Module 19: Protection

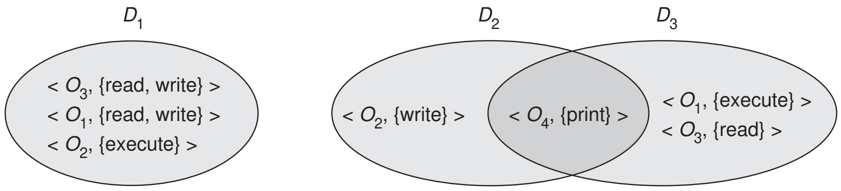
- Goals of Protection
- Domain of Protection
- Access Matrix
- Implementation of Access Matrix
- Revocation of Access Rights
- Capability-Based Systems
- Language-Based Protection

Protection

- Operating system 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.

Domain Structure

- Access-right = <object-name, rights-set>
  Rights-set is a subset of all valid operations that can be performed on the object.
- Domain = set of access-rights

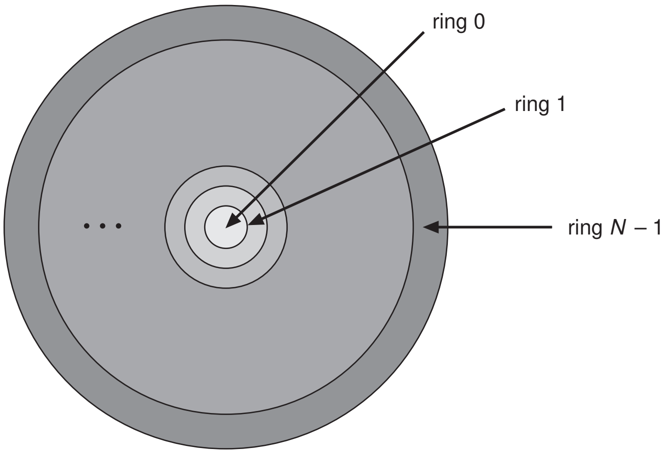


Domain Implementation

- System consists of 2 domains:
  - User
  - Supervisor
- UNIX
  - Domain = user-id
  - Domain switch accomplished via file system.
    - Each file has associated with it a domain bit (*setuid bit*).
    - When file is executed and setuid = on, then user-id is set to owner of the file being executed. When execution completes user-id is reset.

Multics Rings

- Let D_i and D_j be any two domain rings.
- If $j < i \Rightarrow D_i \subseteq D_j$.



Access Matrix

- Rows – domains
- Columns – domains + objects
- Each entry – Access rights
  Operator names

	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.
- 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
    - *control* – D_i can modify D_js access rights
    - *transfer* – switch from domain D_i to D_j

Use of Access Matrix (Cont.)

- Access matrix design separates mechanism from policy.
  - Mechanism
    - Operating system provides Access-matrix + rules.
    - It 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.

Implementation of Access Matrix

- Each column = Access-control list for one object
  Defines who can perform what operation.

  Domain 1 = Read,Write
  Domain 2 = Read
  Domain 3 = Read
  ⋮

- Each Row = Capability List (like a key)
  For each domain, what operations allowed on what objects.

  Object 1 – Read
  Object 4 – Read,Write,Execute
  Object 5 – Read,Write,Delete,Copy

Revocation of Access Rights

- Access List – Delete access rights from access list.
  - Simple
  - Immediate
- Capability List – Scheme required to locate capability in the system before capability can be revoked.
  - Reacquisition
  - Back-pointers
  - Indirection
  - Keys

Capability-Based Systems

- Hydra
  - Fixed set of access rights known to and interpreted by the system.
  - Interpretation of user-defined rights performed solely by user's program; system provides access protection for the use of these rights.
- Cambridge CAP System
  - *Data capability* – provides standard read, write, execute of individual storage segments associated with object.
  - *Software capability* –interpretation left to the subsystem, through its protected procedures.

Language-Based Protection

- Specification of protection in a programming language allows the high-level description of policies for the allocation and use of resources.
- Language implementation can provide software for protection enforcement when automatic hardware-supported checking is unavailable.
- Interpret protection specifications to generate calls on whatever protection system is provided by the hardware and the operating system.