NC STATE UNIVERSITY Computer Science

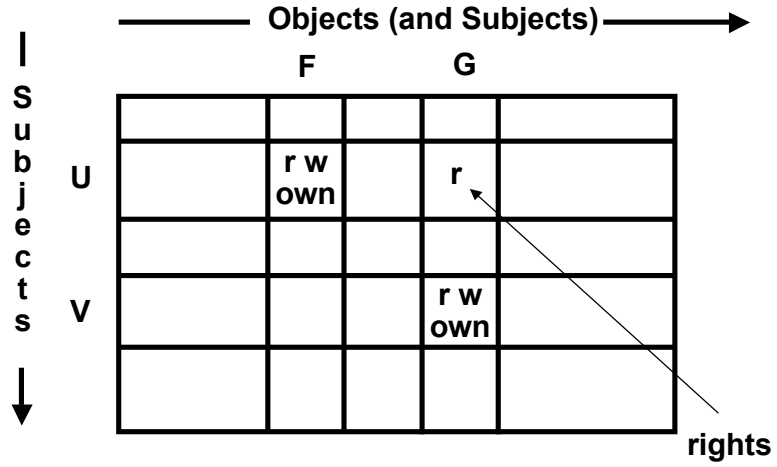
CSC 474/574 Information Systems Security

Topic 4.1: Basic Concepts of Access Control

Outline

- Access matrix model
- Access control lists versus Capabilities
- Content and context-based controls
- Discretionary versus mandatory controls
- Trojan Horses
- Bell-LaPadula model

ACCESS MATRIX MODEL

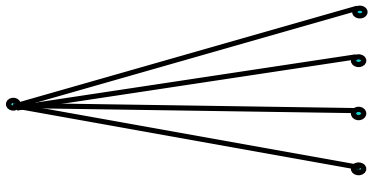


ACCESS MATRIX MODEL

- Basic Abstractions
  - Subjects
  - Objects
  - Rights
- The rights in a cell specify the access of the subject (row) to the object (column)

Users and Principals

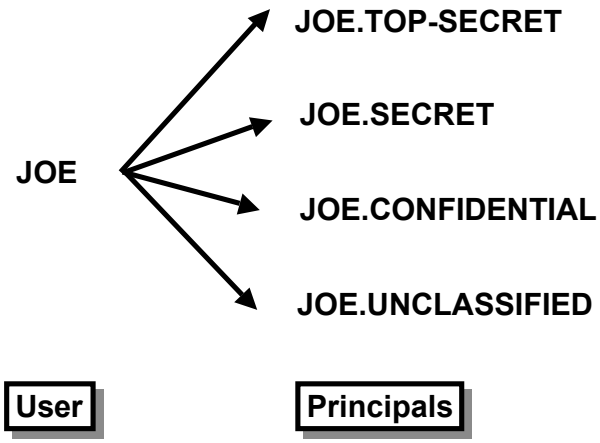
- The system authenticates the user in context of a particular principal



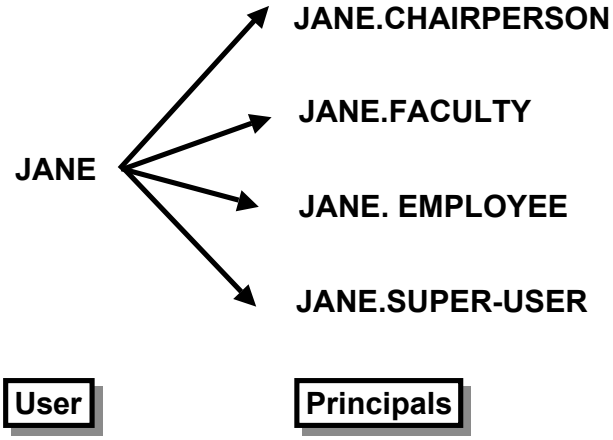
Users **Principals**

Real World User **Unit of Access Control**

Users and Principals



Users and Principals



Users and Principals

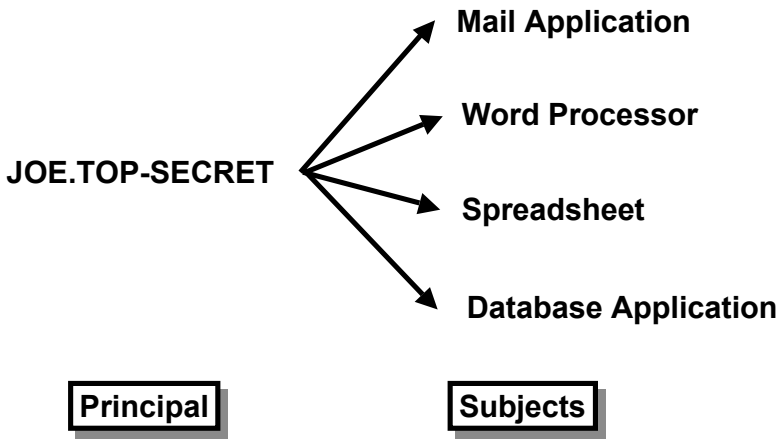
- There should be a one-to-many mapping from users to principals
  - a user may have many principals, but
  - each principal is associated with an unique user
- This ensures accountability of a user's actions

