
- But when a user logs in, she can only activate one role
- This complies with the Principle of Least Privilege. That is, one is granted rights just needed to finish the intended task

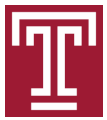



Users
Roles
Resources
Role 1
Role 2
Role 3



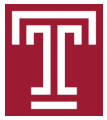
Role vs. Group

- A role is a job title, while a group is a set of users
- A user can have zero or one active role at any given time, but can belong to many groups at any time



Summary

- Concepts
  - Access Control
  - Subject, Object
- Goals of Access Control
  - Confidentiality
  - Integrity
- Access Matrix
  - View of Columns: Access Control Lists
  - View of Rows: Capability Lists
- Types of Access Control Policies
  - DAC
  - MAC
  - RBAC



Writing Assignments

- In which scenarios DAC, MAC and RBAC should be used, respectively?
- Does RBAC belong to DAC or MAC?