Access Control

ITS335: IT Security

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Access Control Concepts

Discretionary Access Control

Role-Based Access Control

Mandatory Access Control

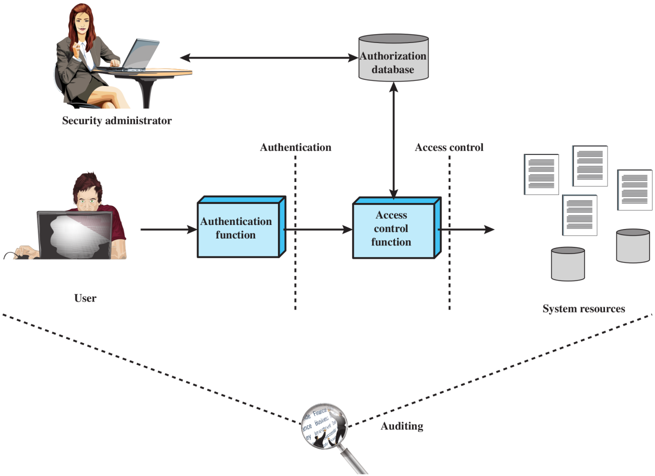
Summary

Access Control

The prevention of unauthorized use of a resource, including the prevention of use of a resource in an unauthorized manner.

— ITU-T Recommendation X.800 “Security architecture for Open Systems Interconnection”

Relationship Among Access Control and Other Security Functions



Credit: Figure 4.1 in Stallings and Brown, *Computer Security*, 2nd Ed., Pearson 2012

Access Control and Other Security Functions

Authentication	verification that the credentials of a user or other entity are valid
Authorization	granting of a right or permission to a system entity to access a resource
Audit	independent review of system records and activities in order to test for adequacy of system control, ensure compliance to policy, detect breaches and recommend changes

Access Control Policies

Discretionary Access Control use identity of requestor and access rules (that determine what requestor is allowed to do) to control access; entities may allow other entities to access resources

Mandatory Access Control compare security labels with security clearances to determine access; entities cannot grant access to resources to other entities

Role-based Access Control roles of users in system and rules for roles are used to control access

DAC, MAC and RBAC are not mutually exclusive

General Requirements of Access Control

- Reliable input
- Fine and coarse specifications
- Least privilege
- Separation of duty
- Open and closed policies
- Policy combinations and conflict resolution
- Administrative policies
- Dual control

Basic Elements of Access Control System

Subject entity capable of access resources
- Often subject is a software process
- Classes of subject, e.g. Owner, Group, World

Object resource to which access is controlled
- E.g. records, blocks, pages, files, portions of files, directories, email boxes, programs, communication ports

Access right describes way in which a subject may access an object
- E.g. read, write, execute, delete, create, search

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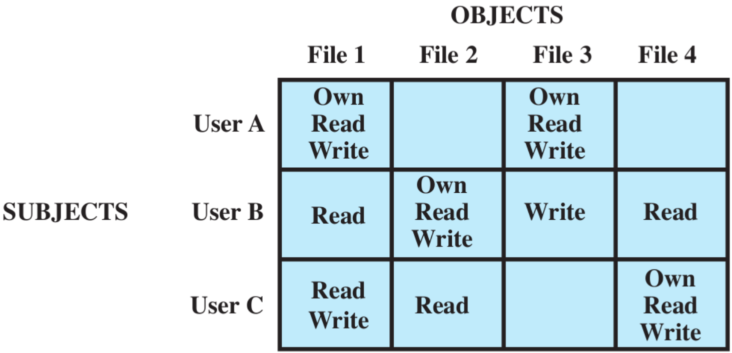
Discretionary Access Control

- DAC: an entity may be granted access rights that permit the entity, if they choose so, to enable another entity to access a resource
- Common access control scheme in operating systems and database management systems
- Access Matrix specifies access rights of subjects on objects
- In practice, access matrix is sparse, so implement as either:

  Access Control Lists (ACL) For each object, list subjects and their access rights

  Capability Lists For each subject, list objects and the rights the subject have on that object
- Alternative implementation: authorization table listing subject, access mode and object; easily implemented in database

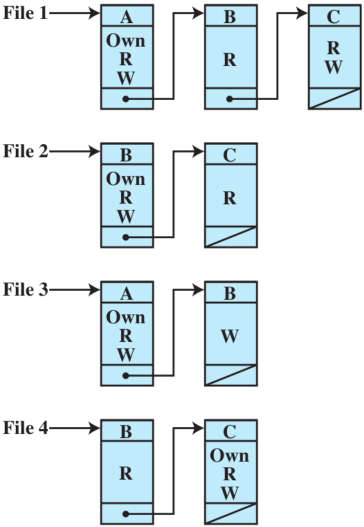
Example of DAC Access Matrix



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

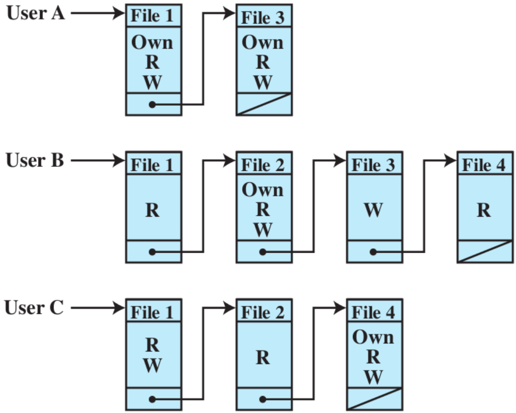
Credit: Figure 4.3(a) in Stallings and Brown, *Computer Security*, 2nd Ed., Pearson 2012