In other words, shared accounts (principals) are bad for accountability

Principals and Subjects

- A subject is a program (application) executing on behalf of a principal
- A principal may at any time be idle, or have one or more subjects executing on its behalf

Principals and Subjects



Principals and Subjects

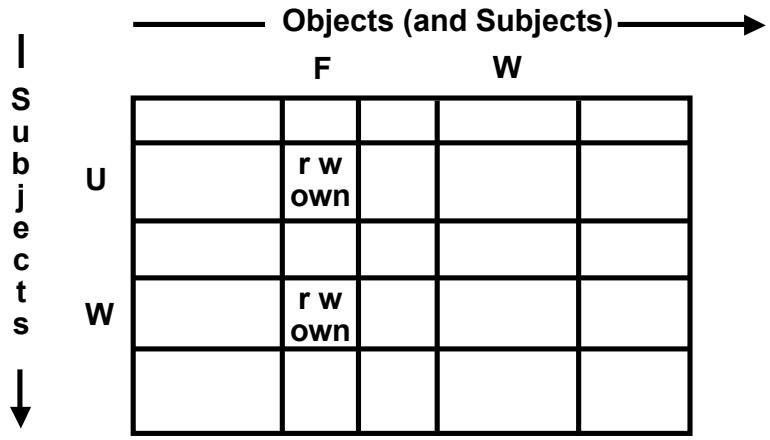
- Usually (but not always)
  - each subject is associated with a unique principal
  - all subjects of a principal have identical rights (equal to the rights of the invoking principal)
- This case can be modeled by a one-to-one mapping between subjects and principals

For simplicity, a principal and subject can be treated as identical concepts. On the other hand, a user should always be viewed as multiple principals

Objects

- An object is anything on which a subject can perform operations (mediated by rights)
- Usually objects are passive, for example:
  - File
  - Directory (or Folder)
  - Memory segment
- But, subjects can also be objects, with operations
  - kill
  - suspend
  - resume

ACCESS MATRIX MODEL

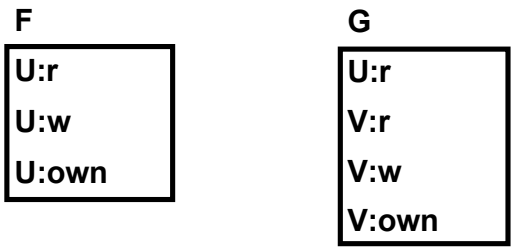


IMPLEMENTATION

- Access Control Lists
- Capabilities
- Relations

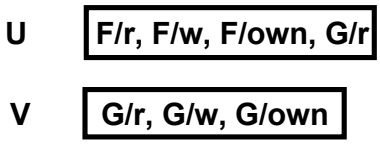
ACCESS CONTROL LISTS (ACLs)

- Each column of the access matrix is stored with the object corresponding to that column



CAPABILITY LISTS

- each row of the access matrix is stored with the subject corresponding to that row



ACCESS CONTROL TRIPLES

Subject	Access	Object
U	R	F
U	W	F
U	Own	F
U	R	G
V	R	G
V	W	G
V	Own	G

commonly used in relational database management systems

ACL'S VS CAPABILITIES

- ACLs require authentication of subjects
- Capabilities do not require authentication of subjects, but do require unforgeability and control of propagation of capabilities

ACL'S VS CAPABILITIES

- ACCESS REVIEW
  - ACL's provide for superior access review on a per-object basis
  - Capabilities provide for superior access review on a per-subject basis
- REVOCATION
  - ACL's provide for superior revocation facilities on a per-object basis
  - Capabilities provide for superior revocation facilities on a per-subject basis

ACL'S VS CAPABILITIES

- The per-object basis usually wins out so most Operating Systems protect files by means of ACL's
- Many Operating Systems use an abbreviated form of ACLs with just three entries
  - owner
  - group
  - other

ACL'S VS CAPABILITIES

- LEAST PRIVILEGE
  - Capabilities provide for finer grained least privilege control with respect to subjects, especially dynamic short-lived subjects created for specific tasks

CONTENT DEPENDENT CONTROLS

- content dependent controls such as
  - you can only see salaries less than 50K, or
  - you can only see salaries of employees who report to you
- are beyond the scope of Operating Systems and are provided by Database Management Systems

CONTEXT DEPENDENT CONTROLS

- context dependent controls such as
  - you cannot access classified information via a remote login
  - salary information can be updated only at year end
  - the company's earnings report is confidential until announced at the stockholders meeting
- can be partially provided by the Operating System and partially by the Database Management System
- more sophisticated context dependent controls such as based on past history of accesses definitely require Database support

DISCRETIONARY VERSUS MANDATORY

- Discretionary access controls (DAC)
  - Allow access rights to be propagated from one subject to another
  - Possession of an access right by a subject is sufficient to allow access to the object.
- Mandatory access controls (MAC)
  - Restrict the access of subjects to objects on the basis of security labels
    - Label both the subjects and the objects.
    - Allow a subject to access an object only when certain constraints are satisfied.

