

Module 19: Protection

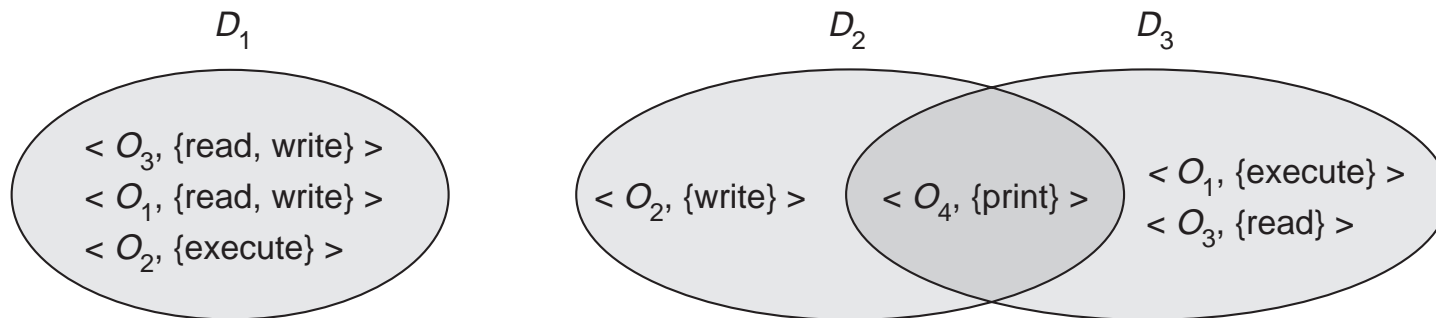
- Goals of Protection
- Domain of Protection
- Access Matrix
- Implementation of Access Matrix
- Revocation of Access Rights
- Capability-Based Systems
- Language-Based Protection

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 = $\langle \text{object-name, rights-set} \rangle$
Rights-set is a subset of all valid operations that can be performed on the object.
- Domain = set of access-rights

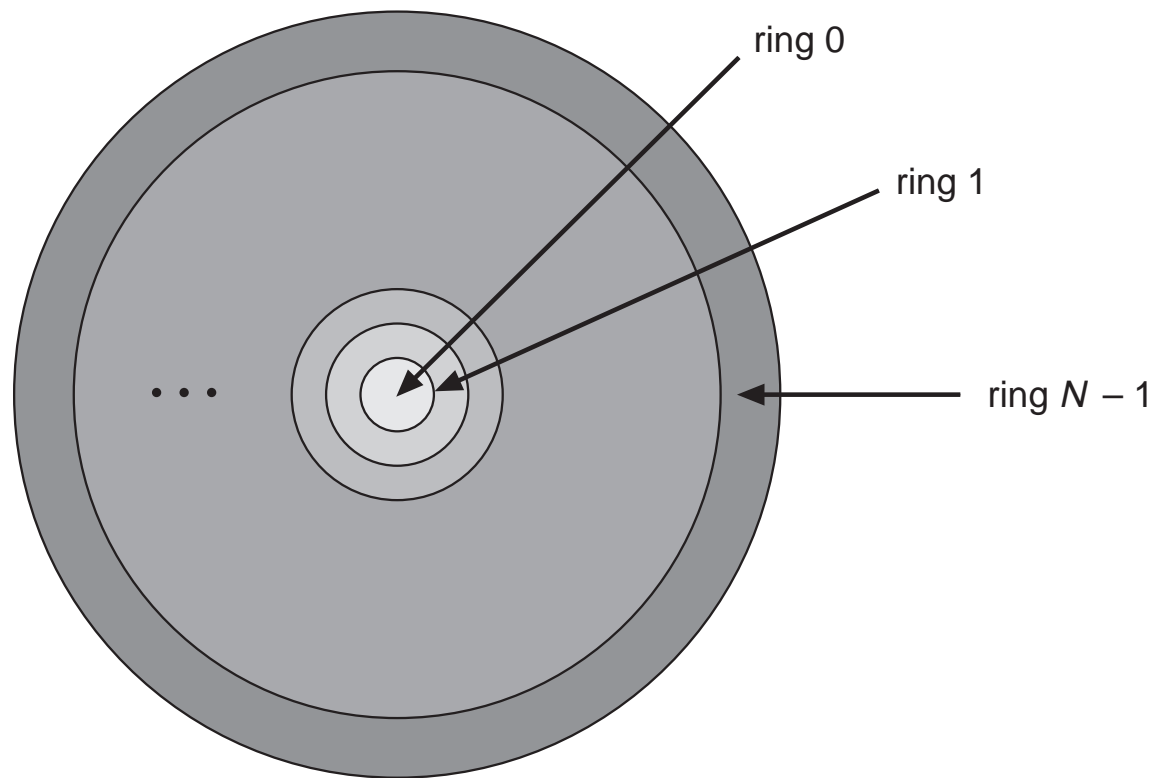


Domain Implementation

- 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_j
 - * *copy* op from O_i to O_j
 - * *control* – D_i can modify D_j 's 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

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- 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.