Example of Access Control Lists



Credit: Figure 4.3(b) in Stallings and Brown, *Computer Security*, 2nd Ed., Pearson 2012

Example of Capability Lists



Credit: Figure 4.3(c) in Stallings and Brown, *Computer Security*, 2nd Ed., Pearson 2012

Example of Authorization Table

Subject	Access Mode	Object
A	Own	File 1
A	Read	File 1
A	Write	File 1
A	Own	File 3
A	Read	File 3
A	Write	File 3
B	Read	File 1
B	Own	File 2
B	Read	File 2
B	Write	File 2
B	Write	File 3
B	Read	File 4
C	Read	File 1
C	Write	File 1
C	Read	File 2
C	Own	File 4
C	Read	File 4
C	Write	File 4

Credit: Table 4.1 in Stallings and Brown, *Computer Security*, 2nd Ed., Pearson 2012

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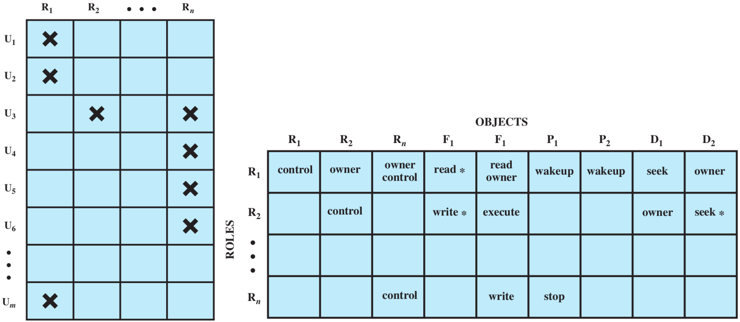
Role-Based Access Control

- RBAC: users are assigned to roles; access rights are assigned to roles
- Roles typically job functions and positions within organisation, e.g. senior financial analyst in a bank, doctor in a hospital
- Users may be assigned multiple roles; static or dynamic
- Sessions are temporary assignments of user to role(s)
- Access control matrix can map users to roles and roles to objects

Example of RBAC Access Control Matrix



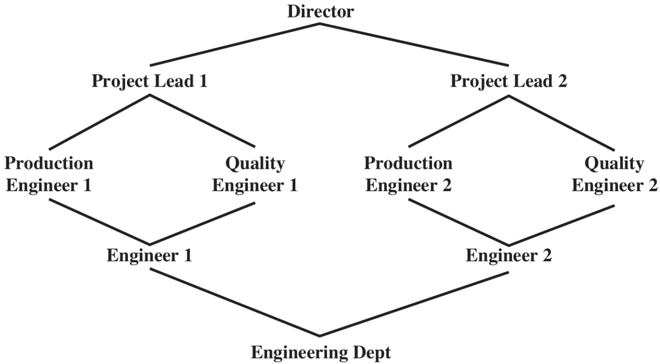
	R_1	R_2	• • •	R_n
U_1	✖			
U_2	✖			
U_3		✖		✖
U_4				✖
U_5				✖
U_6				✖
⋮				
U_m	✖			

		OBJECTS								
		R_1	R_2	R_n	F_1	F_1	P_1	P_2	D_1	D_2
ROLES	R_1	control	owner	owner control	read *	read owner	wakeup	wakeup	seek	owner
	R_2		control		write *	execute			owner	seek *
	⋮									
	R_n			control		write	stop			

Credit: Figure 4.8 in Stallings and Brown, *Computer Security*, 2nd Ed., Pearson 2012

Hierarchies in RBAC

- Hierarchy of an organisation can be reflected in roles
- A higher role includes all access rights of lower role



Credit: Figure 4.10 in Stallings and Brown, *Computer Security*, 2nd Ed., Pearson 2012

Constraints in RBAC

- Constraints define relationships between roles or conditions on roles
- A higher role includes all access rights of lower role
- Mutually exclusive roles: user can only be assigned to one role in the set
- Cardinality: maximum number with respect to roles, e.g.
    - maximum number of users assigned to a role
    - maximum number of roles a user can be assigned to
    - maximum number of roles that can be granted particular access rights
- Prerequisite: condition upon which user can be assigned a role, e.g.
    - user can only be assigned a senior role if already assigned a junior role

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Mandatory Access Control

- Based on multilevel security (MLS)

  top secret > secret > confidential > restricted > unclassified

- Subject has security clearance of a given level
- Object has security classification of a given level
- Two required properties for confidentiality:

  No read up Subject can only read an object of less or equal security level

  No write down Subject can only write into object of greater or equal security level

- Clearance and classification is determine by administrator; users cannot override security policy
- Bell-LaPadula model formally defines multilevel security and MAC

Implementations of MAC

- SELinux: Linux kernel modules available to most Linux distributions (RedHat, Debian, Ubuntu, SuSE, . . .)
- AppArmor: some Linux distributions (Ubuntu, SuSE)
- TrustedBSD: FreeBSD, OpenBSD, OSX, . . .
- Mandatory Integrity Control: Vista, Windows 7, Windows 8

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Key Points

- Access control to prevent unauthorized use of resources (objects) by subjects
- Subjects are processes on behalf of users and applications
- Classes of subjects: owner, group, world
- Objects: files, database records, disk blocks, memory segments, processes, . . .
- Access rights: read, write, execute, delete, create, . . .
- DAC: access rights may be granted to other subjects (common in operating systems and databases)
- RBAC: subjects take on role; access rights assigned to roles
- MAC: subjects/objects assigned to levels; subjects cannot modify assignment (e.g. military classification)

Security Issues

- Rely on correct assignment of capabilities/levels to subjects and objects by human administrator

Areas To Explore

- Trusted Computing and Trusted Platform Module (TPM)
- Secure Boot