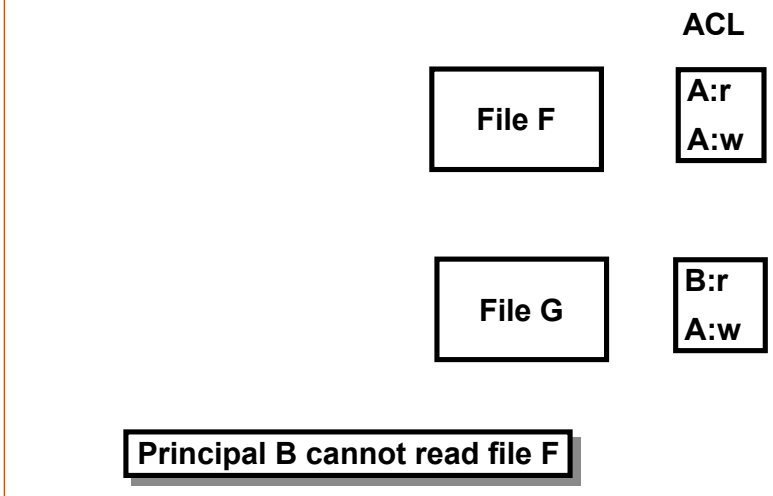
INHERENT WEAKNESS OF DAC

- Unrestricted DAC allows information from an object which can be read by a subject to be written to any other object
- Suppose our users are trusted not to do this deliberately. It is still possible for Trojan Horses to copy information from one object to another.

TROJAN HORSES

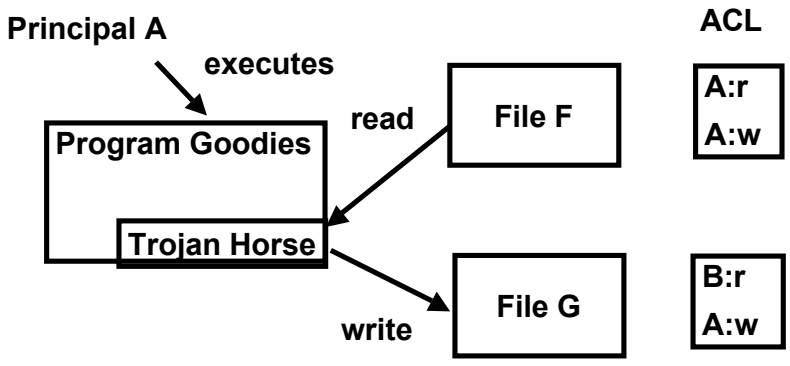
- A Trojan Horse is rogue software installed, perhaps unwittingly, by duly authorized users
- A Trojan Horse does what a user expects it to do, but in addition exploits the user's legitimate privileges to cause a security breach

TROJAN HORSE EXAMPLE



TROJAN HORSE EXAMPLE

- Principal B can read contents of file F copied to file G



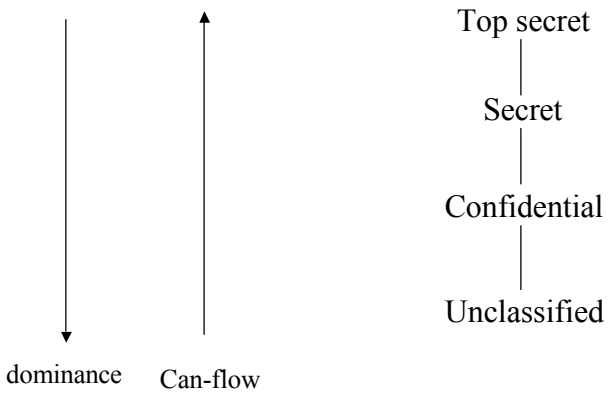
TROJAN HORSES

- Trojan Horses are the most insidious threat
- Viruses and logic bombs are examples of Trojan Horses
- It is possible to embed Trojan Horses in hardware and firmware
- It is possible to embed Trojan Horses in critical system software such as compilers and Database Management Systems

A Preview of A MAC Model

- Bell LaPadula (BLP) Model
  - Simple security: Subject S can read object O only if
    - Label(S) dominates label(O).
    - Information can flow from label(O) to label(S)
    - Intuitively, *no read up*
  - Star property: Subjects can write object O only if
    - Label(O) dominates label(S)
    - Information can flow from label(S) to label(O).
    - Intuitively, *no write down*.

BLP Model



Trojan Horse Example Again