Protection

Objectives

- Discuss the goals and principles of protection in a modern computer system
- Explain how protection domains combined with an access matrix are used to specify the resources a process may access
- Examine capability and language-based protection systems

Goals of Protection

- In one protection model, computer consists of a collection of objects, hardware or software
- Each object has a unique name and can be accessed through a well-defined set of operations
- Protection problem - ensure that each object is accessed correctly and only by those processes that are allowed to do so

Principles of Protection

- Guiding principle – **principle of least privilege**
  - Programs, users and systems should be given just enough **privileges** to perform their tasks
  - Limits damage if entity has a bug, gets abused
  - Can be static (during life of system, during life of process)
  - Or dynamic (changed by process as needed) – **domain switching**, **privilege escalation**
  - "Need to know" a similar concept regarding access to data

Principles of Protection (Cont.)

- Must consider "grain" aspect
  - Rough-grained privilege management easier, simpler, but least privilege now done in large chunks
    - For example, traditional Unix processes either have abilities of the associated user, or of root
  - Fine-grained management more complex, more overhead, but more protective
    - File ACL lists, RBAC
- Domain can be user, process, procedure

- **Granularity** which literally means "**level or scale of detail**" and hence granularity in authorization means the level of details used to put on authorization rules for evaluating a decision to grant or deny the access.
- ***Coarse grained:***
- Assume the following permission sets which defines the access based on role assigned to the user
- **Rule 1**: The users having the role "X" can access the page "/xyz/abc" .
- **Rule 2:** The users with role "Y" can access the service "S1".
- authorization system called **Role Based Access Control system (RBAC)**

- ***Fine grained authorization:***
- Now imagine if we want to restrict the access based on other additional conditions as well for the same scenario and as per below rules :
- **Rule 1**: The service “S1” can be accessed by users
- a) Having role “Y” assigned to them **And**
  b) Belonging to region “Chicago” **And**
  c) Between 8 am to 5 pm **And**
  d) From a particular list of IPs’.

- **<u>Rule 2</u>** : The page “/xyz/abc” can be accesses by users:
- a) Having role “X” assigned to them **And**
  b) Gender is “Male” **And**
  c) Age greater than 45 **And**
  d) Qualification is “Grad” **Or** “PostGrad”.
- his granularity is achieved here by taking these attributes and it is known as **“Attribute based Access Control” (ABAC)** in today’s era.

Access Matrix

- View protection as a matrix (**access matrix**)
- Rows represent domains
- Columns represent objects
- **`Access(i, j)`** is the set of operations that a process executing in $Domain_i$ can invoke on $Object_j$

object / domain	F_1	F_2	F_3	printer
D_1	read		read	
D_2				print
D_3		read	execute	
D_4	read write		read write	

Use of Access Matrix

- If a process in Domain D_i tries to do "op" on object O_j, then "op" must be in the access matrix
- User who creates object can define access column for that object
- Can be expanded to dynamic protection
  - Operations to add, delete access rights
  - Special access rights:
    - *owner of* O_i
    - *copy op from* O_i *to* O_j *(denoted by "* *")*
    - *control –* D_i *can modify* D_j *access rights*
    - *transfer – switch from domain* D_i *to* D_j
  - *Copy* and *Owner* applicable to an object
  - *Control* applicable to domain object

Use of Access Matrix (Cont.)

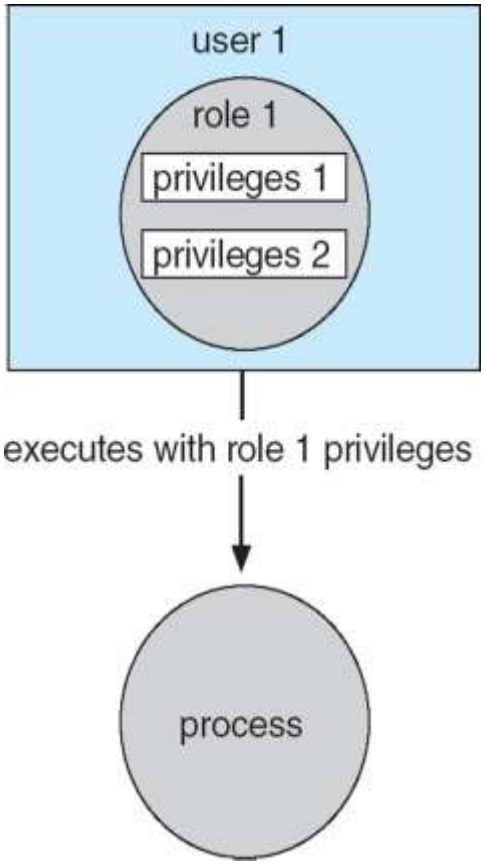
- **Access matrix** design separates mechanism from policy
  - Mechanism
    - Operating system provides access-matrix + rules
    - If ensures that the matrix is only manipulated by authorized agents and that rules are strictly enforced
  - Policy
    - User dictates policy
    - Who can access what object and in what mode
- But doesn't solve the general confinement problem

Access Matrix of Figure A with Domains as Objects

domain \ object	F_1	F_2	F_3	laser printer	D_1	D_2	D_3	D_4
D_1	read		read			switch		
D_2				print			switch	switch
D_3		read	execute					
D_4	read write		read write		switch			

Access Control

- Protection can be applied to non-file resources
- Oracle Solaris 10 provides **role-based access control** (**RBAC**) to implement least privilege
  - ***Privilege*** is right to execute system call or use an option within a system call
  - Can be assigned to processes
  - Users assigned ***roles*** granting access to privileges and programs
    - Enable role via password to gain its privileges
  - Similar to access matrix



Revocation of Access Rights

- Various options to remove the access right of a domain to an object
  - **Immediate vs. delayed**
  - **Selective vs. general**
  - **Partial vs. total**
  - **Temporary vs. permanent**
- **Access List** – Delete access rights from access list
  - **Simple** – search access list and remove entry
  - **Immediate**, **general** or **selective**, **total** or **partial**, **permanent** or **temporary**